Shree Warana Vibhag Shikshan Mandal's

Tatyasaheb Kore Institute of Engineering And Technology, Warananagar

DEPARTMENT OF CHEMICAL ENGINEERING

Final Year B. Tech. Chemical Engineering

Syllabus Structure under Autonomous Status of TKIET, Warananagar

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Chemical Engineering)

Semester-VII

(To be implemented from 2023 - 24)

Credit Scheme

Course Code	Category	Course Title	Teaching Scheme					Examination & Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
CHE 701	PCC	Transport Phenomena	3	--	--	2	3	ESE	60	24	40
								ISE	40	---	
CHE 702	PCC	Chemical Processes & Green Technology	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 703	PCC	Chemical Process Design	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 704	PCE	Mathematical Modeling in Chemical Engineering	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 705	PEC	Elective – I	3	--	--	2	3	ESE	60	24	40
								ISE	40	---	
CHE 701T	PCC	Transport Phenomena	--	1	--	1	1	ISA	25	10	10
CHE 706T	IP	In-Plant Training	--	--	2	1	2	ISA	25	10	10
CHE 707T	PCC	Comprehensive Tests	--	--	2	1	2	ISA	75	30	30
CHE 703P	PCC	Chemical Process Design	--	--	2	1	2	ISA	25	10	10
								POE	25	10	10
CHE 704P	PCE	Mathematical Modeling in Chemical Engineering	--	--	2	1	2	ISA	25	10	10
								POE	25	10	10
CHE 708P	PW	Project Work & Seminar	--	--	6	2	6	ISA	50	20	20
								POE	25	10	10
CHE 709A	--	**Audit Course – VII** Certificate Course in Piping & Design / Industrial Safety offered by the respective program	--	--	--	--	--	--	--	--	--
			15	1	14	20	30	--	800	---	--

Note:

1] Weekly Contact hours are not mentioned for Industrial Internship Course, as student is expected to be in industry regularly for 12 weeks. However, Student needs to report to institute mentors as and when required.

2] The evaluation of industrial internship will be carried out in the final year examination.

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Chemical Engineering)

Semester-VIII

(To be implemented from 2023 - 24)

Credit Scheme

Capstone Pattern / Academic Pattern

Course Code	Category	Course Title	Teaching Scheme					Examination & Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
CHE 801	PCC	Process Economics and Project Engineering	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 802	PCC	Process & Plant Safety	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 803	PEC	Elective – II	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 804	PEC	Elective – III	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 801T	PCC	Process Economics and Project Engineering	--	1	--	1	1	ISA	25	10	10
CHE 802T	PCC	Process & Plant Safety	--	--	–	–	--	*ISA	25	10	10
CHE 803T	PEC	Elective – II	--	--	–	–	--	*ISA	25	10	10
CHE 804T	PEC	Elective – III	--	--	–	–	--	*ISA	25	10	10
CHE 805P	PCC	Advanced Separation Processes	1	--	2	2	3	ISA	25	10	10
								POE	25	10	10
CHE 806P	PW	Project Work	--	--	6	4	6	ISA	100	40	40
								POE	150	60	60
CHE 808A	--	**Audit Course – VIII** Paper Presentation / Publication Project	--	--	--	--	--	--	--	--	--
			13	1	8	19	22	--	800	---	--

* indicates the ISA will be based on assignments and hands on programming.

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar

Final Year B. Tech. (Chemical Engineering)

Semester-VIII

(To be implemented from 2023 - 24)

Credit Scheme

Industrial Internship Pattern

Course Code	Category	Course Title	Teaching Scheme					Examination & Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
CHE 801	PCC	Process Economics and Project Engineering	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 802	PCC	Process & Plant Safety	3	--	--	3	3	ESE	60	24	40
								ISE	40	---	
CHE 801T	PCC	Process Economics and Project Engineering	--	1	--	1	1	ISA	25	10	10
CHE 802T	PCC	Process & Plant Safety	--	--	--	--	--	*ISA	25	10	10
CHE 805P	PCC	Advanced Separation Processes	1	--	2	2	3	ISA	25	10	10
								POE	25	10	10
CHE 806P	PW	Project Work	--	--	6	4	6	ISA	100	40	40
								POE	150	60	60
CHE 807P	II	Industrial Internship	--	--	6	6	6	ISA	100	40	40
								POE	150	60	60
CHE 808A	--	**Audit Course – VIII** Paper Presentation/ Publication Project	--	--	--	--	--	--	--	--	--
			7	1	14	19	22	--	800	---	--

* indicates the ISA will be based on assignments and hands on programming.

List of Professional Elective Course

Sr. No.	B. Tech. (Chem) Semester-VII	B. Tech. (Chem) Semester-VIII	
	PEC-CH-705 Elective-I	PEC-CH-803 Elective-II	PEC-CH-804 Elective-III
1	**Petroleum Refinery Engineering**	**Petro Chemical Technology**	**Energy Conservation and Resources**
2	**Optimization Techniques in Chemical Engineering**	**Artificial Intelligence in Process Engineering**	**Nano Technology**
3	**Green Processes**	**Chemical Product Design and Process Development**	**Down Stream Processing**

PCC-CH-701
TRANSPORT PHENOMENA

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hours/week	**ISE**	:	40 Marks
Credits	:	2	**ESE**	:	60 Marks
Tutorial	:	1 hours/week	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	NA
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• Students will be able to get depth knowledge of momentum, energy and mass transfer
• Applications of fundamental subjects learned, towards chemical engineering problems
• Ability to analyze industry oriented problems

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Understanding of transport processes. .	Recall
CO2	Student will learn to establish and simplify appropriate conservation statements for momentum, energy and mass transfer processes.	Understand
CO3	Ability to do momentum, energy and mass transfer analysis.	Understand
CO4	To apply conservation principles, along with appropriate boundary conditions for any chemical engineering problem.	Apply

Description:		
Prerequisites:	1:	Fluid Mechanics & Heat Transfer
	2:	Mass Transfer

Section – I		
Unit 1	**Introduction** Viscosity and the mechanism of momentum transport: Newton's law of viscosity, non Newtonian fluids, pressure & temperature dependence of viscosity, estimation of viscosity from critical properties. Velocity distribution in laminar flow Shell momentum balances, boundary conditions, flow of a falling film, flow through a circular tube, flow through annular, creeping flow along a solid sphere.	**6 hrs.**
Unit 2	**The equations of change for isothermal systems:** Time derivatives, the equation of continuity, the equation of motion, the equations of change in curvilinear, co-ordinates, use of the equations of change to set up steady flow problems. **Velocity distributions:** Time-Dependent Flow of Newtonian Fluids Unsteady viscous flow, flow near a wall suddenly set in motion.	**5 hrs**

Unit 3	**Inter phase transport in isothermal systems:** Definition of friction factors, friction factors for flow in tubes, friction factors for flow around spheres, friction factors for packed column. **Macroscopic balances for isothermal systems:** The Macroscopic mass balance, the macroscopic mechanical energy balances, estimation of friction loss. **Thermal conductivity and the mechanism of energy transport:** Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids, theory of thermal conductivity of gases at low density.	**7 hrs**
	Section – II	
Unit 4	**Temperature distributions in solids and in laminar flow:** Shell energy balance, boundary conditions, Heat conduction with an electrical heat source, Heat conduction in cooling fins, heat conduction with exothermic reactions. **Interphase Transport in Non isothermal Systems:** Definition of heat transfer coefficients, Heat transfer coefficient for forced convection in tubes, Heat transfer coefficient for forced convection around submerged objects and through packed beds, Heat transfer coefficient for free convection, Heat transfer coefficient for condensation of pure vapors.	**7 hrs**
Unit 5	**Diffusivity and the mechanism of mass transports:** Definitions of concentrations, velocities & mass fluxes, Fick's law of diffusion, Temperature & pressure dependence of mass diffusivity, Maxwell's law of diffusion. Concentration distributions in solids and in a laminar flow: Shell mass balance, boundary conditions, diffusion through a stagnant gas film, Diffusion with heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction, Diffusion in to a falling liquid film.	**6 hrs**
Unit 6	**Introduction to the Computational Fluid Dynamics:** Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, in viscid, potential and creeping flows, classification of flows, Grid Generation, Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving engineering problems.	**5 hrs.**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2						3								1	
CO3										2					
CO4					2										1
CO5									1				2		
CO6				3											

