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

Syllabus
of

Diploma in Chemical Engineering [CHE]

Part-III (5th Semester)

Revised 2022

CURRICULAR STRUCTURE FOR PART-III (SEMESTER 5) OF THE FULL-TIME DIPLOMA COURSES IN CHEMIICAL ENGINEERING

BRANCH: **CHEMICALCAL ENGINEERING**					**SEMESTER 5**					
SL No	Category	Code No	Course Title	L	P	Total Class per week	Credit	Full marks	Internal Marks	ESE Marks
1	Program Core	CHEPC301	Mass Transfer - II	3	-	3	3	100	40	60
2	Program Core	CHEPC303	Chemical Reaction Engineering	3	-	3	3	100	40	60
3	Program Core	CHEPC305	Process Control	3	-	3	3	100	40	60
4	Program Core	CHPC307	Instrumentation	3	-	3	3	100	40	60
5	Program Elective	CHPE301	Plant Utilities/Ceramic Technology	3	-	3	3	100	40	60
6	Program Elective	CHPE303	Petroleum Refinery Engineering/Safety in Chemical Process Industries	3	-	3	3	100	40	60
7	Program Core	CHPC309	Mass Transfer Lab	-	3	3	1	100	60	40
8	Program Core	CHPC311	Chemical Reaction Engineering Lab	-	3	3	1	100	60	40
9	Major Project	PR301	Major Project	-	3	3	1	100	60	40
10	Internship	SI301	Internship - II	-	-	-	1	100	100	0
			Total	18	9	27	22	1000	520	480
STUDENT CONTACT HOURS PER WEEK: 27 hours (Lecture-18 hours; Practical-9 hours) Theory and Practical Period of 60 minutes each. FULL MARKS-1000 (Internal Marks-520; ESE Marks-480) L-Lecture, P-Practical, ESE- End Semester Examination										

Credit Distribution	**Credit**
Program Core	14
Program Elective	6
Project	1
Internship 2	1
Total	22

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)		**Credit**
1. **Plant Utilities** (Sub code: **CHEPE301/1**)	Any one	3
2. **Ceramic Technology** (Sub code: **CHEPE301/2**)		
3. **Petroleum Refinery Engineering** (Sub code: **CHEPE303/1**)	Any one	3
4. **Safety in Chemical Process Industries** (Sub code: **CHEPE303/2**)		

Total =6

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Core	Semester: **Fifth**
Code no.: **CHEPC301**	Theory: 100 Marks
Course Title: **Mass Transfer-II**	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:

1.	This subject will provide the students the basic concept of mass transfer.
2.	It will impart knowledge to understand working of mass transfer equipment used in chemical process industries.
3.	This subject will provide adequate information about the unit operations involved in Humidification, Drying, Adsorption and Crystallisation.

2. Course Outcomes:

On completion of the course, students will be able to:	
CO1	Describe the processes of humidification and dehumidification. Define absolute humidity, Dry bulb and wet bulb temperature, relative humidity, percentage saturation, humid volume, humid heat and enthalpy of a gas-vapour mixture. Use Psychometric chart for calculation of above parameters for air-water vapor mixture. Explain function of cooling tower, spray chamber and spray pond.
CO2	Describe the process of drying. Define moisture content – equilibrium, bound, unbound and free moisture Explain their graphical representation. Explain the rate of drying curve for batch drying - initial adjustment, constant rate period and falling rate period. Calculate drying time for batch drying. Explain the function of direct heat and indirect heat dryers; such as tray dryer, rotary dryer and spray dryer.
CO3	Describe some commercial adsorbents and their applications, Explain the required characteristics and properties of adsorbents. Describe the process of adsorption and adsorption equillibria. Define percolation and elution. Explain fixed bed and continuous adsorbers. Calculate some basic calculation on adsorption.
CO4	Define crystal geometry, crystal size and shape factor. Describe the process of crystallization and nucleation Describe the rate of crystallization and its controlling technique, Explain the effect of temperature and impurities on crystal formation. Explain the function of vacuum, draft and growth type crystalliser. Calculate the yield of crystal.

3. Pre-Requisites:

1.	Knowledge of basic concept on physics, Chemistry and Mathematics.
2.	Idea about basic separation processes.

4. Theory Components:

Unit	Description	Contact hours
Unit 1 HUMIDIFICATION	Concept of absolute humidity, Dry and wet bulb temperature, relative humidity, percentage saturation, humid volume, humid heat and enthalpy of a gas-vapour mixture. Application of Psychometric chart. Concept of humidification & dehumidification. Basic idea about cooling tower, spray chamber & spray pond. Simple numerical problems	12
Unit 2 DRYING	Concept of moisture content – equilibrium, bound, unbound and free moisture and their graphical representation. Concept of drying, constant drying condition, rate of drying curve for batch drying- initial adjustment, constant rate period, falling rate period, Calculation of drying time for batch drying. Simple numerical problems. Concept of direct heat and indirect heat dryers. Basic idea about tray dryer, rotary dryer and spray dryer.	12
Unit 3 ADSORPTION	Commercial Adsorbents and their applications. Characteristics and properties of adsorbents. Concept of adsorption and adsorption equillibria. Concept of percolation and elution. Batch adsorption in a stirred vessel. Basic idea about fixed bed and continuous adsorbers. Simple numerical problems	12
Unit 4 CRYSTALLIZATION	Crystal geometry, crystal size and shape factor. Concept of crystallization and nucleation, Rate of crystallization and its controlling technique. Effect of temperature and impurities on crystal formation. Basic concept about vacuum, draft and growth type crystalliser. Simple numerical problems.	9
Sub Total: 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 Mass Transfer-II. 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 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 least one 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		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

