ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(UGC AUTONOMOUS)
(Affiliated to AU, Approved by AICTE& Accredited by NBA & NAAC)
Sangivalasa 531 162, Bheemunipatnam Mandal, Visakhapatnam Dist

DEPARTMENT OF CHEMICAL ENGINEERING

R-20 regulations w.e.f. 2020-21 admitted batch

	I Year – I Semester									
Code	**Title of the Course**	**Category**	**L**	**T**	**P**	**Total**	**Max. Marks**		**Total Marks**	**Credits**
							Sess.	**End Exam.**		
CHE111	Engineering Mathematics – I	BS	3	0	0	3	40	60	100	3
CHE112	Engineering Physics	BS	3	0	0	3	40	60	100	3
CHE113	Engineering Chemistry	BS	3	0	0	3	40	60	100	3
CHE114	Introduction to Chemical Engineering	PC	3	0	0	3	40	60	100	3
CHE115	Engineering Drawing	ES	2	0	3	5	40	60	100	3.5
CHE116	Engineering Physics Lab	BS	0	0	3	3	50	50	100	1.5
CHE117	Engineering Chemistry Lab	BS	0	0	3	3	50	50	100	1.5
CHE118	Engineering Workshop	ES	0	0	3	3	50	50	100	1.5
CHE119	Human Values and Professional Ethics (Mandatory non-credit course)	MC	3	0	0	3	50	0	50	0
	Total		**17**	**0**	**12**	**29**	**400**	**450**	**850**	**20**

	I Year – II Semester									
Code	**Title of the Course**	**Category**	**L**	**T**	**P**	**Total**	**Max. Marks**		**Total Marks**	**Credits**
							Sess.	**End Exam.**		
CHE121	Engineering Mathematics – II	BS	3	0	0	3	40	60	100	3
CHE122	Communicative English	HS	3	0	0	3	40	60	100	3
CHE123	Basic Mechanical Engineering	ES	3	0	0	3	40	60	100	3
CHE124	Basic Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100	3
CHE125	Problem solving with C	ES	3	0	0	3	40	60	100	3
CHE126	English Language Lab	HS	0	0	3	3	50	50	100	1.5
CHE127	Problem solving with C Lab	ES	0	0	3	3	50	50	100	1.5
CHE128	Environmental Science (Mandatory non-credit course)	MC	3	0	0	3	50	0	50	0
	Total		**18**	**0**	**6**	**24**	**350**	**400**	**750**	**18**

Code	Title of the Course	Category	L	T	P	Total	Max. Marks		Total Marks	Credits
	II Year –I Semester									
							Sess.	End Exam.		
CHE211	Engineering Mathematics – III	BS	3	0	0	3	40	60	100	3
CHE212	Organic Chemistry	BS	3	0	0	3	40	60	100	3
CHE213	Biology for Engineers	ES	2	0	0	2	100	-	100	2
CHE214	Chemical Process Calculations	PC	3	0	0	3	40	60	100	3
CHE215	Mechanical Operations	PC	3	0	0	3	40	60	100	3
CHE216	Organic Chemistry Lab	BS	0	0	3	3	50	50	100	1.5
CHE217	Mechanical Operations Lab	PC	0	0	3	3	50	50	100	1.5
	Total		**14**	**0**	**6**	**20**	**360**	**340**	**700**	**17**
	II Year –II Semester									
CHE221	Engineering Mathematics – IV	BS	3	0	0	3	40	60	100	3
CHE222	Humanities Elective	HS	3	0	0	3	40	60	100	3
CHE223	Engineering Thermodynamics	ES	3	0	0	3	40	60	100	3
CHE224	Momentum Transfer	PC	3	0	0	3	40	60	100	3
CHE225	Numerical Methods for Chemical Engineers	SC	3	0	0	3	40	60	100	3
CHE226	Professional Elective – I	PE	3	0	0	3	40	60	100	3
CHE227	Momentum Transfer Lab	PC	0	0	3	3	50	50	100	1.5
CHE228	Computational Lab	SC	0	0	3	3	50	50	100	1.5
CHE229	Seminars	SC	0	0	2	2	100	---	100	1
	Total		**18**	**0**	**8**	**26**	**390**	**510**	**900**	**22**

Code	Title of the Course	Category	L	T	P	Total	Max. Marks		Total Marks	Credits
	III Year –I Semester									
							Sess.	End Exam.		
CHE311	Open Elective-I	OE	3	0	0	3	40	60	100	3
CHE312	Chemical Engineering Thermodynamics	PC	3	0	0	3	40	60	100	3
CHE313	Heat Transfer	PC	3	0	0	3	40	60	100	3
CHE314	Mass Transfer – I	PC	3	0	0	3	40	60	100	3
CHE315	Chemical Technology	PC	3	0	0	3	40	60	100	3
CHE316	Professional Elective – II	PE	3	0	0	3	40	60	100	3
CHE317	Heat Transfer Lab	PC	0	0	3	3	50	50	100	1.5
CHE318	Chemical Technology Lab	PC	0	0	3	3	50	50	100	1.5
CHE319	Quantitative and Verbal Aptitude – I	HS	0	0	3	3	100	0	100	1.5
CHE310	Summer Internship - I	PR	0	0	0	0	0	100	100	2
	Total		**18**	**0**	**6**	**24**	**340**	**460**	**800**	**24.5**
	III Year –II Semester									
CHE321	Open Elective – II	OE	3	0	0	3	40	60	100	3
CHE322	Mass Transfer – II	PC	3	0	0	3	40	60	100	3
CHE323	Chemical Reaction Engineering – I	PC	3	0	0	3	40	60	100	3
CHE324	Process Dynamics and Control	PC	3	0	0	3	40	60	100	3
CHE325	Professional Elective-III	PE	3	0	0	3	40	60	100	3
CHE326	Professional Elective - IV	PE	3	0	0	3	40	60	100	3
CHE327	Mass Transfer Lab	PC	0	0	3	3	50	50	100	1.5
CHE328	Process Dynamics and Control Lab	PC	0	0	3	3	50	50	100	1.5
CHE329	Quantitative Aptitude – II & Soft Skills	HS	0	0	3	3	100	0	100	1.5
	Total		**18**	**0**	**6**	**24**	**340**	**460**	**800**	**22.5**