References:

	Text Books
1	R.B. Bird, W.E. Stewart and E.N. Lightfoot, —Transport Phenomenal, John Wiley & Sons, Inc, New York.
	Reference Books
1	C.O. Bennett, J.E. Mayers, —Momentum, Heat & Mass transfer , 3 Edn.,McGraw Hill, Chemical Engineering Series,1985.
2	Alan S. Foust, Leonard A. Wenzel, Curtisw Clump, Louis Maus,L Bryce Andersen
3	Principles of Unit Operationsl,2ndedn.,McGraw Hill, 1985, C.J. Geankoplis" Transport Processes Momentum And Mass" Bacon Inc. 1983.
4	L.E. Sissom& D.R. Ritts ,"Elements of Transport Phenomena" McGraw Hill, J.R. Welty, R.E. Wilson & C.E. Wicks, " Fundamentals of momentum, heat & mass transfer" 2nd edn. John Wiley, New York 1973.
5	Anderson Jr J. D., —Computational Fluid Dynamics: The Basics with Applicationsl, McGraw Hill.1995
6	Muralidhar K. and Sundararajan T., —Computational Fluid Flow and Heat Transferl, Narosa Publishing House. 2003
7	Ranade V. V, —Computation Flow Modeling for Chemical Reactor Engineering, Academic Press. 2002

PCC - CHE- 702
CHEMICAL PROCESSES & GREEN TECHNOLOGY

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60Marks
Tutorial	:	-	**ISA**	:	-
Credits	:	-	**POE**	:	NA
Total Credits	:	3	**Total Marks**	:	100

Course Objectives: The objective of the course is to
• To learn Chemical Glass processes and Nitrogen based Products.
• To learn Chemical manufacturing processes of chloro- alkali industries & Sulfuric Acid industries.
• To study an Explosives, Phosphorous industries and Alcohol Industries.
• To learn green Chemistry , Ecological threats, Nonconventional Fuels & Sustainable development
• To learn Pharmaceutical industries:

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Students will able to explain Chemical processes and the role of Chemical Engineer in Chemical field and manufacturing processes of Glass and Nitrogen based Products	Recall
CO2	Students will able to explain knowledge of manufacturing processes of chloro-alkali industries & Sulfuric Acid industries.	Understand
CO3	Students will able to know the types of Explosives and manufacturing processes of Fermentation Industry.	Understand
CO4	Students will able to aware the importance of Green Chemistry & Ecological Threats.	Apply
CO5	Students will able to explain the Nonconventional Fuels & Sustainable development.	Understand
CO6	Students will able to explain knowledge of Pharmaceutical industries.	Understand

Description:		
Prerequisites:	1:	Student should have a knowledge of Basic Chemistry
	2:	Student should have knowledge of Unit Operations of Chemical Engineering.

Section – I		
Unit 1	**Glass & Nitrogen industries**	
	Glass raw materials, Manufacturing, Types and Applications Synthetic ammonia, Nitric acid, Ammonium nitrate, Urea	**5hr**
Unit 2	**Chloro – alkali and electrolytic industries**	
	Soda ash, caustic soda, Chlorine,Bleaching powder, Sodium bicarbonate, Aluminum, Sodium, Chlorates and perchlorates Sulfuric Acid- Frasch Process, Manufacturing of sulphuric acid	**5hr**
Unit 3	**Explosives and Fermentation Industry**	
	Explosives: Types of explosives, explosive characteristic, Industrial explosives, propellants, missiles. Elemental phosphorous, Raw materials and process for phosphoric acid, Manufacturing of ammonium phosphate, Baking powder. Absolute Alcohol, Beer, wines &liquors, vinegar , citric acid and lactic acid	**8hr**
Section – II		
Unit 4	**Green Chemistry & Ecological Threats**	
	An Overview, Energy Scenario in the world, twelve principles of green chemistry, The Greenhouse Effect, Climate Change, Ozone Layer Depletion, Global Warming, Kyoto protocol and Carbon credits, photochemical smog, Old Technology vis-à-vis Green Technology with Suitable examples to understand comparative advantage of Green Technology over Old one, Renewable resources , Process intensification	**7hr**
Unit 5	**Nonconventional Fuels & Sustainable development**	
	Green chemistry in batteries, Fuel cell and electric vehicles, Solar energy and hydrogen production, biodiesel, bio-hydrogen. Esterification and transesterification processes, catalyst concentration, methanol to oil ratio, reaction temperature, reaction time Best practices in Green Chemistry for sustainable development with suitable examples	**7hr**
Unit 6	**Pharmaceutical industries:**	**4hr**
	Classification of pharmaceutical products. Manufacture of antibiotics, Isolates from animals	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2								1				1		
CO2	2	1							1				1		
CO3	2	1		1							1			1	
CO4	2	1					2	1						1	
CO5	2	1					2	1						1	
CO6	2								1		1		1		

References:

Text Books	
1	George T. Austin, —Shreve's Chemical Process Industries, 5th edn. , McGraw Hill Book Company, 1985. References:
2.	Paul T. Anastaj; —Green Chemistry – Theory and Practicel
Reference Books	
1	S.D. Shukla, G.N. Pandey. —A Text book of Chemical Technology, 3rd Edition.
2	C.E. Dryden, —Outlines of Chemical Technology, Affiliated East-West Press, 1973
3	D. Venkteshwaralu, —Chemical Technology, I & III manuals of Chemical Technology Chemical Engg. Ed. Dev. III Madras, 1977
4	Faith, —Industrial Chemicalsl
5	Rogers, —Industrial Chemistry.
6	Anastas, P.; Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London, 1998
7	Zimmerman, J.B.; Anastas, P.T. —The 12 Principles of Green Engineering as a Foundation for Sustainabilityl in Sustainability Science and Engineering: Principles. Ed.Martin Abraham, Elsevier Science. available 2005.
8	Anastas, P.; Zimmerman, J. —Design through the Twelve Principles of Green Engineering,l Environmental Science and Technology, 37, 94A – 101A, 2003.

PEC –CHE 703
CHEMICAL PROCESS DESIGN

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60Marks
Practical	:	2 hrs /week/Batch	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	25Marks
Total Credits	:	4	**Total Marks**	:	150

Course Objectives: The objective of the course is to

- Give up-to-date knowledge for designing the process equipment such as heat and mass transfer equipment used in chemical process plants.
- Have the knowledge to analyze a problem and finding a process design method for the equipment used in chemical process plants.
- Study and Use latest Computer Software and application of these software to design and solve process design problems.

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Understand various types of Process Flow sheets and Symbols.	Understand
CO2	Do Process Designs of heat transfer equipments.	Do
CO3	Do Process Designs of mass transfer equipments.	Do
CO4	Finalize Process Designs with the help of design software.	Finalize
CO5	Prepare printed outcomes of various Flowsheets and Process Designs.	Prepare
CO6	Use and apply the knowledge to execute Process Designs.	Apply

Description:

Prerequisites:	1:	Basic idea of Chemical equipment and their Nomenclature.
	2:	Mechanical details of Stress-Strain and Dimensional analysis.
	3:	Completion and Knowledge of Chemical Equipment Design course.