9. Suggested Learning Resources:

Sl. No	Book Title	Author	Publisher
1	Principles of Mass Transfer and Separation Processes	B. K. Dutta	Prentice Hall of India
2	Mass Transfer Operations	Treybal	Mc Graw-Hill Book Co. Ltd., New York and Kogakusha Co Ltd., Tokyo.
3	Unit Operations of Chemical Engineering	Mc Cabe and Smith	Mc Graw-Hill Book Co. Ltd., New York and Kogakusha Co. Ltd., Tokyo.
4	Introduction to Chemical engineering	Badger and Banchero	McGraw-Hill Book Co. Ltd., New York and Kogakusha Co. Ltd., Tokyo
5	Introduction to Chemical Engineering	Ghosal, Sanyal, Dutta	Tata Mc Grow-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: Program Core	Semester: **Fifth**
Code no.: **CHEPC303**	Theory: 100 Marks
Course Title**: Chemical Reaction Engineering**	Examination Scheme: i) External Assessment: 60 Marks (End Semester Examination)
Duration: 17 weeks	
Total lecture class/week: 3	ii) Internal Assessment:40 Marks [Class Test: 20 Marks Assignment/Viva voce/Quizzes: 10 Marks Class attendance : 10 Marks]
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.	To impart the knowledge of reaction mechanism and kinetics.
2.	Ideas on different type of industrial reactors.
3.	Process design of reactors of different types.

2. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Classify chemical reactions, factors affecting the rate of reaction, and the effect of temperature on rate of reaction.
CO2	Analyze the experimental data for determining the order of reaction and reaction rate constant.
CO3	Ability to relate rate of reaction with design equation for reactor sizing.
CO4	Illustrate with the comparisons of ideal reactor types (batch, plug flow, mixed flow).
CO5	Explain the fundamental concept of Catalyst and catalytic reactor.

3. Pre-Requisites:

1.	Knowledge of basic concept on physics, Chemistry and Mathematics.
2.	Knowledge on basic chemical reaction and catalyst.

4. Theory Components:

Unit	Description	Teaching Hours
Unit I: KINETICS OF HOMOGENOUS REACTIONS	Introduction. Basic idea on Single and Multiple Reactions, Homogeneous and heterogeneous reactions, Elementary and Non-elementary Reactions. Concept of the Rate Equation. Molecularity and Order of Reaction. Heat of reaction-Endothermic reaction and Exothermic reaction. Temperature-dependent term of a rate equation-Temperature Dependency from Arrhenius' Law, collision theory, transition state theory. Concept of equilibrium constant- Van't Hoff Equation.	12
Unit II: INTERPRETATIONS OF BATCH REACTOR DATA	Idea on Batch Reactor including performance equation. Varying-Volume Batch Reactor and its performance equation. Integral Method of Analysis of Batch Reactor Data and related problems. Irreversible Unimolecular-Type First-Order Reactions. Irreversible Bimolecular-Type Second-Order Reactions. Zero-Order Reactions. Overall Order of Irreversible Reactions from the Half-Life. Irreversible Reactions in Series and parallel. First-Order Reversible Reactions.	12
Unit III: CONTINUOUS REACTORS	Concept on continuous stirred-tank reactor (CSTR) and plug flow reactor (PFR). Space-Time or Residence Time. Performance equation for steady-state CSTR and steady-state Plug Flow Reactor (PFR) and related problems.	12
Unit IV: CATALYSTS AND CATALYTIC REACTIONS	Catalysis. Homogeneous and heterogeneous Catalysis. Basic concept on Autocatalytic Reactions. Theory on heterogeneous catalytic reaction. Importance of adsorption in solid catalysis. Rate of a catalytic reaction and related problems. Performance equations for reactors containing porous catalyst particles. Concept on Thiele modulus, catalyst effectiveness factor. Differential Reactor and Integral Reactor. Concept on Mixed Flow Catalytic Reactor. Basic concept on Trickle Bed Reactor and Fluidized Bed Reactor (only description).	9

Sub Total: 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 Chemical Reaction Engineering. 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 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 least one 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		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

9. Suggested Learning Resources:

Sl. No.	**Title of Book**	**Name of Authors**	**Publisher**
1.	Chemical Reaction Engineering	Octave Levenspiel	Wiley Easter Ltd., New York.