Code	Title of the Course	Category	L	T	P	Total	Max. Marks		Total Marks	Credits
	IV Year –I Semester									
Code	**Title of the Course**	**Category**	**L**	**T**	**P**	**Total**	**Sess.**	**End Exam.**	**Total Marks**	**Credits**
CHE411	Open Elective – III	OE	3	0	0	3	40	60	100	3
CHE412	Chemical Reaction Engineering – II	PC	3	0	0	3	40	60	100	3
CHE413	Transport Phenomena	PC	3	0	0	3	40	60	100	3
CHE414	Chemical Process Economics and Equipment Design	PC	3	0	0	3	40	60	100	3
CHE415	Process Modeling and Simulation	SC	3	0	0	3	40	60	100	3
CHE416	Professional Elective-V	PE	3	0	0	3	40	60	100	3
CHE417	Chemical Reaction Engineering Lab	PC	0	0	3	3	50	50	100	1.5
CHE418	Process Modeling and Simulation Lab	SC	0	0	3	3	50	50	100	1.5
CHE419	Project Phase – I	PR	0	0	3	3	100	0	100	2
CHE410	Summer Internship - II	PR	0	0	0	0	0	100	100	2
	Total		**18**	**0**	**9**	**27**	**400**	**500**	**900**	**25**
	IV Year –II Semester									
CHE421	Open Elective – IV (MOOCS)	OE	3	0	0	3	40	60	100	3
CHE422	Project Phase-II	PR	0	0	9	9	100	100	200	8
	Total Credits		**9**	**0**	**9**	**12**	**140**	**160**	**500**	**11**

R -2020 regulations – List of electives

CHE 222 Humanities Elective	
CHE 222(A)	Industrial Management
CHE 222(B)	Managerial Economics and Financial Analysis
CHE 222(C)	Operations Research
CHE 226 Professional Elective – I	
CHE 226 (A)	Polymer Technology
CHE 226 (B)	Entrepreneur Engineering
CHE 226 (C)	Design Thinking
CHE 316 Professional Elective – II	
CHE 316 (A)	Industrial safety
CHE 316 (B)	Fertilizer Technology
CHE 316 (C)	Pharmaceutical Technology
CHE 316 (D)	Electrochemical Engineering
CHE 325 Professional Elective – III	
CHE 325 (A)	Industrial pollution and control
CHE 325 (B)	Membrane technology
CHE 325 (C)	Catalysis
CHE 325 (D)	Electrochemical energy
CHE 326 Professional Elective – IV	
CHE326 (A)	Material Science and Engineering
CHE326 (B)	Petrochemicals
CHE326 (C)	Energy engineering
CHE 326 (D)	Biochemical engineering
CHE 416 Professional Elective – V	
CHE 416 (A)	Petroleum Refinery Engineering
CHE 416 (B)	Nanotechnology
CHE 416 (C)	Process optimization
CHE 416 (D)	Computational fluid dynamics
Open Electives	Food Processing Technology
	Engineering Biology
	Fuel Cell Technology
	Design of experiments
	Fundamentals of Industrial Safety and Health
	Bioinformatics
	Corrosion Engineering
	Computational tool for Engineers

CHEMICAL REACTION ENGINEERING – II

Course Code – Category: CHE 412 – PC

L	T	P	E	O	Credits: 3
3	0	0	1	4	Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites: Chemical Reaction Engineering-I

Course Objectives:

1. To have an overview of temperature and pressure effects on chemical reactions
2. To analyze different non-ideal reactors
3. To interpret and design solid catalyzed and fluid-fluid reactors

Course Outcomes:

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

1. Analyze the temperature and pressure effects of chemical reactions
2. Distinguish between ideal and non-ideal reactors
3. Characterize the catalyst by knowing their properties
4. Design solid-catalytic reactors
5. Formulate the mechanisms for solid-fluid and fluid-fluid reactions

CO – PO – PSO Matrix:

		PO												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO	1	3	2	2	2					1	1		1	2	3
	2	3	2	2	2					1	1		1	2	3
	3	3	1	1	1					1	1		1	2	3
	4	3	3	3	3					1	1		1	2	3
	5	3	3	3	3					1	1		1	2	3

SYLLABUS

UNIT I **9L + 3T**

Temperature and Pressure Effects:

Heats of reaction and temperature – Equilibrium constants from thermodynamics – Equilibrium conversion – General graphical design procedure – Optimum temperature progression – Adiabatic operations.

Learning Outcomes:

At the end of this unit, student will be able to

- Compute temperature progression
- Calculate equilibrium constant and conversion

UNIT II **9L + 3T**

Non Ideal Flow:

Basics of non-ideal flow: C, E and F curves – Conversion in non-ideal flow reactors – Dispersion model – Tanks-in-series model.

Learning Outcomes:

At the end of this unit, student will be able to

- Determine conversion in non-ideal flow reactors
- Model the non-ideal flow by dispersion and tanks in series models

UNIT III **9L + 3T**

Heterogeneous Catalysis:

Physical adsorption – Chemisorption – Catalyst properties – Estimation of surface area, pore volume and porosity – Catalyst preparation – Catalyst poisons – Catalytic deactivation.

Learning Outcomes:

At the end of this unit, student will be able to

- Differentiate various adsorption isotherms
- Calculate the catalyst properties

UNIT IV **9L + 3T**

Solid Catalysed Reactions:

Rate equations – Pore diffusion combined with surface kinetics – Thiele modulus – Effectiveness factor – Performance equations for reactions containing porous catalyst particles – Experimental methods for finding rates – Determining controlling resistances.