Section – I		
Unit 1	**Flow sheet preparation and drawing**	
	The nature and function of process design, sketching techniques, Equipment Lettering and Numbering, Equipment Symbols, Instruments Symbols, Stream designations for Process and Utility. Process Planning, Scheduling and Flow Sheet Design, Organizational structure, Process design scope, Types of Flow sheets, P and I diagrams.	
Unit 2	**Heat Exchangers**	
	Process Design of Counter Flow Double pipe heat exchanger (DPHE) Process Design of Counter Flow Shell and Tube heat exchangers (STHE)	
Unit 3	**Multiple Effect Evaporator**	
	Process Design of Multiple Effect Evaporator (MEE) design with Forward Feed and Backward Feed Arrangements.	
Section – II		
Unit 4	**Distillation**	
	Process Design of Binary Distillation Column	
Unit 5	**Cyclone Separator**	
	Process Design of Gas-Solid Cyclone Separator	
Unit 6	**Software for Design of Chemical Process Plant**	
	Application and Use of Computer Programs for Chemical Process Piping and Equipment Design. Case studies involving the application of Computer Software Packages such as Aspen /Aspen Plus /Chem Cad / Hysis (UniSim) / DWSIM /PDMS/P & ID or any other software for Design of Chemical Process Equipment.	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	1	2		2			3				1	1		
CO2	1	1	3		3			2				1	1	2	
CO3	1	1	3		3			2				1	1		
CO4	1	3	3	1	2	1	1	3	1	3		1		2	2
CO5			1	1	2	1		2	3		2			2	3
CO6	1		2		1	3		1	1		2	2			3

References

Text Books	
1	G.D.Ulrich, "A Guide to Chemical Engineering Process Design and Engineering", John Wiley and Sons, New York, 1984.
2	D.Q. Kem, "Process Heat Transfer", Tata McGraw Hill Company, New York, 1997. Process Simulation and Control using Aspen, A.K. Jana, Prentice Hall of India
3	Richardson and Coulson Vol. 6
Reference Books	
1	E.E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol.I,II,III, Gulf Publication, 3rd edition London, 1994.
2	R.H. Perry & Don W. Gress, "Perry's Chemical Engg.", Hand-book , 7th Edition McGraw Hill Company, New York, 1997.
3	S.D. Dawande, "Process Design of Equipment", Dennet Publication, Vol. I and II, 5th Edition 2005.
4	R. E. Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill Company, Singapore, 1980.

NOTE :TKIET Institute Approved DATA BOOK may be Provided for ISE/ ESE.

Additional Timing of HALF / ONE HOUR may be given to search Live Data from DATA BOOK During ISE / ESE compared with the other subjects.

TERM - WORK

Drawing and Representation of the following on any Design Software :(**Minimum Seven**)

1. Equipment symbols
2. Instrument symbols
3. Process and Utility Stream designations
4. Instrumentation diagrams
5. DPHE
6. STHE
7. MEE
8. Binary Distillation Column
9. Batch Reactor
10. Cyclone Separator

PCE-CHE -704

MATHEMATICAL MODELING IN CHEMICAL ENGINEERING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Practical	:	2 hrs per week	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	25 Marks
Total Credits	:	4	**Total Marks**	:	150 Marks

Course Objectives: The objective of the course is to
• To introduce basic concepts of modeling and fundamental equations for systems in chemical process industries
• To develop system and to visualize the effect of various Processes inputs on • system performance and state variables
• To introduce the basics of simulation software used in chemical engineering

Course Outcomes:

Cos	At the end of successful completion of the course the student will beable to	Blooms Taxonomy
CO1	Remember the basics of modeling and physical and chemical laws for the given system	Remember
CO2	Apply model equations for the given chemical system	Applying
CO3	Understand mathematical model of systems	Understanding
CO4	Evaluate model equations for the mass transfer operations	Evaluating
CO5	Analyze model equations for the plug flow reactor	Analyzing
CO6	Understand simulation software used in chemical engineering	Understanding

Description:		
Prerequisites	1:	Chemistry, Engineering Mathematics,
	2:	Material & Energy Balance Calculations,
	3:	Chemical Engineering Thermodynamics,

Section – I		
Unit 1	**Basic Modeling:** Introduction to modeling–Types of Models, Dependent & Independent Variables, Application and scope coverage, Modeling fundamentals, Chemical engineering modeling, several aspects of the modeling approach, general modeling procedure	5 Hrs.
Unit 2	**Formulation of dynamic models:** Mass balance equation - Balancing procedure, Case studies: CSTR, Tubular reactor, Total mass balance – Case Studies: Tank drainage, Component balances - Case Studies: Waste holding tank, Energy balance-Heating in a filling tank, Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – Dimensionless model equations, CSTR, Gas liquid mass transfer in a continuous reactor.	7 Hrs.
Unit 3	**Modeling of stage wise processes:** Introduction, Stirred tank reactor, Reactor Configurations, Heat transfer to and from reactors, Steam heating in jacket, Dynamics of the metal jacket walls, Batch reactor – Constant volume, Semi - batch reactor, CSTR - Constant volume CSTR, CSTR cascade, Reactor stability.	6 Hrs.
Section – II		
Unit 4	**Mass transfer models:** such as liquid-liquid extraction, distillation, multicomponent separation, multicomponent steam distillation, absorber- stage wise absorption, steady state gas absorption with heat effects, evaporator, Heat Transfer Models (Heat exchanger, Evaporator, etc).	7 Hrs.
Unit 5	**Dynamic modeling:** Plug flow reactor, Plug flow reactor contactors, Liquid– liquid extraction column.	4 Hrs.
Unit 6	**Simulation of chemical engineering:** Process simulation, Scope of process simulation, Formulation of problem, Step for steady state simulation, Process simulation approaches for steady state simulation, Strategies, Process simulator, Structure of process simulator, Integral process simulation, Simulation tools, ISIM, ICAS– Integrated Computer Aided System, Sequential modular method.	7 Hrs.

Practical's:

1. Mathematical modeling and simulation of gravity flow tank.
2. Mathematical modeling and simulation of Interacting tank reservoir system.
3. Mathematical modeling and simulation of CSTR.
4. Mathematical modeling and simulation of liquid – liquid extraction column.
5. Mathematical modeling and simulation of Shell and Tube heat exchanger.
6. Mathematical modeling and simulation of Batch Distillation
7. Mathematical modeling and simulation of complex Batch reactor.
8. Mathematical modeling and simulation of multicomponent distillation column.

Note- Experiments are conducted by using Aspen Plus software and any Open source software. ChemSep , Berkely madonna

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	3	3	2										2	
CO2	2	3	3	2									3		
CO3	1	3	2	3	1										2
CO4	2	3	3	3	2	1									
CO5	2	3	3	3	3	1	1	1	1					1	
CO6	1	2	2	2	2	2	2	1	2	1					

References:

	Text Books
1	John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, —Chemical Engineering Dynamics, VCH Publishers Inc., New York,1974.
2	C. L. Smith, R. L. Pike and P. W. Murill, —Formulation Optimization of Mathematical Models□, International Text, Pennsylvania,1970.
3	R. W. Gaikwad, Dr. Dhirendra, — Process Modeling and Simulation, Central Techno Publications, Nagpur, 2003.
	Reference Books
1	W. L. Luyben, —Process Modeling, Simulation and Control for Chemical Engineering, McGraw Hill Book co., 1973.

PEC - CHE – 705 – 1 – Elective – I
PETROLEUM REFINERY ENGINEERING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	2	**ESE**	:	60Marks
Tutorial	:	-	**ISA**	:	--
Credits	:	-	**POE**	:	NA
Total Credits	:	2	**Total Marks**	:	100

Course Objectives: The students completing this course are expected to understand and learn
• What is crude oil, what are various petroleum resources
• Origin of petroleum, exploration techniques and drilling techniques in details
• Composition, classification, distillation & separation techniques including pre-treatment.
• Properties & specification of petroleum products and overall separation processes
• Various conversion processes, Treatment methods and post production operations of Petroleum refineries.
• Recent trends, advancement in Petroleum refineries

Course Outcomes:

Cos	At the end of successful completion of the course	Blooms Taxonomy
CO1	Students will get aware about basic information about crude, resources and overall scenario of refineries in India as well across the world.	Aware
CO2	Students will be able to understand about origin, exploration techniques, Drilling Rigs and Drilling techniques in detailed manner..	Understand
CO3	Students will be able to understand composition, Classification of crude oil and able to understand various distillation processes & separation methods.	Understand
CO4	Students will be able to understand properties and specification of petroleum products and Overall separation processes	Understand
CO5	Students will be able to evaluate various steps in conversion processes, treatments and post operations in refinery.	Evaluate
CO6	Students will be able to analyse about recent trends, capacities of petroleum refineries.	Analyse