2.	A Text book of Chemical Reaction Engineering	S C Roy and C Guha	Dhanpat Rai & Co. (P) Ltd.
3.	Elements of Chemical Reaction Engineering	H. Scott Fogler	Prentice Hall International Series

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Core	Semester: **Fifth**
Code no.: **CHEPC305**	Theory: 100 Marks
Course Title: **Process control**	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:

1.	To study the transfer function of first order and second order system along with mathematical modeling.
2.	To understand the concept of stability of a control system

2. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Calculate the Laplace transform and the inverse Laplace transform
CO2	Formulate the mathematical model of a system Calculate steady state gain and steady state error of a system
CO3	Calculate the time required for ultimate response for first order system Calculation of transportation Lag of a system
CO4	Determine the stability of a system

3. Pre-Requisites:

1	Knowledge of basic concepts of sciences such as physics.
2	Basic Knowledge of differential and integral Calculus.
3	Fundamentals of Fluid Mechanics

4. Theory Components:

Content	**Description**	Hrs./Unit
Unit: 1: Laplace transforms & Inverse Laplace Transforms:	Introduction & Definition of Laplace Transform, Existence of Laplace Transform, Linear property of Laplace Transformation, Shifting Property of Laplace Transformation, Change of Scale Property, Laplace transform on derivative, Laplace transform on Integrals, multiplication by t^n, Division by t, Laplace transformation of Periodic Function, Laplace Transformation on Unit Step Function Inverse Laplace Transforms: Definition, Lerch's Theorem,	12

	Linear Property of Inverse Laplace Transform, shifting property of Inverse Laplace Transform, change of scale, Property of Inverse Laplace Transform, Inverse Laplace transform on derivatives, multiplication by S^n, Division by S, Inverse Laplace Transform of Integrals, Convolution Property of Inverse Laplace Transform, Method of Partial Fraction to find Laplace Inverse Transform	
Unit 2: Introductory concepts:	Importance of Process Control, Mathematical Modelling of a system, Initial Value Theorem, Final Value Theorem Dynamic behaviour of systems – First order system, derivation of transfer functions for first order system, Poles and Zeros of a Transfer Function, Qualitative Analysis of the response of a system Transient response of first order system, forcing functions, Step response, Impulse Response, Ramp Response, Sinusoidal Response.	10
Unit 3: Examples of first order system	liquid level, temperature, pressure, flow and concentration control processes, linearization of nonlinear systems, interacting and non-interacting systems.	**8**
Unit 4: Higher order system:	second order systems, natural frequency, damping factor, overshoot, decay ratio, rise time and settling time, Transportation Lag. (Only definition and simple formula-based problems)	**6**
Unit 5: Concept of Feedback Control & Stability	Types Feedback controllers, Block Diagram and The Closed loop Response, Effect of Proportional Control on the Response of a Controlled Process, Effect of P, I, D, PI, PD, PID control actions Definition of stability of control systems, Stability Criterion, Routh Test for Stability.	**10**
Sub Total: 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 Process control. 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 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 least one 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	6×5=30

	from each unit).	

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

Sl No.	Performance Indicators		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

5. Suggested Learning Resources:

Sl. No.	**Title of Book**	**Name of Authors**	**Publisher**
1	Process System Analysis and Control	Coughanowr	McGraw-Hill co. New Delhi
2	Chemical Process Control- An Introduction to theory and Practice	Stephanopoulos	Prentice Hall of India Pvt.Ltd., New Delhi
3	Automatic Process Control	Eckman	Wiley Eastern Pvt. Ltd., NewDelhi
4	Principles of Process Control	Patranobis	Tata McGraw-Hill Pub. Co.Ltd., New Delhi

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Core	Semester: **Fifth**
Code no.: **CHEPC307**	Theory: 100 Marks
Course Title: **Instrumentation**	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:

1.	To study the transfer function of first order and second order system along with mathematical modelling.
2.	To understand the concept of stability of a control system

2. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Explain various elements of an instrument and their functions. Describe the basic characteristics of Instruments.
CO2	Explain the working principles of pressure measuring devices such as Manometers, Bourdon gauge, Mc Leod gauge, Pirani gauge and ionization gauge, strain gauge, Linear Variable Differential Transformer.
CO3	Describe the working principles of important temperature measuring devices such as bimetallic thermometer, liquid in glass and liquid in metal thermometer, gas thermometers, vapour pressure thermometer, Resistance thermometer, thermocouples, Thermistor, Radiation and optical pyrometer.
CO4	Explain the working principles of important flow measuring devices such as orifice meter, Venturi meter, Pitot tube, rotameter, notches and weirs, turbine flow meter, Target flowmeter, electromagnetic flowmeter, heat transfer flowmeter, hot wire anemometer, Doppler flowmeter Nutating disc meter, rotating vane meter and Lobed impeller meter.
CO5	function of important instruments such as Chemical composition analyzer, oxygen analyzer, moisture eter, refractometer, polarimeter, thermal conductivity meter, hydrometer which are used in different