Learning Outcomes:

At the end of this unit, student will be able to

- Estimate the Thiele modulus and effectiveness factor the particular reaction
- Calculate the catalyst required for various reactors

UNIT V **9L + 3T**

Non-Catalytic Systems:

Design of fluid-fluid reactors – Factors to consider in selecting a contractor – Various contractors and contacting patterns for G/L reactions. Design of fluid particle reactions – Progressive Conversion Model (PCM), Shrinking Core Model (SCM) – Comparison – Controlling mechanisms – Determination of rate controlling step.

Learning Outcomes:

At the end of this unit, student will be able to

- Predict the model equations for various fluid-fluid reactors
- Analyze the controlling mechanisms for fluid-particle reactions

Text Book:

1. Leven spiel O. *Chemical Reaction Engineering*, 3rd Edition, John Wiley & Sons.

Reference books:

1. J. M. Smith., *Chemical Engineering Kinetics*, 3rd edition., Mc-Graw Hill, Inc.
2. H. Scott Fogler., *Elements of Chemical Reaction Engineering*, 5th edition., PHI Learning Private Ltd

TRANSPORT PHENOMENA

Course Code – Category: CHE 413 – PC

L	T	P	E	O	Credits: 3
3	0	0	1	4	Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites: Engineering Mathematics, Momentum Transfer, Heat Transfer and Mass Transfer

Course Objectives:

1. To provide basic knowledge on laminar flow using shell balances in momentum, heat and mass transfer.
2. To familiarize with the equation of change for non-isothermal systems.
3. To acquaint knowledge on velocity, temperature and concentration distributions in turbulent flow.

Course Outcomes:

By the end of the course, the student would be able to:

1. Determine the dependency of transport properties on pressure and temperature.
2. Identify the coordinates and develop velocity, temperature and concentration profiles in laminar flow.
3. Apply equations of change for non-isothermal systems for solving steady state problems.
4. Evaluate velocity distributions using time smoothed quantities.
5. Estimate the friction factors, heat transfer coefficients and mass transfer coefficients.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	1	1				1	1		1	2	3
	2	2	2	2	2	1				1	1		1	2	3
	3	3	3	3	3	1				1	1		1	2	3
	4	2	2	2	2	1				1	1		1	2	3
	5	2	2	2	2	1				1	1		1	2	3

SYLLABUS

UNIT I **9L + 3T**

Momentum transport: Viscosity and the mechanism of momentum transport, Newton's law of viscosity, Non-Newtonian fluids and pressure and temperature dependence of viscosity.

Velocity distributions in laminar flow: Shell momentum balances boundary conditions, flow of a falling film, flow through a circular tube and flow through an annulus.

Learning Outcomes:

At the end of this unit, student will be able to

- Calculate the viscosity of fluids at a given temperature and pressure conditions
- Perform shell momentum balance calculations for laminar flow steady-state problems

UNIT II **9L + 3T**

The equations of change for isothermal systems: The equations of continuity, motion and mechanical energy in rectangular and curvilinear coordinates, use of the equations of change to set up steady flow problems and dimensional analysis of the equations of change.

Velocity distributions in turbulent flow: Fluctuations and time-smoothed quantities, time-smoothing of the equations of change for an incompressible fluid and semi empirical expressions for the Reynolds stresses.

Learning Outcomes:

At the end of this unit, student will be able to

- Use the equations of continuity and bulk equations to solve steady-state flow problems
- Represent the time smoothed equations of change for an incompressible fluid

UNIT III **9L + 3T**

Energy transport: Thermal conductivity and the mechanism of energy transport, Fourier's law of heat conduction and temperature and pressure dependence of thermal conductivity in gases and liquids.

Temperature distributions in solids and in laminar flow: Shell energy balances boundary conditions, heat conduction with an electrical heat source, heat conduction with a viscous heat source, heat conduction through composite walls, forced convection and free convection.

Learning Outcomes:

At the end of this unit, student will be able to

- Predict the thermal conductivity of gases and liquids using empirical equations
- Execute the shell energy balance calculations to find temperature distribution in solids and laminar flow fluids

UNIT IV **9L + 3T**

Mass transport: Diffusivity and mechanism of mass transport, Definitions of concentrations, velocities and mass fluxes, Fick's law of diffusion and temperature and pressure dependence of mass diffusivity.

Concentration distribution in laminar flow: Shell mass balances – boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, mass transfer with chemical reaction, diffusion with homogeneous chemical reaction and diffusion into a falling liquid film.
The equations of change for multi component systems: The equations of continuity for a binary mixture.

Learning Outcomes:

At the end of this unit, student will be able to

- Assess the temperature and pressure dependence of mass diffusivity
- Derive the concentration profile for steady-state laminar flow problems

UNIT V **9L + 3T**

Interphase transport in isothermal systems: Definition of friction factors, friction factors for flow in tubes and for flow around spheres. Definition of the heat transfer coefficient, heat transfer coefficients for forced convection in tubes and around submerged objects and heat transfer coefficients for free convection. Definition of binary mass transfer coefficients in one phase, correlations of binary mass transfer coefficients in one phase at low mass-transfer rates, definition of binary mass-transfer coefficients in two phases at low mass-transfer rates

Learning Outcomes:

At the end of this unit, student will be able to

- Determine friction factor and heat transfer coefficients for flow in tubes and for flow around submerged objects
- Define mass transfer coefficient for one and two phases for binary compounds.

Text Book:

1. R. Byron Bird, Warren E. Steward and Edwin N. Lightfoot, *Transport Phenomena*, 2nd edition, John Wiley and Sons Inc., New York, 2007.

Reference Books:

1. Geankoplis, C.J. *Transport Processes and Separation Process Principles*, Pearson New International Edition, New Delhi, 4th edition, 2013.
2. V. Kumaran, *Fundamentals of Transport processes with Applications,* Cambridge University Press, New edition, 2022.
3. Sunil Kumar Thamida, *Transport Phenomena: Chemical Processes,* Stadium press India Pvt Ltd., 2016.