Description:		
Prerequisites	1:	Chemistry and reactions
	2:	Unit operations

Section – I		
Unit 1	**Introduction to petroleum refineries:** Resources of petroleum ,Origin and exploration techniques, Origin of petroleum, methods of exploration, drilling rigs, drilling techniques, production methods of crude oil, etc.	6 Hrs.
Unit 2	**Pre-refining operations:** Composition of crude, classification of crude, types of distillation methods – ASTM, TBP, pretreatment of crude, Different arrangement of Distillation column, Multi component of atmospheric distillation, vacuum distillation, transportation of crude.	6 Hrs
Unit 3	Properties and specifications of fuel gas, LPG, gasoline, naphtha, jet fuel, kerosene, diesel, lubricating oils, greases, waxes, coke, etc. Separation processes: Solvent extraction processes, solvent de-waxing.	6 Hrs
Section – II		
Unit 4	**Conversion process:** Thermal cracking, tiebreaking, coking, catalytic cracking, thermal reforming, catalytic reforming, hydro cracking, hydro processing, alkylation, Isomerization and polymerization.	8 Hrs
Unit 5	**Treatment methods:** Sweetening process, hydrodesulphurization, smoke point improvement.	6 Hrs
Unit 6	**Post production operations:** Blending of additives (ETBE, MTBE, Ethanol, Lead), of products, marketing of petroleum and petroleum products, safety and pollution considerations in refineries. **Recent trends in petroleum refineries:** Recent trends in petroleum in terms of Distillation, Packing materials, Catalyst, Non conventional fuels, Necessity of Bio-fuels, Trans-esertification process, etc.	6 Hrs

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2						3								1	
CO3										2					
CO4					2										1
CO5									1				2		
CO6				3											

References:

Text Books	
1	Petroleum Refinery Engineering , Dr. Ram Prasad
2	Gary J H, Handwerk G E, _Petroleum refining
Reference Books	
1	Nelson W. L., —Handbook of Petroleum Refinery Engg.I, McGra Hill,International, Auckland,1982
2	B. K. Bhaskara Rao Modern Petroleum Refining Processes
3	Guthre, V.B., —Petroleum ProductsI, Hand-Book McGraw Hill.

PEC –CHE – 705 – 2 - Elective – I
OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs/week	**ISE**	:	40 Marks
Credits	:	2	**ESE**	:	60Marks
Tutorial	:	---	**ISA**	:	---
Credits	:	---	**POE**	:	NA
Total Credits	:	2	**Total Marks**	:	100

Course Objectives: The objective of the course is to
• Introduces the basic concepts in optimization and how to obtain a mathematical representation of the optimization problem.
• The basic theoretical principles in optimization, formulate the optimization problem, and choose appropriate method/solver for solution of the optimization problem.
• The course includes both linear and nonlinear programming problems.
• A set of software tools for solution of optimization problems are also discussed.
• An emphasis on problems arising in Chemical Engineering applications.

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	The basic concepts in optimization.	Recall
CO2	Obtain a mathematical representation of the optimization problem.	Understand
CO3	Linear and nonlinear programming problems.	Understand
CO4	Formulate the optimization problem, and choose appropriate method/solver for solution	Apply
CO5	Select a set of software tools for solution of optimization problems.	Analysis
CO6	Exercise the Chemical Engineering applications	Evaluate

Description:		
Prerequisites	1:	Mathematics
	2:	Unit operations

Section – I		
Unit 1	**Introduction**	
	Introduction, Scope, Function of single variables, Methods of optimum point search and Constrained optima, Equality constraints, Inequality constraints	
Unit 2	**Functions**	
	Multivariable functions. Direct search methods, First order, second order methods	
Unit 3	**Application in Unit operations**	
	Application to flashing of multicomponent mixture, Equilibrium composition of products of chemical reactions, Heat conduction etc. applications there to batch distillation column, Ammonia synthesis etc.	
Section – II		
Unit 4	**Mathematical Programming**	
	Linear programming, Non – linear programming, Geometric programming, Mathematical Tool – Solver in Excel	
Unit 5	**Applications in Programming**	
	Applications to extraction and solvent recovery systems, Condenser design, Complex chemical Equilibria	
Unit 6	**Dynamic Programming**	
	Dynamic programming and its applications, Pumping Stations Distribution, variation methods and its applications.	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2						3								1	
CO3										2					
CO4					2										1
CO5									1				2		
CO6				3											

References:

Text Books	
1	Optimization of Chemical Processes – T.F. Edgar and Hemmelblue, McGraw Hill Book Company
2.	Optimization – Theory and its Applications, S. R. Rao.
Reference Books	
1	C.L. Smith, R. N. Pike, P. W. Muralli, Formulation and Optimization ofMathematical Model, International Textbook Co., Perrylvania – 1970.
2	Moocs/ Swayam/NPTEL Courses on Optimization in Chemical Engineering

PEC –CHE – 705 – 3 - Elective – I
GREEN PROCESSES

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Practical	:	--	**ISA**	:	--
Credits	:	2	**POE**	:	--
Total Credits	:	3	**Total Marks**	:	100 Marks

Course Objectives: The objective of the course is to		
Course Outcomes:		
Cos	**At the end of successful completion of the course the student will beable to**	**Blooms Taxonomy**
CO1	To provide basic knowledge on green technology.	Create
CO2	To understand the principles of green chemistry and eco friendly methodologies	Analyse
CO3	To create awareness on Cleaner development mechanisms.	Create
CO4	To develop concepts on various energy efficient Green process systems.	Evaluate
CO5	To implement Green technologies for addressing the problems of different process.	Understand
CO6	To understand Challenges and Practical Implementation	Implement

Description:		
Prerequisites:	1:	Environment Engineering
	2:	Engineering Chemistry

Section – I		
Unit 1	**Green technology :Definition, importance, factors affecting** Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems **Concepts of green chemistry and Process intensification**	9 Hrs.
Unit 2	**Green Synthesis and Catalysis:** Green oxidation and photochemical reactions, Microwave and Ultrasound assisted reactions, Synthesis of Green Reagents, Green solvents, Green nanotechnology and Ionic liquids. Solvent free techniques- Reaction on solid supports. Alternative solvents Ionic liquids- general synthesis, applications.	8 Hrs.
Unit 3	**Cleaner development technologies:** Cleaner development mechanisms, role of industry; reuse, reduce and recycle, raw material substitution; wealth from waste; carbon credits, carbon trading, carbon sequestration, eco labelling. Oxidation technology for waste water treatment- Cavitation, Fenton chemistry, photocatalysis and hybridprocesses.	8 Hrs.
Section – II		
Unit 4	**Green process : Fuel cell , Green Hydrogen, Ethanol** Advanced Fuel cell Technology, Application Advanced technology for production of green hydrogen Green process in Ethanol Production :1G,2G,3G and 4G	8 Hrs.
Unit 5	**Industrial case studies:** Green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies	8 Hrs.
Unit 6	**Challenges and Practical Implementation:** Responsibilities and potentials of companies for action. Green Productivity and emerging technologies. Implementation of the practical applications of Green emerging technologies and sustainable development. Case studies in Green Technology. Green laws compliance	9 Hrs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2	1	2	1	-	-	2	1	-	-	-	-	-	-	-
CO2	2	1	2	1	-	-	2	1	-	-	-	-	-	-	-
CO3	2	2	2	1	-	-	2	1	-	-	-	-	-	-	-
CO4	2	2	2	1	-	-	2	1	-	-	-	-	-	-	-
CO5	2	3	2	1	-	-	2	1	-	-	-	-	-	-	-
CO6	2	2	2	2	-	-	2	1	-	-	-	-	-	-	-

References:

	Text Books
1	Paul T. Anastaj; —Green Chemistry – Theory and Practice
2	Albert S. Matlack ; —Introduction to Green Chemistry
	Reference Books
1	Anastas, P.; Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London, 1998.
2	Zimmerman, J.B.; Anastas, P.T. —The 12 Principles of Green Engineering as a Foundation for Sustainability in Sustainability Science and Engineering: Principles. ‖ Ed. Martin Abraham, Elsevier Science. available 2005.
3	Anastas, P.; Zimmerman, J. —Design through the Twelve Principles of Green Engineering, Environmental Science and Te ‖ chnology, 37, 94A – 101A, 2003.