3. Pre-Requisites:

1	Knowledge of basic concepts of sciences such as physics.
2	Basic Knowledge of differential and integral Calculus.

4. Theory Components:

Content	Description	Hrs./Unit
Unit 1 Introduction	Importance of instruments in different chemical process industries. Functional Elements of instruments and their Performance characteristics.	5
Unit 2 Pressure measurement	Manometers–U tube, well tube, enlarged leg, inclined tube, inverted U tube. Elastic type–Bourdon gauge, diaphragm element, bellows element and bell gauge. Vacuum type–Mc Leod gauge, Pirani gauge and ionization gauge. Electrical type–resistive- strain gauge and potentiometric, inductive- Linear Variable Differential Transformer, and capacitive.	9
Unit 3 Temperature measurement	Expansion Thermometers-Solid expansion type – bimetallic thermometer, Liquid expansion type – liquid in glass and liquid in metal thermometer, gas expansion type- gas thermometers. Filled system thermometers – Liquid filled thermometers, vapour pressure thermometer. Electrical type – Resistance thermometer, thermocouples, Thermistor, Radiation and optical pyrometer.	9
Unit 4 Flow measurement	Orifice meter, Venturi meter, Pitot tube, rotameter, notches and weirs – rectangular, vee and trapezoidal notches. Electrical type – turbine flow meter and Target flowmeter, electromagnetic flowmeter, Thermal flowmeters- heat transfer flowmeter and hot wire anemometer, Ultrasonic flow meter - time difference type and Doppler flowmeter. Mass flow meter – positive displacement type- Nutating disc meter, rotating vane meter, Lobed impeller meter.	9
Unit 5 Liquid level measurement	Direct methods- Hook type level indicator, sight glass, Float type and displacer type level indicator. Indirect methods- Hydrostatic pressure type and Electrical methods. Hydrostatic pressure type – Pressure gauge method, Air bellows and Air purge system. Electrical methods – Capacitance level indicator and radiation level detector.	8
Unit 6 Other instruments	Chemical composition analyzer, oxygen analyzer, moisture meter, pH meter, refractometer, polarimeter, thermal conductivity meter, hydrometer.	5
Sub Total: 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 Instrumentation. 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 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 least one 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		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

9. Suggested Learning Resources:

Sl. No	Book Title	Author	Publisher
1	Industrial Instrumentation and Control	S. K. Singh	Tata Mc Graw Hill Pub. Co. Ltd., New Delhi
2	Principles of Industrial Instrumentation	D. Patranobis	Tata Mc Graw Hill Pub. Co. Ltd., New Delhi
3	Measurement Systems-Application & Design	Doeblin	Mc Graw-Hill Kogakusha, Ltd., New Delhi
4	Industrial Instrumentation	Eckman	Wiley Eastern Pvt. Ltd., New Delhi

Name of the Course: **Diploma in Chemical Engineering**	
Category: Program Elective	Semester: **Fifth**
Code no.: **CHEPE301/1**	Theory: 100 Marks
Course Title: **Plant utilities** Duration: 17 weeks Total lecture class/week: 3 Credit: 3	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]
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.	To understand different processes and their utilities in relevant industry.
2.	To understand waste and disposal methods

2. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Explain relevant parameters required for water treatment in corresponding equipment.
CO2	Perform Energy balance around boilers and application of steam table
CO3	Perform energy balance around refrigerators and choose suitable refrigerant
CO4	Describe scaling up and choosing suitable techniques for waste disposal

3. Pre-Requisites:

1.	Knowledge of basic concepts of sciences such as physics.
2.	Basic Knowledge of differential and integral Calculus.
3	Fundamentals of Fluid Mechanics, heat transfer and mass transfer.

4. Theory Components:

Content	Description	Hrs./Unit
Unit 1: IMPORTANCE OF UTILITIES	Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.	12
Unit 2: STEAM AND STEAM GENERATION	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. Scaling and Trouble Shooting. Steam Traps and Accessories.	10

Unit 3: REFRIGERATION	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.	**8**
Unit 4: COMPRESSED AIR	Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Slip Factor, Impeller Blade Shape. Properties of Air –Water Vapours and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.	**6**
Unit 5: FUEL AND WASTE DISPOSAL	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. Waste Disposal.	**9**
Sub Total: 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 Plant utilities. 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 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 least one 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		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied

			to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

9. Suggested Learning Resources:

Text and reference books:			
Sl. No.	Title of the Book	Name of Authors	Publisher
1.	Thermal Engineering	P. L. Ballaney	Khanna Publisher New Delhi.
2.	Plant utilities	D B DHONE	Nirali Prakashan.
3.	Basic Refrigeration & Air-Conditioning	P. N. Ananthanarayan,	Tata McGraw Hill, New Delhi.
4.	Refrigeration & Air-Conditioning,	Sadhu Singh,	Khanna Publishing House. New Delhi

Name of the Course**: Diploma in Chemical Engineering**	
Category: **Program Elective**	Semester**: Fifth**
Code no.: **CHEPE301/2**	Theory: 100 Marks
Course Title: **Ceramic 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:

1.	This subject will provide the knowledge of Ceramic industry
2.	This subject will give the idea about the raw materials and products of Ceramic industry.
3	It will help a student to deal with the of Fabrication methods of ceramic products.
4	It will impart knowledge on the analysis of chemical process from engineering & technical viewpoints.

2. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Classify ceramic materials and point out application areas
CO 2	Identify equipments required in operation along with relevant parameters
CO 3	Explain methods for fabrication of ceramic materials.
CO 4	Choose proper refractories for appropriate operations
CO 5	Describe glass fabrication process and Porcelain production

4. Theory Components:

Unit	Description	Contact hours
Unit1: Introduction to Ceramics	Concept of ceramic materials Classification of ceramic materials. Composition, properties & application of ceramic Materials.	4
Unit2: Beneficiation Process	Definition of Beneficiation, Objective of Beneficiation The operations involved in the beneficiation step of ceramic materials Comminution techniques followed in ceramic industry. Names of Equipment used in Comminution Working principle of some comminution equipments: Jaw crusher, Cone crusher, Gyratory crusher, Ball mill, Attrition mill (Details not necessary)	6
Unit3: Fabrication and Forming of Ceramics	Basic steps involved in fabrication of ceramic objects Forming processes : Concept of Dry pressing , Cold isostatic pressing , Plastic forming: Concept of Extrusion, Jiggering, Casting process: Slip casting, Drying process: Factors affecting in drying, Mechanism of Spray Drying, (Details not necessary) Concept of Firing techniques, Sintering, Vitrification and Cooling. Concept of Glazing and ceramic glaze defects.	12
Unit4: Introduction to Refractories	Definition of Refractories, Classification of Refractories, Raw materials of refractory materials. Properties of refractory materials. General method of manufacture of refractory. Applications of some following refractories: Acid (Silica) Refractories, Basic Refractories, Insulating refractories, Special refractories, Neutral refractories. Selection of refractories.	8
Unit 5 : Introduction to Cement Technology	Concept of cement. Types of Cement. Properties of cement, Raw materials of Cement and manufacturing processes of Portland cement. Reactions occurred in different zones of Rotary Kiln for manufacturing of Portland Cement, Working principles of Rotary kiln, Refractory used in Rotary Kiln.	7
Unit 6: Glass & Porcelain Industry	Definition of Glass. Types of Glass. Elementary properties of Glass (Details not necessary). Concept of vitrification of glass. Glass processing: Raw materials, Melting of raw materials, Forming Processes: Blowing, Moulding, Shaping, Refining of Glass (Testing of properties are not necessary). Definition of Whitewares. Raw materials, Composition and Classification of Whiteware. Porcelain production process: Raw materials, Clay beneficiation step, Porcelain processing technology.	8
Sub Total: 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 Ceramic Technology. 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 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 least one 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	Accomplishing assigned problem
3	Presentation Skill
4	In Time submission of Assignment report / micro-project task
5	Viva-voce or Quizzes

9. Suggested Learning Resources:

Sl. No	Book Title	Author	Publisher
1	Elements of Ceramics	F.H Norton	Longman Higher Education
2	Introduction to Ceramics	W.D. Kingery	Wiley India Pvt. Ltd
3	Industrial Ceramics	Singer & Singer	Chapman and Hall
4	The Technology of Ceramics and Refractories	P.P Budnikov	MIT Press
5	Cement Chemistry	F.W.H. Taylor	Thomas Telford Ltd

Name of the Course**: Diploma in Chemical Engineering**	
Category: **Programme Elective**	Semester : **Fifth**
Code no. : **CHEPE303/1**	Theory : 100 Marks
Course Title **: Petroleum Refinery Engineering**	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 Outcomes**: On completion of the course , students will be able to :

Sl No	Course Outcomes
i)	Explain origin and composition of petroleum
ii)	Describe distillation processes of crude petroleum.
iii)	Explain different purification processes of petroleum product with necessary flowchart

iv)	Discuss the important properties of petroleum products
v)	Describe different cracking and reforming processes in petroleum industry with necessary flowchart

2. Theory Components:

Unit	Topics & Sub-topics	Teaching Hours
Unit 1 : INTRODUCTION	Origin of Petroleum. Composition of Petroleum Classification of Petroleum Nature of Indian Crude. Name of some important Petroleum Products and their uses.	**3**
Unit: 2: PROCESSING OF CRUDE OIL	Concept of pre-treatment of crude oil: Electrical Dehydration of crude oil, Desalting of Crude oil, Stabilization of crude oil, Heating of Crude oil Working principle of Pipe Still Heater. Description of Single Stage, Two Stage & Three Stage distillation Unit with diagram. Atmospheric & Vacuum distillation unit with diagram.	**6**
Unit 3: PURIFICATION OF PETROLEUM PRODUCTS.	Objective of purification of petroleum products Sweetening process : Description of Doctor' Sweetening Process, Copper Chloride Sweetening process, Solutizer Process, Catalytic Desulphurisation process, Hydrofining Desulphurisation process. Dewaxing process: Description of Chilling & Pressing process, Solvent Dewaxing (MEK & Propane) process, Urea dewaxing process. Deoiling of wax : Sweating , Settling and Solvent deoiling process Acid, Alkali & Clay treatment of Petroleum products. Concept of Deasphalting Description of Propane deasphalting process. Description of Dearomatisation of Kerosene (Edeleanu Process) Concept of some other Solvent Extraction Process; Furfural Extraction, Phenol Extraction, Duo- Sol Extraction, Udex (Glycol) Extraction Process.	**12**
Unit 4: PROPERTIES OF PETROLEUM PRODUCTS	Concept of some important properties of petroleum products: Specific Gravity, Molecular Weight, Vapour Pressure, Kinematic viscosity (by Red Wood Viscometer), Viscosity Index, Flash Point (by Pensky Martin's apparatus), Fire Point, Cloud Point, Pour Point, Freezing Point, Smoke Point, Char Value, Carbon Residue, Aniline Point, Diesel Index, Octane Number, Cetane Number, Performance Number, Emulsification, Oxidation Stability, Distillation Range, Sulphur Content, Moisture Content (Dean & Stark apparatus), Sediment, Calorific Value and Ash in Petroleum Products.	**10**
Unit 5: CRACKING	Concept of Cracking Types of Cracking Influence of Various parameters in Cracking. Thermal Cracking Processes: Description of Pyrolysis, Visbreaking and Delayed coking). Catalytic Cracking Processes : Feed for catalytic cracking, Catalysts used in catalytic cracking, Catalytic cracking reaction, Description of Thermofer Catalytic Cracking (TCC) Moving Bed Process, Single Stage Fluidised Bed Catalytic Cracking (FCC) process, Hydrocracking.	**7**
Unit 6: REFORMING :	Concept of Reforming. Feed for Reforming, Reforming Reactions Types of Reforming. Thermal reforming. Catalytic reforming: Reactions involved, Effect of Variables in Catalytic Reforming. Description of commercial catalytic Reforming processes: Non–Regenerative Fixed Bed Platforming process, Regenerative fixed Bed Hydroforming process, Thermofer Catalytic Reforming (TCR) Moving Bed process, Fluidised Bed Hydroforming process.	**7**
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 Petroleum Refinery Engineering. He or She may also conduct Viva-Voce or Quizzes for the students based on the different units of Petroleum Refinery 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 3 hours**]**