CHEMICAL PROCESS ECONOMICS AND EQUIPMENT DESIGN

Course Code – Category: CHE 414 – PC

Credits:3
Sessional Marks: 40

L	T	P	E	O
3	1	0	0	4

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites: Heat Transfer, Mass Transfer

Course Objectives:

1. To familiarize process development and general design considerations.
2. To provide the knowledge of various equations used for cost analysis of process plant
3. To provide the knowledge on mechanical design of equipments.
4. To familiarize the design of heat and mass transfer equipments.

Course Outcomes:

At the end of the course, the student would be able to

1. Outline the general design considerations for design / expansion of the process.
2. Estimate the time value of money and depreciation
3. Compute the cost of an equipment and process plant
4. Evaluate mechanical design of pressure vessels
5. Design process equipment like Heat exchangers and Distillation columns

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	3	3	3					1	1		1	2	3
	2	1	1	1	1					1	1	3	1	2	3
	3	3	2	2	2					1	1	3	1	2	3
	4	3	2	2	2					1	1		1	2	3
	5	3	3	3	3	2				1	1		1	2	3

SYLLABUS

UNIT I **9 L+ 3 T**

General process design considerations: Procedure for project design, design information from the literature survey, flow diagrams, preliminary design, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, health and safety hazards, fire and explosion hazards, personnel safety, loss prevention, plant location and layout.

Learning Outcomes:

At the end of this unit, student will be able to

- Explain the stages of process design development
- Summarize general design consideration during the project development

UNIT II **9 L+ 3 T**

Time Value of money and depreciation: Types of interest- discrete and continuous, equations for economic studies, annuities - relation between ordinary annuity and the periodic payments, Depreciation definition and types; Methods of calculating depreciations – Straight Line Method, Declining Balance Method, Sum of Years Digits Method and Sinking Fund Method

Learning Outcomes:

At the end of this unit, student will be able to

- Predict the interest involved in investment cost of a project
- Calculate the depreciation involved in the project cost

UNIT III **9 L+ 3 T**

Cost estimation and Profitability: Basic relationship in accounting, balance sheet and income statement, various ratios to study the balance sheet and income statements, break even chart, cost indices, capacity factors, cost estimation of an equipment and process plant, alternate investments and replacements for profitability evaluation.

Learning Outcomes:

At the end of this unit, student will be able to

- Estimate the equipment cost and product cost using cost indices and other methods
- Determine the profitability of a project using profitability analysis

UNIT IV **9L+ 3 T**

Mechanical design of process equipment: Pressure vessel shell, closures, nozzles, flanges, supports, storage vessels, tall vertical column, Reactor-thickness, agitator.

Learning Outcomes:

At the end of this unit, student will be able to

- Predict the thickness of the plate required for the pressure vessel under the given conditions
- Choose suitable components like headers, flanges, supports etc. for the pressure vessel

UNITV **9 L+ 3 T**

Process equipment design: Design of Shell and Tube Heat exchanger-film coefficient and pressure drop, procedure for optimum design of heat exchanger, Finite-stage contactors- bubble cap tray, sieve tray and valve tray units, maximum allowable vapor velocities, plate and column efficiency, Continuous contactors – types of packing, liquid distribution, pressure drop, packing efficiencies.

Learning Outcomes:

At the end of this unit, student will be able to

- Implement area calculations for heat exchange equipment including evaporators
- Perform process design calculations for mass transfer equipment like distillation column

Text Books:

1. M. S. Peters & K. D. Timmerhaus, *Plant design and Economics for Chemical Engineers*, 4th edition, Mc Graw Hills Publishing Company, 1991.
2. M. V. Joshi, *Process Equipment Design*, 3rd Edition, MacMillan India Ltd 1981(**UNIT-IV**)

References:

1. Hebert E. Schweyer, *Process Engineering Economics*, McGraw Hill Books company 1955.
2. J. M. Coulson & J. F. Richardon, *Chemical Engineering Volume-VI (An introduction to Chemical Engineering Design*
3. J. R. Backhurst & J. H. Harker , *Process-Plant-Design*, Heieman Education London.

PROCESS MODELING AND SIMULATION

Course Code – Category: CHE 415 – PC

L	T	P	E	O		Credits: 3
3	0	0	1	4		Sessional Marks: 40
End Exam: 3 Hours						End Exam Marks: 60

Prerequisites: Process Control, Heat transfer, Mass transfer, Chemical reaction engineering, Fluid Mechanics

Course Objectives:

1. To use the fundamental laws in developing model equations.
2. To understand various chemical engineering systems.
3. To develop mathematical models for solving process problems.
4. To gain skills by proper usage of simulators for modeling chemical processes.

Course Outcomes:

By the end of the course the student will be able to:

1. Apply the fundamental laws to develop a mathematical model for simple flow systems.
2. Formulate mathematical models for various types of reactors
3. Develop a mathematical model for various Mass transfer equipment.
4. Solve the mathematical models using numerical methods.
5. Simulate mathematical models for various operations.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2	2	2					1	1		1	2	3
	2	3	3	3	3					1	1		1	2	3
	3	3	3	3	3					1	1		1	2	3
	4	3	1	1	1	2				1	1		1	2	3
	5	3	2	2	2	3				1	1		1	2	3

SYLLABUS

UNIT I **9L + 3T**

Introduction: Use and scope of mathematical modeling, Principles of model formulation, Role and importance of steady-state and dynamic simulation, Degree-of-freedom analysis, Selection of design variables, Model simulation.

Fundamental laws: Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties like phase equilibria, bubble and dew points.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply fundamental laws to develop model
- Formulate the models for different processes

UNIT II **9L + 3T**

Mathematical modeling-I: Chemical processes-Gravity flow tank, Two heated tanks, Gas phase pressurized CSTR, Non-isothermal CSTR, Series of isothermal, constant hold up CSTRs, CSTRs with variable hold-ups.

Learning Outcomes:

At the end of this unit, student will be able to

- Develop models for rate based equipments

UNIT III **9L + 3T**

Mathematical modeling-II: Modeling of Single component vaporizer, Multicomponent flash drum, pH systems, Batch reactor, Reactor with mass transfer, Ideal binary distillation and Batch distillation with holdup.