IP -CHE 706T
INPLANT TRAINING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	NA	**ISE**	:	NA
Credits	:	--	**ESE**	:	NA
Practical's	:	2 hrs per week	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	NA
Total Credits	:	1	**Total Marks**	:	25

In-Plant Training:		
	In-Plant Training Evaluation:	
	1. The students are required to undergo at least **four weeks** of In-plant training during summer vacation between T.Y. B.Tech Part -II and Final year B.Tech Part –I. **2.** They will be required to submit a **written report** on their In-plant training. The report should consist of Major products of the company, Plant description General plant layout Processes for Major Products (no confidential proprietary information may be included) **3.** Chemistry of processes studied (in case of chemical manufacture) based on Journal papers, Patents, Books, etc. Safety and Health (Material Safety Data Sheets, Safety Policy) Environmental Protection (measures used and general description of the processes and facilities used) Standards and compliance thereof (ISO 9000, ISO 14000, OHSAS 18000, etc.) **4.Three Major Equipment** – description with sketch (no detailed drawing to be given: just a sketch with major dimensions, nozzle location and dimensions thereof) Heat Exchangers: total number and types, Pumps and Compressors: total number and types, Improvements proposed by the student, for example, Power savings for pumps, blowers, compressors, etc. Cycle time reduction in case of batch processes, Waste heat recovery, Waste solvent recovery, Product quality improvement, Any project assigned to you by the company (title, a short description, results and conclusions. **5.** Students will present their work before a panel of teachers in the Institute which will be assessed internally at B.Tech. Part -I. **6.**The report would carry 50% weightage and the presentation would carry 50% weigh In case, due to illness or any other reasonable problems the student fails to undergo above said training, he may be allowed to visit/ tour some industries and submit a report.	

PCC –CHE 707T
COMPREHENSIVE TESTS

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	--	**ISE**	:	--
Credits	:	--	**ESE**	:	--
Practical	:	2 hrs / week	**ISA**	:	75 Marks
Credits	:	1	**POE**	:	--
Total Credits	:	1	**Total Marks**	:	75

The objectives of the comprehensive test are to assess the overall level of proficiency and the scholastic attainment of the student in the various subject's studies during the degree course by conducting weekly tests. The Staff member/members shall guide the student in preparing for the weekly tests, which consists mainly bit questions and small problems. The term work assessment shall be based on the performance of the student in the test. Minimum10 tests should be conducted.

QUESTION PAPER STRUCTURE (TOTAL 50 Marks)

GATE PATTERN: (50 Marks)

20 Multiple Choice Questions --- 20 Marks (One Mark Each)
15 Problematic Questions --- 30 Marks(Two Marks Each)

INDUSTRY ORIENTED PATTERN : (25 Marks)

25 Campus Short Questions Related with Subject --- 25 Marks(One Mark Each)

Syllabus of varioussubjects forthetest

1.Mathematics:-

Linear Algebra, Calculus, Differential equations, Complex variables, Probability and Statistics, Numerical Methods

2.Mechanical Operation: -

Size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

3.Fluid Mechanics:-

Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory

4.Heat Transfer: -Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

5.Process Calculations: -

Laws of conservation of mass and energy; use of tie components; recycle, by pass and purge calculations; degree of freedom analysis.

6.Mass Transfer:-

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage wise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquidextraction, drying, humidification, dehumidification and adsorption.

7.Chemical Reaction Engineering:-

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

8.Instrumentation &Process Control:-

Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

9.Chemical Technology:-

Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

10.Plant Design & Economics:-

Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

References: -

1. A text book of Applied Mathematics: Vol.I,IIandIIIbyJ. N.Wartikar& P. N.Wartikar, Vidyarthi Griha Prakashan, Pune.
2. McCabeW.L. and Smith J.C._ Unit Operations of Chemical Engg. 'VIIed. Mcgraw Hill Book Co., International ed. 1993
3. Himmelblau D.M.,—Basic Principles and Calculations in Chemical Engineeringl, Sixth Edition, Prentice-Hall of India Pvt. Ltd., 2004.
4. J.M.Smith and H.C.VanNess,— Introduction to Chemical Engg.l,
5. Thermodynamics 6th Edition, International student edition, McGraw Hill publication. Eckman D.P.—Industrial Instrumentationl, Willey Eastern Ltd,New Delhi,1984.
6. Robert E.Treybal,—Mass Transfer Operationsll, Third Edition, McGraw Hill,1980.
7. StephanopoulosG,—ChemicalProcessControlandintroductiontotheoryandpracticel
8. S.H.Fogler,lElementsofChemicalReactionEngineeringl,PHI,3rdEdition.
9. GeorgeT. Austin,—Shreve'sChemicalProcess Industriesl,5thedn.,McGrawHillBookCompany,1985.
10. M.S. Peters &K.D.Timmerhaus, —Plant Design and Economics for Chemical Engineersl, 3rd edition,McGraw HillInternational Book Co., 1980.

CHE 708P
PROJECT WORK & SEMINAR

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	--	**ISE**	:	-
Credits	:	--	**ESE**	:	-
Practical	:	6 hrs / week	**ISA**	:	50 Marks
Credits	:	2	**POE**	:	25Marks
Total Credits	:	2	**Total Marks**	:	75 Marks

Course Objectives: The objective of the course is to
1: An ability to apply one's knowledge of mathematics, science, and engineering
2: An ability to design and conduct experiments, as well as to analyze and interpret data
3: An ability to design a system, component, or process to meet the needs within realisticconstraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
4: An ability to function on multidisciplinary teams.
5: An ability to identify, formulate, and solve engineering
6: An understanding of professional and ethical responsibilities.
7: An ability to communicate effectively.
8: A broad education in order to understand the impact of engineering solutions in a global,economic, environmental and societal context.
9: A recognition of the need for, and an ability to engage in, life-long learning.
10: Knowledge of contemporary issues.
11: An ability to use the techniques, skills and modern engineering tools that are necessary for engineering practice

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Projects offer the opportunity to apply and extend material learned throughout the program.	Understand
CO2	Personal competences of students are reinforced most during the FYP process, including the preparation, elaboration, presentation and defense stage.	Analyze
CO3	Students will learn , a seminar presentation, submission of a thesis, and a public demonstration of work undertaken.	Understand
CO4	Students will learn and experience the process of conducting a good research project	Create
CO5	Students will understand socio-economic process.	Apply

Description:

Prerequisites	1:	Student must have knowledge of basics/fundamentals of chemical Engg.
	2:	Student must have computer literacy
	3:	Student must have presentation skills &analytical skills

Project Guidelines

The project work is to be completed under the guidance of a guides and /or External guides and submit a typed report in duplicate.

The Project Report consists of

1) Certificate
2) Acknowledgement
3) Statement of Problem
4) Synopsis / Abstract.
5) Index.
6) Introduction.
    - Importance of Project
    - Market Situation
    - Consumption Data
    - Need of such Plant

7) Literature survey – Process Selection.
8) Theoretical conditions – Process Parameters, Composition.
9) Process Description – Process Floe-sheet (Block Diagram)
10) Basic Engg. Data.
    - Physical
    - Chemical
    - Thermodynamic
    - Analytical Methods

11) Details of Experimental Set up & Experimental Work.- Purpose method, Chemicals, Calculations, Analysis of Data, Results, Discussion.
12) Material Balance & Energy Balance.
13) Selection of Equipments& Specifications.
14) Design of Specific Equipment.
    - Process design
    - Mechanical Design

15) Control & Safety of Process.
16) Plant layout & Location.
17) Cost Estimation & Economic Analysis
18) Pollution Control, Safety, Marketing
19) Conclusion & Remarks.
20) References.
    - Books
    - Journals

21) Appendix.
    - o List of Tables
    - oSample Calculation
    - oDataTables, etc

Each group should consist of maximum 3 to 4 students. For term-work (ISA) 50 marks,the assessment should be by conducting frequent, PPT, seminars during the year & an oral exam at the end of the year conducted by all the faculty-members members of the dept.The Head of the Dept. should see that the assessment procedure should be the same for all the students of the class. For external 25 marks, the project work shall be assessed by an oral exam to be held by at least two examiners, one internal and one external preferably fromIndustry at the end of the year.