Question Type	Marks
Objective type questions carrying 1 mark for 20 questions (QSs) out of 25 Qs throughout the syllabus.	1 X 20 = 20
Questions carrying 2 marks for 5 Qs out of 8 Qs (at least 1 Q from each unit)	2 X5 =10
Q s carrying 6 marks for 5 Qs (Subjective type) out of 8Qs (at least 1 Q from each unit)	6 X 5 = 30
	Total = 60

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

Sl No.	**Performance Indicators**
1	Sketch Flow sheet for different processing of Petroleum
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.	Modern Petroleum Refining Processes	Rao	Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2.	Petroleum Refinery Engineering,	Nelson	McGraw-Hill Book Co., Inc., New York and Kogakusha Co. Ltd., Tokyo.

3.	Elements of fuels, furnaces and refractories.	Gupta	Khanna Publishers, Delhi
4.	Petroleum Processing	Hengstebeck	McGraw-Hill Pub. Co. Ltd., New York
5	Indian Petroleum Handbook, Petroleum Information Service	Petroleum Information Service	11,Parliament Street, New Delhi
6	Outlines of Chemical Technology	Dryden	Affiliated East-West Press Pvt. Ltd., New Delhi
7	Introduction to Chemical Engineering	Ghosal ,Sanyal & Dutta	Tata McGraw-Hill Pub. Co. Ltd., New Delhi
8	Petroleum Refining Technology	Dr. Ram Prasad	Khanna
9	Petroleum Refining and Petrochemicals	N.K. Sinha	Umesh Publications

Name of the Course: **Diploma in Chemical Engineering**	
Category: **Program Elective**	Semester: **Fifth**
Code no.: **CHEPE 303/2**	Theory: 100 Marks
Course Title: **Safety in Chemical Process Industries**	Examination Scheme: i) External Assessment: 60 Marks (End Semester Examination)
Duration: 17 weeks	
Total lecture class/week: 3	ii) Internal Assessment: 40 Marks [Class Test: 20 Marks Assignment/Viva voce/Quizzes: 10 Marks Class attendance: 10 Marks]
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 knowledge of safety issues in industry
2.	This subject will give the idea about the hazard identifications in industry.
3	It will help a student to deal with risk analysis in industry.
4	It will impart knowledge of safety protocols and waste disposal.

2. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Identify safety issues
CO 2	Perform risk analysis and assessment
CO 3	Perform hazard identification
CO 4	Design safe waste disposal methodology
CO 5	Design safe operation protocols

4. Theory Components:

Unit	Description	Contact hours
Unit 1:	Hazard identification methodologies, risk assessment methods - PHA, HAZOP, MCA, ETA, FTA, consequence analysis,	6
Unit 2:	Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the above situations.	8
Unit 3:	Workers' exposures to hazardous chemicals, TLVs of chemicals, physical and chemical properties of chemicals leading to accidents like fire explosions, ingestion and inhalation, pollution in work places due to dangerous dusts, fumes and vapours, guidelines and safe methods in chemicals handling, storage and entry into confined spaces.	12
Unit 4:	Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries.	12
Unit 5:	Safety education and training - safety management, fundamentals of safety tenets, measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audit.	7
Sub Total : 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 Safety in Chemical Process Industries. 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 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 least one 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		
	Exceeds expectation (5)	Meets expectation (3)	Does not meet expectations (1)
1.			
3. Problem setup	Problems are translated into proper mathematical forms which are ready to be solved.	Problems are translated into mathematical forms which are ready to be solved with minor errors	Unable to translate problem into proper mathematical forms
4. Mathematical modeling	Combines mathematics and/or scientific principles to formulate models of thermodynamics;	Chooses, rather than develops, a mathematical model and/or scientific principle that applies to thermodynamics	Does not understand the connection between a mathematical model and/or scientific principles applied to thermodynamics
5. Engineering problem solving	Executes calculation correctly by hand and/or using math/engineering software	Minor errors in calculations by hand or using math/engineering software	Calculations not performed or performed totally incorrectly by hand or does not know how to use math/engineering software