Learning Outcomes:

At the end of this unit, student will be able to

- Develop models for equilibrium based equipments

UNIT IV **9L + 3T**

Methods for solving non-linear equations: Interval Halving method, Newton-Raphson method, False Position method, Wegstein method. Numerical integration of ordinary differential equations: Euler Algorithm and Runge-Kutta (Fourth-Order) methods.

General Concepts of Simulation for Process Design: Introduction, modular approaches to process simulation- sequential modular approach, simultaneous modular approach, equation solving approach, tearing.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply numerical techniques to solve equations
- Solve set of equations

UNIT V **9L + 3T**

Simulation examples: Gravity flow tank, Three CSTRs in series with constant hold-up, Three CSTR's in series with variable hold-up. Simulation of Non-isothermal CSTR, Batch reactor and Binary distillation column.

Learning Outcomes:

At the end of this unit, student will be able to

- Solve models using numerical techniques
- Develop algorithms for different model equations

Textbooks:

1. W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd Ed., McGraw Hill India Pvt. Ltd., 2014.
2. Raghu Raman, Chemical Process Computations, Elsevier Applied Science Publishers Ltd., New York, 1985 (**UNIT-IV**)

Reference Books:

1. Upreti, Simant R. Process Modeling and Simulation for Chemical Engineers: Theory and Practice. John Wiley & Sons, 2017.
2. Verma, Ashok Kumar. Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering. CRC Press, 2014.
3. H. Scott Fogler, Elements of Chemical Reaction Engineering, 3rd Ed., Prentice Hall of India, 2004.
4. Ian T. Cameron and K. Hangos, Process Modelling and Model Analysis, 1st edition, Academic press, 2001

PROFESSIONAL ELECTIVE - V

PETROLEUM REFINERY ENGINEERING

Course Code – Category: CHE416 (A) – PE

L	T	P	E	O	Credits: 3
3	0	0	1	3	Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites:
Engineering chemistry and organic chemistry

Course Objectives:

1. To understand the scenario of petroleum refining and future prospects.
2. To understand the process technologies for the petroleum products.
3. To understand suitable processes for obtaining the valued added petroleum products.

Course Outcomes:
By the end of the course the student will be able to:

1. Outline the formation of crude oil and its reserves
2. Acquire knowledge on pretreatment and fractionation of petroleum
3. Predict the suitable treatment techniques for the desired products
4. Classify various petroleum cracking operations
5. Identify different refinery value addition processes

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	2								1	1		1	3	2
	2	2	1	1	1					1	1		1	3	2
	3	2	1					1		1	1		1	3	2
	4	2								1	1		1	3	2
	5	2								1	1		1	3	2

SYLLABUS

UNIT-I **9L+3T**

Origin, formation and composition of petroleum: Origin, formation and composition of petroleum, Reserves and deposits of world, Petro Glimpses and petroleum industry in India, future prospects.

Learning Outcomes:
At the end of this unit, student will be able to

- Recognize the scenario of petroleum refining and future prospects in India and worldwide.
- Understand the origin and formation of petroleum.

UNIT II **9L+3T**

Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, atmospheric and vacuum distillation, blending of gasoline.

Learning Outcomes:

At the end of this unit, student will be able to

- Know the various testing methods for petroleum fractions.
- Understand dehydration and desalting of crudes.
- Acquires knowledge on distillation of crude oil.

UNIT III **9L+3T**

Treatment techniques: Fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

Learning Outcomes:

At the end of this unit, student will be able to

- Categorize various treatment techniques for petroleum fractions
- Predict the suitable treatment techniques for the gasoline, kerosine and lubes

UNIT IV **9L+3T**

Cracking processes: Thermal cracking-Thermocracking operations – Properties of cracked materials – Visbreaking, Catalytic cracking – Feed stocks - Catalysts - Process variables, Catalytic Crackers -FCC, Catalytic reforming.

Learning Outcomes:

At the end of this unit, student will be able to

- Classify various cracking operations.
- Comprehends process variables.
- Understand coking and visbreaking processes.

UNIT V **9L+3T**

Refining processes:

Naphtha cracking, Coking, Hydrogen processes – Hydro cracking, Hydrodesulphurization & Hydrotreatment, Alkylation, Isomerization, Polymerization, Asphalt and air blown asphalt.

Learning Outcomes:

At the end of this unit, student will be able to

- Classify different refinery value addition processes.
- Acquires knowledge on hydrotreating and air blown asphalt methods.

Textbooks:

1. B. K. Bhaskara Rao, *Modern Petroleum Refining Processes*, 5th Edition, Oxford & IBH Publishing, 2011.

Reference Books:

1. Ram Prasad, *Petroleum Refining Technology*, 1st Edition, Khanna Publishers, 2002.
2. J. H. Gary and G. E. Handwerk, *Petroleum Refining Technology and Economics*, 4th Edition, Marcel Dekkar Inc., 2001.
3. Nelson, W.L. *Petroleum refining Engineering*, 4th Edition, McGraw Hill, New York, 1969.

PROFESSIONAL ELECTIVE - V

NANOTECHNOLOGY

Course Code – Category: CHE 416 (B)– PE

L	T	P	E	O		Credits: 3
3	0	0	1	3		Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites:

Course Objectives:

1. To provide a basic understanding of nanotechnology and its importance towards chemical engineering

Course Outcomes:

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

1. Understand the basics of nanotechnology
2. Classify different classes of nanomaterials
3. Apply nanotechnology to chemical and its related industries
4. Identify different synthesis routes of nanomaterials
5. Apply chemical reaction engineering concepts for production of different nanomaterials

CO – PO – PSO Matrix:

		PO												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO	1	3								1	1		1	3	2
	2	3	1							1	1		1	3	2
	3	2	1							1	1		1	3	2
	4	3	1	1	1					1	1		1	3	2
	5	3	1	1	1					1	1		1	3	2

SYLLABUS

UNIT I **9L + 3T**

Basics and Scale of Nanotechnology: Introduction, Scientific revolutions, Definition of a nano system, Dimensionality and size dependent phenomena, Surface to volume ratio -Fraction of surface atoms, Surface energy and surface stress, surface defects, Properties at nanoscale (optical, mechanical, electronic and magnetic).