The object of the VIVA VOCE examination (Internal and External Orals) is to determine whether the objectives of the project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the project work.

IMPLEMENTATION PROCEDURE FOR CONDUCTING FINAL YEAR PROJECT

The main objective of the Final Year Project is to learn and experience the process of conducting a good research project. The following points serve as a guideline of activities that take place in the process.

Problem Statement

A problem statement is a concise statement of the problems which initiate/spark the researchquestions or design ideas. Some of the points that could be highlighted are:

a. What is the issue that we want to address (problem or question)?

b. Why need to address the issues?

c. How the project can solve the issues?

d. Who get benefits from the project?

Objective sets a clear goal of what we want to accomplish by doing the research work. It **SHOULD NOT INCLUDE** the objective of doing the Final Year Project (e.g. to learn how to manage a project etc.). Student should only state the technical objective of the project (e.g. to evaluate the performance of the design, to test a hypotheses, to study the relationship betweenvariable x and variable y etc.). Use measurable action verbs when defining an objective (e.g. define, design, identify, describe, analyze, evaluate etc).

Scope

Scope sets a clear boundary (time, geography, environment, function etc.) of our work to providea common understanding of the project among stakeholders (in FYP the stakeholders are students, lecturer, panels etc.). Scope makes our project achievable and realistic by defining the limits and constrains of the study.

Literature review

A literature review discussed published information in a particular subject area. The purpose of aliterature review is to summarize and synthesize the ideas of others. When we write a literature review, it usually consists of 3 main sections:

a. Introduction section that describe the topic of the review.

b. Body section which contains the discussion of sources.

Conclusions from the discussion of sources and recommendations (if any). The main point inthe conclusion of the literature review would be the clarification and emphasis of the gaps (unexplored/unsolved problem in the field) and the contribution of the student's project.

The discussion of the sources could be arranged chronologically, thematically or methodologically or in combination of any of them. In the discussion, students should:

Be clear of the items that need to be discussed. It can be a variable or a technique or differentdesign decisions.

a. Make comparisons and give technical comments. Summary of the comparison could betabulated or shown in graphs to clarify the differences.
b. For engineering design, discuss on the tradeoff of a particular design decision

ISE-ASSESMENT METHODS (Project Progress)

Marks						
	First Review-Seminar I			Second Review-Seminar II		
Examination Panel	**Presentation PPT**	**Seminar report on introduction literature survey, objectives, selection, ,proposed methodology.**	**Total**	**VIVA VOCE (INTERNAL) (actual work done**	***Draft Final Report**	**Total**
Total	40	10	50	40	10	50

* indicates ,students has to submit the final typed reports by making correction suggested in second review.

Note – For final Marks , average marks of two reviews must be considered.

Draft Report

This document is a working version of the final report. You should send it to your supervisor /guideat least 2 weeks before the final report submission deadline, in order to allow your supervisor sufficient time to read it and suggest improvements. Bear in mind that your supervisor is only expected to read one draft of your report.

In your own interests, the draft report should be as complete as possible so that your supervisor/guide can give you useful feedback. Your supervisor/guide will be the examiner on other projects, and will tell you what they are looking for from the projects they examine. If your report does not conform to their expectations you will be able to rectify it in time.

This document draft is not formally assessed and should be sent directly to your supervisor./guide

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1			2									
CO2				2											
CO3								1							
CO4			1					2							
CO5							2				3				

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T.K.I.E.T, Warananagar

Tatyasaheb Kore Institute of Engineering and Technology
Department of Chemical Engineering
Autonomous Institute
Warananagar - ESTD - 1983

Seal of Institute

Final Year B. Tech Semester-VIII (Chemical Engineering)

PCC-CHE - 801
PROCESS ECONOMICS AND PROJECT ENGINEERING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Tutorial	:	1	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	-
Total Credits	:	4	**Total Marks**	:	125 Marks

Course Objectives: The objective of the course is
• To understand economical aspects in chemical industry
• To introduce and understand general common terms related to economics
• To make students to develop skills required for project Engineering

Course Outcomes:

Cos	At the end of successful completion of the course the student will beable to	Blooms Taxonomy
CO1	Apply knowledge of process design & development, general design consideration in industries.	Apply
CO2	Evaluate cost accounting, estimation & BEP analysis in industries	Evaluate
CO3	Understand types of interest, taxes, insurances, profitability, alternative investment, replacement and optimum design in industries	Understand
CO4	Apply knowledge of process development and commercialization	Apply
CO5	Select the contractor with its scope & types with concept of plant start-up.	Analyse
CO6	Knowledge of project conception and project engineering, PERT, CPM in industries.	Understand

Description:

Cost and Asset accounting, Break Evan analysis , Interest, Time value of Money, Taxes and Insurance Profitability, Depreciation, Process development and commercialization, Project conception and definition PERT/ CPM

Prerequisites	1:	Students should have basic knowledge of Process Design
	2:	Students should have basic knowledge of financial terms and transactions
	3:	should have basic knowledge of an Industry , Organization and Management

Section – I		
Unit 1	Introduction, General design considerations like plant location layout, HAZOP,FTA, SIL, QRA, Process Design Development.	**5 Hrs.**
Unit 2	Cost and Asset accounting, Different ratio in accounting, Analysis of Cost estimation and break even analysis.	**7 Hrs.**
Unit 3	Interest, Time value of Money, Taxes and Insurance Profitability, Depreciation, Alternative investments and replacements, Optimum design and Design strategy.	**6 Hrs.**
Section – II		
Unit 4	Process development and commercialization: Introduction, Exploratory research and its types, development for final process design, Process Licensing: Licensing principles, License agreement, and Agreement implementation.	**7 Hrs.**
Unit 5	Selection of contractor scope and contract types :Introduction, Detailing of scope of work, detailing of contract types, Factors in selecting type of contract. Plant Startup :Introduction, Organization of startup, Budget for startup, Information centre, Planning and schedules, Plant startup . Procurement and Construction	**4 Hrs.**
Unit 6	Project conception and definition: Selection of plant capacity Causes for time and cost over runs of a Project, Process Optimization, Selection of Alternative Processes Equipment. Project Planning, Scheduling and Controlling , PERT/ CPM - Introduction, Activity Sequencing, Network building, Time estimates, Critical path calculations.	**7 Hrs.**

Assignments:- Minimum 4 Assignments should be completed on above syllabus & 1 assignment should be on your Project i.e. Cost estimation of your project.

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	1	2			1					1	1			
CO2	2	1	1	2	1	2	1				1	2			
CO3	3		3	2	3	1		1	3	3	2		1		
CO4	2		3	1	1	3	1	1	2	2	1	2			1
CO5	2	3	2	2	3	2	2	1	1	3	2	1		2	
CO6			3	3	2	1	1	1	2	2	1	3			

References:

	Text Books
1	M.S. Peters & K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", 5th edition, McGraw Hill International Book Co., 2003.
2	J.M. Coulson & J.F Richardson, "Chemical Engineering", Vol.6, 5th edition Pergamon & ELES, 2003
3	Chemical Project Economics, Mahajani V. V. and Mokashi S M.
4	Srinath L.S. "PERT & C.P.M. Principles and Applications"3rd edition, East-West Publication 2003
5	Lundu, "The Chemical Plant".
6	GAEL D. ULRICH, "A Guide to Chemical Engineering Process Design and E" John Wiley & Sons,1984.
	Reference Books
1	Rase, H.F. Barrow, M.H. "Project Engineering of Process Plants", JohnWiley.
2	Chilton, C.H., "Cost Engineering in Process Industries", McGrawHill
3	Schewayer, H.E. "Process Engineering Economics", McGrawHill
4	V.W. Wani. & A.W. Hankins, "Technical Economics for Chemical Engineers" (AICHE) 1971.