9. Suggested Learning Resources:

Sl. No	Book Title	Author	Publisher
1	Chemical Process Safety Fundamentals with Applications	Daniel A. Crowl, Joseph F. Louvar	Pearson Education
2	Chemical Process Safety Learning from Case Histories	Roy E. Sanders	Butterworth-Heinemann
3	Hazards and Safety in Process Industries Case Studies	Mihir Kumar Purkait, Piyal Mondal, Murchana Changmai, Vikranth Volli, Chi-Min Shu	CRC Press
4	Safety in the Process Industries	Ralph King	Elsevier Science
5	Process Safety for Engineers	CCPS (Center for Chemical Process Safety)	Wiley

Name of the Course: **Diploma in Chemical Engineering**	
Category: **Program Core**	Semester: **Fifth**
Code no.: **CHEPC309**	Practical: **100** Marks
Course Title: **Mass Transfer Laboratory** Duration: 17 weeks Total lecture class/week: 3 Credit: 1	**Examination Scheme:** **i) Internal Assessment: 60** Marks **[**Continuous assessment of class performance and in the time of 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 Objectives:

1.	Proper handling of instruments.

2.	Measuring physical quantities accurately.
3.	To observe the phenomenon and to list the observations in proper tabular form.
4.	To adopt proper procedure and precautions while performing the experiment.
5	To plot the graphs
6	To verify the principles, laws, using given instruments under different conditions.

2. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Illustrate proper procedure and precautions while performing the experiment.
CO2	Analyze the experimental data to obtain the relevant mass transfer equations.
CO3	Observe of the phenomenon and to list the observations in proper tabular form.
CO4	Validate the principles, laws, using given instruments under different conditions.

3. Pre-Requisites:

1.	Knowledge of basic concept on physics, Chemistry and Mathematics.
2.	Knowledge on basic mass transfer operations.

4. 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 the Experiment
1	To determine molecular diffusivity of a volatile substance through a non-diffusing gas.
2	To verify Rayleigh's equation for batch distillation of a binary mixture.
3	To determine the partition coefficient of benzoic acid between water and benzene at room temperature.
4	To study wetted wall columns.
5	To study mass transfer in a spray tower.
6	To study azeotropic distillation.
7	Determination of wet bulb depression from thermometer and comparing with theoretical values.
8	Determination of humidity from psychrometric chart using dry and wet bulb thermometer.
9	Plotting of drying rate curve for atmospheric drying.
10	Plotting of drying rate curve for drying in hot air oven.
11	To determine the solubility of a substance at room temperature and also to draw its solubility curve.
12	To determine the adsorption isotherm of acetic acid by activated charcoal
13	Study of the adsorption of oxalic acid in aqueous solution on charcoal and prove the validity of Freundlich's adsorption isotherm and Langmuir adsorption isotherm.
14	To determine the solubility of a substance in water at three different temperatures and calculate its enthalpy of solution.

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

Sl No.	Performance Indicators
1	Awareness about the significance of particular test
2	Presentation Skill
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

6. Suggested Learning Resources:

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

<table>
<tr><td colspan="2">Name of the Course: Diploma in Chemical Engineering</td></tr>
<tr><td>Category: Program Core</td><td>Semester: Fifth</td></tr>
<tr><td>Code no.: CHEPC311</td><td>Practical: 100 Marks</td></tr>
<tr><td>Course Title: Chemical Reaction Engineering Laboratory
Duration: 17 weeks
Total lecture class/week: 3
Credit: 1</td><td>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 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>

7. Course Objectives:

1.	Proper handling of instruments.
2.	Measuring physical quantities accurately.
3.	To observe the phenomenon and to list the observations in proper tabular form.
4.	To observe the Reactions involved in the experiments.

8. Course Outcomes:

On completion of the course, students are expected to:	
CO1	Illustrate proper procedure and precautions while performing the experiment.
CO2	Analyze the experimental data to obtain the reaction rate expression (reaction order and specific reaction rate constant).
CO3	Observe of the phenomenon and to list the observations in proper tabular form.
CO4	Validate the principles, laws, using given instruments under different conditions.

9. Pre-Requisites:

1.	Knowledge of basic concept on physics, Chemistry and Mathematics.
2.	Knowledge on basic chemical reaction and titration.

10. Suggested Assignments for Continuous Assessment:

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

Experiment No.	Name of the Experiment
1	Determination of reaction rate constant for the Hydrolysis of Ethyl Acetate catalyzed by Hydrochloric Acid (1st order) in a Batch Reactor.
2	Determination the order of reaction (n) and the reaction rate constant (k) for the given saponification reaction of ethyl acetate in aqueous sodium hydroxide solution in a Batch Reactor.
3	Determination of the rate constant of the Hydrolysis of Methyl Acetate in presence of an Acid Catalyst
4	To study the influence of Ionic strength on reaction between Potassium Persulphate and Potassium Iodide solution.
5	To study the kinetics of decomposition of Hydrogen peroxide in presence of Potassium Iodide.
6	To study the kinetics of Iodination of Acetone.