Learning Outcomes:

At the end of this unit, student will be able to

- Identify the nanomaterial
- Influence the various properties of the nanomaterial with respect to size.

UNIT II **9L + 3T**

Nanomaterials: Classification based on dimensionality, Quantum Dots, Wells and Wires, Carbon based nano materials (bucky balls, nanotubes, graphene) Metal based nanomaterials (nanogold, nanosilver and metal oxides) Nanocomposites, Nano polymers, Nano ceramics, Biological nanomaterials.

Learning Outcomes:

At the end of this unit, student will be able to

- Recognize the category of nanomaterial in terms of dimensions
- Identify the category for the various applications

UNIT III **9L + 3T**

Nanotechnology to Nano Engineering: Introduction to nanotechnology, Process Technology in nano engineering, Chemical engineering and new materials, Application of nanotechnology to different fields: Nanotechnology in Biotechnology, Nanotechnology in Petroleum Industries, Nanotechnology in Material Science, Nanotechnology in Environmental Science, Nanotechnology in the Energy Sector, Nanotechnology in Other Specific Fields

Learning Outcomes:

At the end of this unit, student will be able to

- Differentiate engineering and technology
- Utilize various nano-materials in various fields

UNIT IV **9L + 3T**

Nanostructured materials synthesis, Concepts and design: Synthesis Technologies and Challenges, Top-down methods, Bottom-up Methods, Routine Tests for Characterization of Nanostructures, particle characterization, Chemical Analysis, Thermal analysis

Learning Outcomes:

At the end of this unit, student will be able to

- Synthesize nanomaterials in different approaches
- Characterize nanomaterials

UNIT V **9L + 3T**

Nano structured materials manufacturing: Kinetic approach of the reaction, Chemical reactors for manufacturing nanomaterials, Health safety and Environment issues.

Learning Outcomes:

At the end of this unit, student will be able to

- Analyze the kinetic approaches of various nano-reactors
- Identify the safety aspects of using naomaterials.

Text Book:

1. Pradeep T., *A Textbook of Nanoscience and Nanotechnology*, Tata McGraw Hill Education Pvt. Ltd., 2012. (**UNIT-I & II**)
2. Said Salaheldeen Elnashaie, Firoozeh Danafar, Hassan Hashemipour Rafsanjani, *Nanotechnology for Chemical Engineers*, Springer, 2015. (**UNIT-III to V**)

Reference Books:

1. Hari Singh Nalwa, *Nanostructured Materials and Nanotechnology*, Academic Press, 2002.
2. Nabok A., *Organic and Inorganic Nanostructures*, Artech House, 2005.
3. Dupas C., Houdy P., Lahmani M., *Nanoscience: Nanotechnologies and Nanophysics*, Springer-Verlag Berlin Heidelberg, 2007.

PROFESSIONAL ELECTIVE - V

PROCESS OPTIMIZATION

Course Code – Category: CHE 416 (C) – PE

L	T	P	E	O		Credits: 3
3	0	0	1	3		Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites:
Engineering Mathematics

Course Objectives:
1. To learn problem formulation of optimization.
2. To realize the numerical methods of un-constrained optimization
3. To learn linear programming and its applications
4. To know the applications of numerical optimization in chemical engineering principles

Course Outcomes:
By the end of the course, the student will be able to:
1. Apply the knowledge of optimization to formulate the problems
2. Apply different methods of optimization and to suggest a technique for specific problem with a single variable
3. Apply different methods of optimization and to suggest a technique for specific problem with multivariable
4. Apply of simplex method for linear optimization problems
5. Understand how optimization can be used to solve the industrial problems of relevance to the chemical industry

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2	2	2					1	1		1	3	2
	2	3	2	2	2					1	1		1	3	2
	3	3	2	2	2					1	1		1	3	2
	4	3	2	2	2					1	1		1	3	2
	5	3	2	2	2					1	1		1	3	2

SYLLABUS

UNIT I **9L + 3T**

Nature and organization of optimization problems: Introduction to optimization scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, obstacles of optimization.

Basic Concepts of Optimization: constraints in optimization, examples and formulation of constrained optimization problems. Basic concepts of optimization: Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function

Learning Outcomes:

At the end of this unit, student will be able to

- Formulate an optimization problem
- Compute optimum solutions

UNIT II **9L + 3T**

Optimization of unconstrained single variable functions: one-dimensional search: Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of unidimensional search Quadratic interpolation, Cubic interpolation. Applications of one- dimensional search methods to chemical engineering problems.

Learning Outcomes:

At the end of this unit, student will be able to

- Determine the optimum points for single variable unconstrained problem

UNIT III **9L + 3T**

Unconstrained multivariable optimization: Random search methods, grid search, uni-variate search, multivariable Newton‘s method, Steepest descent method, Conjugate search directions, Conjugate gradient method

Learning Outcomes:

At the end of this unit, student will be able to

- Calculate the optimum points for multivariable unconstrained problem

UNIT IV **9L + 3T**

Linear programming and applications: Basic concepts in linear programming, Degenerate LP's – graphical solution, natural occurrence of linear constraints, standard LP form. Simplex method and applications. Simplex method to solve LP problems, duality principle and converting a LP to dual LP.