PCC-CHE- 802
PROCESS AND PLANT SAFETY

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Tutorial	:	NA	**ISA**	:	25 Marks
Credits	:	-	**POE**	:	NA
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• The concept of industrial and social safety.
• Conceptualization of process safety management (PSM).
• Process safety responsibilities for other engineering fields.
• The necessity of process safety as demonstrated by examples of significant process safety incidents.

Course Outcomes:

Cos	**At the end of successful completion of the course the student will be able to**	**Bloom's Taxonomy**
CO1	Explain the safety.	Recall
CO2	Define the concept of "process safety management."	Understand
CO3	Learn what the Center for Chemical Process Safety (CCPS) calls the 20 process safety elements.	Understand
CO4	Process safety concerns exist with some selected unit operations.	Apply
CO5	Different parts of process safety connect to what is already taught in programs for chemical engineering.	Analysis
CO6	Describe the various responsibilities an engineer new to process safety can anticipate in their first few years on the job in terms of process safety.	Evaluate

Description:		
Prerequisites:	1:	Chemical Processes
	2:	Unit operations

Section – I		
Unit 1	**Role of safety in society**	
	Societal approach and method, the concept of societal safety, Dimensions of societal safety: extra ordinary stresses and losses, complexity and mutual dependence, Trust in vital social functions, Societal Safety and Other Safety-Related Areas, Some Dilemmas and Value Choices, Influencing societal safety the relationship between knowledge, prevention and societal safety.	
Unit 2	**Engineering aspects of process plant safety**	
	Process Safety: Risk-Based Process Safety, Process Safety Culture, Process Safety Competency and Hazard Identification. The need for process safety.	
Unit 3	**Chemical hazards and worker safety**	
	Process Hazards: Chemical Reactivity Hazards, Fires and Explosions Risk assessment methods, General principles of industrial safety, toxicity and radiations, Industrial hygiene, Introduction to industrial safety regulations.	
Section – II		
Unit 4	**Process Hazards and Safety Basics**	
	Hazards: Classifications and assessment of various types of hazards, hazard and operability studies (HAZOP), key parameters, Hazard operability (HAZOP) hazard analysis (HAZAN), industrial case study.	
Unit 5	**The Need for Process safety and Engineering disciplines**	
	Process Safety Culture: Methyl Isocyanate Release, Bhopal, India, 1984: Summary, Detailed Description, Key Lessons. Process Safety for Engineering Disciplines: Introduction, Process Knowledge Management and Compliance with Standards.	
Unit 6	**Process safety in Design and Process Hazards**	
	Process Safety in Design: General Unit Operations and Their Failure Modes, Heat Exchange Equipment, Mass Transfer, Distillation, Leaching and Extraction, Absorption, Reactors and Reactive Hazards, Storage.	

Mapping of POs & COs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2						3								1	
CO3										2					
CO4					2										1
CO5									1				2		
CO6				3											

References:

	Text Books
1	Dan Crowlet al., "Introduction to Process Safety for Undergraduates and Engineers," CCPS, Wiley.
2	Banerjee, S., Industrial Hazards and Plant Safety, Taylor &Francis, 2003.
3	Trevor A. Kletz, "Hazop& Hazan: Identifying and Assessing Process Industry Hazards", Fourth edition, CRC Press, 1999.
	Reference Books
1	G.D.Ulrich,"A Guide to Chemical Engineering Process Design and Economics",John Wiley and Sons 1934.
2	Daniel A. Crowl, Joseph F. Louvar, "Chemical Process Safety Fundamentals with Applications", Prentice Hall, Third Edition, 2011
2	Moocs/ Swayam/NPTEL Courses on Optimization in Chemical Engineering

PEC-CH-803-1 Elective-II
PETROCHEMICAL TECHNOLOGY

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Tutorial	:	NA	**ISA**	:	25 Marks
Credits	:	--	**POE**	:	--
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• What are petrochemicals, petrochemical Industries.
• Cost consideration, indigenous technology, natural gas & petroleum, classification of petrochemicals.
• Raw Materials like Organic chemicals, coal, biomass petroleum, Chemicals from Methanol & Synthesis gas.
• Chemicals from Ethane, Ethylene & Acetylene, Propane & Propylene, Butanes & Pentanes.
• Chemicals from aromatics, Polymers, elastomers, synthetic fibers, PVC, Nylon & Polyesters.
• Recent trends, advancement in Petroleum refineries, Integrated Petrochemical complex, Energy crises.

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Bloom's Taxonomy
CO1	Students will get aware about basic information about petrochemicals, industry venture.	Recall
CO2	Students will be able to understand about raw materials	Understand
CO3	Students will be able to understand about product produced	Understand
CO4	Students will be able to understand process, conditions, variables, controlling parameters	Apply
CO5	Students will be able to understand specialized product like polymers.	Analysis
CO6	Students will be able to quite aware about recent trends, energy efficient process.	Evaluate

Description:		
Prerequisites	1:	Chemical Processes
	2:	Unit operations

Section – I		
Unit 1	**General Introduction**	
	Definition of petrochemicals, history of petrochemical industry, development of petrochemical industry in India, product profile of petrochemicals, economics of petrochemical industry, general cost considerations, indigenous technology v/s foreign know-how, economics of R&D, sources of petrochemicals, natural gas & petroleum, classification of petrochemicals.	**4hrs**
Unit 2	**Raw Materials and Chemicals from Methanol, Synthesis gas**	
	Organic chemicals, coal, biomass petroleum, etc., Steam reforming, Oxo-Products, Methanol, Formaldehyde, Carbon-di-sulphide, Hydrogen cyanide.	**5hrs**
Unit 3	**Chemicals from Ethane, Ethylene, Acetylene, Propane and Propylene**	
	Synthetic Ethanol, Acetaldehyde, Acetic acid, Vinyl acetate, Ethylene oxide, Ethylene glycols, Acrylonitrile, Isopropanol, Acetone, Glycerol, Propylene oxide, Propylene Glycols, Isoprene, Cumene.	**6hrs**
Section – II		
Unit 4	**Chemicals from Butanes & Pentanes**	
	Butadiene, Butone epoxides &Butanol amines, Butyl acetate, Methyl-Ethyl Ketone, MTBE, TAME, TPA & DMT, Maleic anhydride, Adipic acid, Hexamethylenediamine, Aniline, Caprolactum.	**6hrs**
Unit 5	**Chemicals from aromatics and Polymers**	
	BHC, Nitrobenzene, Do-decyl benzene, Benzoic acid, Nitrotolune, Pthalic anhydride, Isopthalic acid. Polymers, elastomers, synthetic fibers, PVC, Nylon & Polyesters.	**6hrs**
Unit 6	**Future of Petrochemicals**	**4hrs**
	Integrated Petrochemical complex, Energy crises in Petrochemical industry, Natural gas as Petrochemical feedstock, Import of heavy feedstock on Petrochemicals, Ecology & energy crises, Coal as an alternative to oil, Synthetic fuels, Trends in Petrochemical Industry.	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2						3								1	
CO3										2					
CO4					2										1
CO5									1				2		
CO6				3											

References:

	Text Books
1	B.K. Bhasker Rao, —A Text on Petrochemicals‖2nd Edition, Khanna publishers, 1996.
2	SukumarMaiti, —Introduction to Petrochemicals‖ Oxford & IBH publishing Co. Pvt. Ltd., 1991.
3	C.E. Dryden, —Outlines of Chemical Technology‖, Affiliated East-West Press, 1973.
	Reference Books
1	A.V.G. Halm, —The Petrochemical Industry‖, McGraw Hill 1970.
2	Astle M.J., —The Chemistry of Petrochemicals‖, Reinhold.
3	A.L. Waddams, —Chemicals from Petroleum‖, Chemical publishing Co.
4	MOOC/ Swayam/NPTEL Courses on petrochemical technology

PEC-CH-803-2 Elective-II
ARTIFICIAL INTELLIGENCE IN PROCESS ENGINEERING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40
Credits	:	3	**ESE**	:	60
Practical	:	--	**ISA**	:	25
Credits	:	--	**POE**	:	--
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• Introduce students to statistical tools that are used in process systems engineering problems.
• Have the knowledge about appropriate balance between mathematical rigor and to maintain the problem solving skills
• Study and Use latest Computer Software and application of these software to solve chemical engineering problems

Course Outcomes:		
COs	**At the end of successful completion of the course the student will be able to**	**Blooms Taxonomy**
CO1	Understand the artificial intelligence (AI) in process engineering.	Understand
CO2	Select programming Languages for process engineering	Select
CO3	Select types of problems in AI	Select
CO4	Analyze Expert System Era, Neural Network Era & Data Science Era.	Analyze
CO5	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	Prepare
CO6	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems..	Apply

Description:		
Prerequisites	1:	All Chemical Engineering subjects, Material Science and Engineering, Environmental Engineering and Process Safety.
	2:	Basic idea of Chemical Process and Product Design.