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

Sl No.	Performance Indicators
1	Awareness about the significance of particular test
2	Presentation Skill
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

6. Suggested Learning Resources:

Sl. No.	Title of Book	Name of Authors	Publisher
1.	Chemical Reaction Engineering	Octave Levenspiel	Wiley Easter Ltd., New York.

2.	A Text book of Chemical Reaction Engineering	S C Roy and C Guha	Dhanpat Rai & Co. (P) Ltd.
3.	Elements of Chemical Reaction Engineering	H. Scott Fogler	Prentice Hall International Series

Name of the Course: **Diploma in Chemical Engineering**	
Category: **Programme Core**	**Semester: Fifth**
Code no.: **PR301**	Laboratory: **100** Marks
Course Title: **Major Project**	Examination Scheme: i) External Assessment: 40 Marks (End Semester Examination) ii) Internal Assessment: 60 Marks [Class Test: 40 Marks Assignment/viva voce: 10 Marks Class attendance: 10 Marks]
Duration: 17 weeks	
Total lecture 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. Students should submit two separate reports one based on the general experiments carried out and another on the assigned project work.	

1. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Understand and apply the concept of designing experiments
CO 2	Analysis of generated data
CO 3	Compare the generated data with related findings available in the literature
CO 4	Display the findings in form of technical report and presentation

2. Contents

Sl. No	Name of Experiment
1	General Experiments related to chemical engineering
2	Performing experiments/simulations related to assigned projects

3. Suggested Home Assignments/Students' Activities: Will be decided by the respective Lecturer

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)

7. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication

1	Research Methodology: Methods and Techniques	C.R. Kothari Gaurav Garg	New Age International Publishers

Name of the Course: **Diploma in Chemical Engineering**	
Category: **Programme Core**	Semester: **Fourth**
Code no.: **PR301**	Laboratory: 100 Marks
Course Title: **Major Project** Duration: 17 weeks Total lecture class/week: 3 Credit: 1	Examination Scheme: i) External Assessment: 40 Marks (End Semester Examination) ii) Internal Assessment: 60 Marks [Class Test: 40 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. Students should submit two separate reports one based on the general experiments carried out and another on the assigned project work.	

1. Course Outcomes:

On completion of the course, the students will be able to	
CO 1	Understand and apply the concept of designing experiments
CO 2	Analysis of generated data
CO 3	Compare the generated data with related findings available in the literature
CO 4	Display the findings in form of technical report and presentation

2. Contents

Sl. No	Name of Experiment
1	General Experiments related to chemical engineering
2	Performing experiments/simulations related to assigned projects

3. Suggested Home Assignments/Students' Activities: Will be decided by the respective Lecturer

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)

7. Suggested Learning Resources:

Sl. No.	Title of Book	Author	Publication
1	Research Methodology : Methods And Techniques	C.R. Kothari Gaurav Garg	New Age International Publishers

Name of the Course: **Diploma in Chemical Engineering**	
Category: **Programme Core**	Semester: **Fifth**
Code no.: **SI301**	Laboratory: 100 Marks
Course Title: **Internship II**	Examination Scheme: i) External Assessment: 40 Marks (End Semester Examination) ii) Internal Assessment:60 Marks [Class Test: 40 Marks Assignment/viva voce: 10 Marks Class attendance:10 Marks]
Duration: 17 weeks	
Total lecture class/week:	
Credit:1	
Pass Criterion: Students have to obtain at least 40% marks (pass marks) in both internal assessment and end semester examination separately.	

2. 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 modeling of chemical engineering problems

3. Contents

Sl. No	Description of work (any one of the following activities must be performed)
1	Student must undergo 2–6-week vocational training at a working chemical plant/industry. Prepare a detailed technical report of the training
2	Student may undergo online certification course from reliable platforms under one of the following probable topics • Aspen Plus simulation Software: a basic course for beginners • Optimization in chemical engineering • Mathematical modeling 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 • Basic and advance course on Microsoft excel VBA • Or any other application/design-based course which is not incorporated in regular curriculum Note: In a scenario in which a student is unable to undergo Vocational training at industrial manufacturing unit in either of the semester, and had completed any certification course in INTERNSHIP 1, must adapt the software learnt in Internship 1 to solve higher order problem such as mass/energy balance across a manufacturing unit, optimization of a distillation column,
3.	Student may get trained at government ITI centers for hands on skills such as fitting, crafting, drafting, welding etc.
4.	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

	Note: In a scenario in which a student is unable to undergo Vocational training at industrial manufacturing unit, and had completed any certification course in INTERNSHIP 1, must adapt the subject learnt in Internship 1 to solve higher order problem such as mass/energy balance across a manufacturing unit, optimization of a distillation column, multicomponent absorption or fractional distillation etc…

4. Suggested Home Assignments/Students' Activities: Will be decided by the respective Lecturer