Learning Outcomes:

At the end of this unit, student will be able to

- Solve constrained optimization problem

UNIT V **9L + 3T**

Optimization of UNIT operations: Optimal pipe diameter, minimum work of compression, Economic operation of a fixed bed filter, optimizing recovery of waste heat, optimization of multiple effect evaporator, optimization of flow rates in Liquid- Liquid extraction column, Determination of optimal reflux ratio for staged distillation column, Optimal residence time for maximum yield in an ideal isotherm batch reactor, Chemostat.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply optimization techniques to solve chemical engineering problems

Text Books:

1. T. F. Edgar and D. M. Himmelblau, L. S. Lasdon, *Optimization of Chemical Processes*, McGraw-Hill, New York, 2001.
2. Kalyan Moy Deb, *Optimization for Engineering Design*, PHI Pvt. Ltd., New Delhi, 2000 Codes/Books **(UNIT-III)**

Reference Books:

1. S. S. Rao, *Engineering Optimization: Theory and Practice,* 3rd Ed., John Wiley & Sons, 2009.
2. Dutta, Suman. *Optimization in Chemical Engineering*. Cambridge University Press, 2016.
3. Rangaiah, Gade Pandu. *Multi-objective optimization: techniques and applications in chemical engineering.* Vol. 1. World Scientific, 2009.
5. Nocedal, Jorge, and Stephen J. Wright. *Numerical optimization,* 2nd Ed., 2006.
6. Joshi, Mohan C., and Kannan M. Moudgalya. *Optimization: theory and practice.* Alpha Science Int'l Ltd., 2004.

PROFESSIONAL ELECTIVE - V

COMPUTATIONAL FLUID DYNAMICS

Course Code – Category: CHE 416 (D)– PE

L	T	P	E	O	Credits: 3
3	0	0	1	3	Sessional Marks: 40

End Exam: 3 Hours **End Exam Marks: 60**

Prerequisites:

Engineering Mathematics, Momentum Transfer and Heat Transfer.

Course Objectives:

1. To develop a general method of prediction for momentum, heat and mass transfer.
2. To familiarize with different methods of prediction.

Course Outcomes:

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

1. Identify the governing equations.
2. Apply the various discretization methods
3. Apply the numerical methods to solve physical process that are governed mathematical equations containing only diffusion type.
4. Apply the numerical methods to solve physical process that are governed mathematical equations containing both diffusion and convection type.
5. Estimate the pressure and velocity corrections for calculation of flow field

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	2	2	2	1				1	1		1	3	2
	2	3	2	2	2	1				1	1		1	3	2
	3	3	2	2	2	1				1	1		1	3	2
	4	3	2	2	2	1				1	1		1	3	2
	5	3	2	2	2	1				1	1		1	3	2

SYLLABUS

UNIT I **9L + 3T**

Mathematical description of physical phenomena: Conservation of chemical species, energy equation, momentum equation, time average equations for turbulent flow, the turbulence kinetic energy equation, general differential equation.

Learning Outcomes:

At the end of this unit, student will be able to

- Formulate mathematical equations from basic conservation principles

UNIT II **9L + 3T**

Discretization methods: Discretization concept, structure of discretization equation, Taylor series formulation, variational formulation, method of weighted residuals, control volume formulation.

Learning Outcomes:

At the end of this unit, student will be able to

- Describe discretization techniques and apply to equations

UNIT III **9L + 3T**

Steady and unsteady state molecular phenomena: Steady one dimensional equation – basic equation, grid spacing, non-linearity, source term linearization, boundary conditions and solution. Unsteady one dimensional equation – general discretization equation, explicit, Crank-Nicolson, Fully implicit schemes and equations.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply techniques to steady and unsteady state equations

UNIT IV **9L + 3T**

Steady and unsteady state molecular and convection phenomena: Upwind scheme, exact solution, exponential scheme, hybrid scheme, power law scheme, generalized formulation and consequences of various schemes.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply techniques to molecular and convective models

UNIT V **9L + 3T**

Calculation of flow field: The momentum equations, the pressure and velocity corrections, the pressure correction equation, SIMPLE algorithm, SIMPLER algorithm.

Learning Outcomes:

At the end of this unit, student will be able to

- Solve the pressure and velocity equations

Text Book:

1. Suhas V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Mc Graw Hill Book Company, New York, 1980.

Reference Books:

1. Anil W. Date, *Introduction to Computational Fluid Dynamics*, Cambridge University press, 2005.
2. Muralidhar K. and Sundararajan T., *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House, 2003.

CHEMICAL REACTION ENGINEERING LABORATORY

CHE 417 **Credits: 1.5**
Instruction: 3 Practical hours /week Sessional Marks: 50
End Exam: 3 Hours End Exam Marks: 50

Prerequisites: Chemical Reaction Engineering

Course Objectives:

1. To impart knowledge on the determination of the kinetics of a chemical reaction
2. To enable the students to understand the principles involved in designing of chemical reactors

Course Outcomes:

By the end of the course, the student will be able to

1. Determine the kinetics of a chemical reaction in various reactors
2. Acquire hands on experience on the operation of various ideal and non-ideal reactors

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	3	3	3					3	2		1	2	3
	2	3	3	3	3					3	2		1	2	3

List of Experiments:

1. Determination of the order and rate constant of a reaction using a batch reactor by analyzing the data by different methods.
2. Determination of the activation energy of a reaction using a batch reactor.
3. Determination of the effect of residence time on conversion and estimation of the rate constant using a CSTR.
4. Determination of the effect of residence time on conversion and estimation of the rate constant using a PFR.
5. Determination of RTD and Dispersion number in a Tubular reactor using a tracer.
6. Determination of RTD and the dispersion number for a packed-bed using a tracer
7. Langmuir Adsorption Isotherm: Determination of surface area of activated charcoal.
8. Performance of a PFR followed by a CSTR
9. Performance of a CSTR followed by a PFR.

10. Performance of CSTRs in series.
11. Determination of M-M kinetics for an enzyme catalyzed reaction.
12. Determination of the order and rate constant of a reaction using a semi batch reactor

Prescribed Books:

1. Octave Levenspiel, *Chemical Reaction Engineering*, 3rd edition, 1999, John Wiley
2. J. M. Smith., *Chemical Engineering Kinetics*, 3rd edition., McGraw-Hill, Inc.
3. H. Scott Fogler., *Elements of Chemical Reaction Engineering*, 5th edition, PHI Learning Private Ltd.

PROCESS MODELING AND SIMULATION LABORATORY

CHE 418 **Credits: 1.5**
Instruction: 3 Practical hours/week **Sessional Marks: 50**
End Exam: 3 hrs **End Exams Marks: 50**

Prerequisites:
Engineering Mathematics, Process Modelling and Simulation

Course Objectives:

1. To impart knowledge on simulation packages and tools.
2. To enable the student to have hands-on experience on various simulation tools.

Course Outcomes:

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

1. Represent the process in terms of mathematical equations.
2. Acquire hands-on experience on simulation packages and tools.

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	3	3	3	3				2	2		2	2	3
	2	3	3	3	3	3				2	2		2	2	3

List of experiments

1. Estimation of thermodynamic properties
2. Vapour liquid Equilibria
3. Simulation of a pump
4. Simulation of a heat exchanger
5. Simulation of an evaporator
6. Simulation of an absorber
7. Simulation of distillation column
8. Simulation of a reactor
9. Simulation of a flow sheet
10. Simulation of a flow sheet with recycle stream
11. Optimization of process parameters in a flow sheet
12. Unsteady state operation of a flow sheet

The experiments can be performed in any software / tool to have hands-on experience.

Prescribed Books:

1. Bruce A. Finlayson, *Introduction to Chemical Engineering Computation*, John Wiley and Sons Inc., 1st edition, 2012.
2. W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd Ed., McGraw Hill India Pvt. Ltd., 2014.
3. A. K. Jana, *Chemical Process Modelling and Computer Simulation*, PHI, 2nd edition, 2011.

PROJECT PHASE – I

CHE 419 **Credits: 2**

Instruction: 3 Practical hours/week Sessional Marks: 100

End Exam: 0 hrs End Exams Marks: 00

Course Objectives:

To prepare students to conduct, design and analyze the problems of Chemical Engineering through experimental or theoretical studies and represent them in the form of technical report.

Course Outcomes:

By the end of the course, the student would be able to

1. Identify the gap between the needs of society and available technology through literature survey
2. Formulate and analyze the objectives of their study

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	3	1	1	1	1	1	1	3	3	1	3	3	3
	2	3	3	3	3	3	2	2	2	3	3	3	3	3	3

Project Identification Strategies Projects are classified into three categories

- Theoretical design projects
- Experimental projects
- Simulation projects

The project work should consist of a comprehensive design of a chemical plant in the form of a report with the following chapters.

1. Introduction
2. Physical and chemical properties and uses
3. Literature survey for different processes
4. Selection of the process
5. Material and energy balances
6. Specific equipment design (Process as well as mechanical design with drawings)
7. General equipment specifications
8. Plant location and layout
9. Materials of construction
10. Health and safety factors
11. Preliminary cost estimation
12. Bibliography

Project Evaluation:

The student projects have been evaluated by three internal evaluators and also by the project guide. The project is divided into six parts as follows

- Introduction of the project
- Process description with flow sheet
- Material and Energy balances
- Design of specific equipment
- Plan location, layout and economics
- Over all project

Project seminars are conducted in six phases to evaluate the progress of project work carried. For each presentation 50 marks are allotted to each student by the four evaluators (guide 20M and each examiner 10M). Marks have been awarded based on the performance of the student in terms of presentation skills, communication skills, knowledge on the project, finally all the marks obtained in the six phases are averaged to award total marks for the project

SUMMER INTERNSHIP

Credits: 1

CHE 410

Instruction: 0 Practical hours/week — Sessional Marks: 00

End Exam: 0 hrs — End Exams Marks: 100

Course Objective:

To gain an insight of various unit operations and processes in a chemical industry.

Course Outcomes:

By the end of the course, the student would be able to

1. Practically analyze various unit operations and processes in a chemical industry.
2. Prepare a technical report

CO – PO – PSO Matrix:

		PO												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	1	1	1	1	1	1	1	3	3	2	3	3	3
	2	3	1	1	1				1	3	3	1	3	3	3

- ❖ Assessment for the industrial training is made through external examiner during IV year I Sem

PROJECT PHASE - II

Course Code – Category: CHE 422– PR

L	T	P	E	O	Credits: 8
0	0	9	0	9	Sessional Marks: 100

End Exam: 3 Hours **End Exam Marks: 100**

Course Objectives:

To prepare students to conduct, design and analyze the problems of Chemical Engineering through experimental or theoretical studies and represent in the form of technical report.

Course Outcomes:

By the end of the course, the student would be able to

1. Identify the gap between the needs of society and available technology through literature survey
2. Formulate and analyze the objectives of their study
3. Aggregate research in the form of a written report

CO – PO – PSO Matrix:

		PO												PSO	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO	**1**	3	3	1	1	1	1	1	1	3	3	1	3	3	3
	2	3	3	3	3	3	2	2	2	3	3	3	3	3	3
	3	3	1	1	1	1			3	3	3	1	3	3	3

Project Identification Strategies Projects are classified into three categories

- Theoretical design projects
- Experimental projects
- Simulation projects

The project work should consist of a comprehensive design of a chemical plant in the form of a report with the following chapters.

1. Introduction
2. Physical and chemical properties and uses
3. Literature survey for different processes
4. Selection of the process
5. Material and energy balances
6. Specific equipment design (Process as well as mechanical design with drawings)
7. General equipment specifications
8. Plant location and layout

9. Materials of construction
10. Health and safety factors
11. Preliminary cost estimation
12. Bibliography

Project Evaluation:

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- Process description with flow sheet
- Material and Energy balances
- Design of specific equipment
- Plan location, layout and economics
- Over all project

Project seminars are conducted in six phases to evaluate the progress of project work carried. For each presentation 50 marks are allotted to each student by the four evaluators (guide 20M and each examiner 10M). Marks have been awarded based on the performance of the student in terms of presentation skills, communication skills, knowledge on the project, finally all the marks obtained in the six phases are averaged to award total marks for the project.