Section – I		
Unit 1	**Introduction -**	
	History and relation of artificial intelligence (AI) to process engineering: Knowledge representation I-Predicate calculus and Semantic Networks; Search - Forward/Backward. Depth/breadth/best-first search; Production systems.	
Unit 2	**History. Components-**	
	Knowledge representation II- Frames, Objects; Inexact Reasoning- Introduction, Bayesian certainty factors, Qualitative Physics, Casual Models- Introduction, Backward architecture; Expert Systems - Applications to industry; Programming Languages; Expert System Shells; Neural Nets- Introduction and applications to process engineering.	
Unit 3	**What is Artificial Intelligence**	
	Types of problems AI addresses like Computer Vision, Natural Language Processing, Robotics, Expert Systems.	
Section – II		
Unit 4	**Artificial Intelligence in Chemical Engineering Background:**	
	Early Attempts, Expert System Era Neural Network Era, Effects and Lacunae of Expert System Era and Neural Network Era on Chemical Engineering Deep Learning and Data Science Era.	
Unit 5	**Applications of AI in chemical engineering -**	
	Areas like fault diagnosis, Process control, Process design, Planning and operations, Modeling and simulation and Product design, development and selection like Separation Design, Heat-Exchanger Network Synthesis, Thermodynamic Model Selection and Physical Property Estimation, Oil reservoir image segmentation, Corrosion and crack predictions based on image detection and Machine Learning series.	
Unit 6	**Application of AI in modeling -**	
	Al in chemical process modelling , Al in optimization of chemical, Application of neural networks in chemical process control, Modelling	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	1				1			1						
CO2				2	3										
CO3			3	2											
CO4					3		2								
CO5						1									
CO6					2	1						1			

References:

Text Books	
1	Raff, Edward. Inside Deep Learning: Math. Algorithms and Models. Manning Publications, 2022.
2	Quantrile, Thomas, Liu, Y. A, Artificial Intelligence in Chemical Engineering, Academic Press, 1991.
3.	Michael L. Mavrovouniotis, 1990, Artificial Intelligence in Process Engineering, Academic Press
Reference Books	
1	VenkatVenkatasubramanian, 2019, The Promise of Artificial Intelligence in Chemical Engineering: Is It Here, Finally?, AIChE, Vol. 65, No. 2
2	ZeinabHajjar, ShokoufeTayyebi and Mohammad HoseinEghbal Ahmadi, 2018, Application of AI in Chemical Engineering.
3	N.L. Nilsson, "Problem Solving Methods in Artificial Intelligence", McGraw Hill, 1971.
4	T.E. Quantrille and Y.A. Liu, "Artificial Intelligence in Chemical Engineering" Academic Press, 1991.
5	J. Zurada, "Introduction to Artificial Neural Systems", West Pub. Co. Ltd., St. Paul, MN, 1992.
6	J. F. Davis, G. Stephanopoulos and V. Venkatasubramanian, "Intelligent Systems in Process Engineering", AIChE symposium Series, Vol. 92, 1996.
7	Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning. (Adaptive Computation of oxidative coupling of methane. International Journal of Chemical Reactor Engineering. 2012; 10:1-21

PEC-CH-803-3 Elective-II
CHEMICAL PRODUCT DESIGN AND PROCESS DEVELOPMENT (CPDPD)

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60Marks
Practical	:	--	**ISA**	:	25 Marks
Credits	:	--	**POE**	:	--
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• Give up-to-date knowledge for developing the process & equipment such as heat and mass transfer equipment used in chemical process plants.
• Have the knowledge to analyze a problem and finding optimum process & product development methods for the equipment used in chemical process plants.
• Study and Use latest Computer Software and application of these software to solve process & product development problems.

Course Outcomes:

COs	**At the end of successful completion of the course the student will be able to**	**Blooms Taxonomy**
CO1	Understand the types of Chemical Processes.	Understand
CO2	Select A strategy for a process from amongst the alternatives.	Select
CO3	Determine strategy for carrying out a particular process for a particular product.	Determine
CO4	Finalize Process and Product Designs with the help of design software.	Finalize
CO5	Prepare specifications for particular equipment required.	Prepare
CO6	Use and Apply the knowledge to execute techno- economical Process and Product Design.	Apply

Description:		
Prerequisites	1:	All Chemical Engineering subjects, Material Science and Engineering, Environmental Engineering and Process Safety.
	2:	Basic idea of Chemical Process and Product Design.

Section – I		
Unit 1	**Introduction: Process Development and Requirement**	
	Importance and Goals of Chemical Process Development. Important considerations for process development.	
Unit 2	**Challenges of Process Development**	
	Challenges and solutions of Chemical Process Development. Importance of Heat and Mass transfer in Chemical Process Development.	
Unit 3	**Strategies to improve Chemical Process Development.**	
	Collaborations, Data Analytics and Machine Learning , Process Modelling and Simulation, Automation , Environmental Sustainability, ERP etc. Modern Technologies for Process Development in Chemical Manufacturing	
Section – II		
Unit 4	**Introduction to Product Design -**	
	The design process. Steps in Product Design and Process Development.	
Unit 5	**Product Testing & Product Formulation**	
	Testing Activities & Techniques in Product Design & Process Development Packaging Development	
Unit 6	**Process Development Interwoven with Product Design**	
	Unit Operations , Unit Processes, Processing Limits, Building the Marketing. Product & Process specifications & marketing strategy.	

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	If applicable		
													PSO1	PSO2	PSO3
CO1	3	1				1	1	1	1						
CO2				2	3	1									
CO3			3	2											
CO4					3		2								
CO5						1									
CO6			2		2	1	1					1			

References:

	Text Books
1	Seider W.D., D.R. Lewin by Product & Process Design Principles 4th Ed. Vital source E-Book Wiley 2017
2	Chemical Process Engg. : Design & Economics by Silla H.
3.	Hand Book of Chemical Process Development , Chandalia S.B.
4	Organic Unit Processes by Groggins
	Reference Books
1	Conceptual Chemical Plant Design , Douglas J.M.
2	Industrial Chemical Process Design by D. L. Erwine
3	Product Design & Development 2nd Ed. McGraw Hill 2000
4	Chemical Product Design 2nd Ed. Cambridge University Press 2011.

PEC-CH-804-1 Elective-III

ENERGY CONSERVATION AND RECOVERY

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Tutorial	:	NA	**ISA**	:	25 Marks
Credits	:	-	**POE**	:	NA
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The objective of the course is to
• To study the importance of energy and Indian energy scenario.
• To study the energy available for industrial use and role of energy conservation.
• To study in detail energy management and policy.
• To know basic principles of energy conservation, equipments used for heat recover & energy audit.
• To know basic of cogeneration & energy audit.
• To know the effect of climate change in India, how to do the energy conservation in sugar Industry? & energy conservation act 2001.

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Students will come to know the importance of energy in production & employment & what isenergy scenario in India?	Remembering Understanding
CO2	Students will be able to understand how to forecast industrial energy supply, demand? And what is role of energy conservation in industry?	Understanding
CO3	Course will develop the knowledge of doing comprehensive energy conservation planning.	Remembering
CO4	Students will be able to explain basic principles, equations of calculating waste heat, selectionof equipments for heat recover & how to conduct energy audit.	Understanding
CO5	Students will be able to explain cogeneration concept & how to conduct energy audit.	Understanding
CO6	Students will be able to understand the effect of climate change on energy in India, saving ofenergy in sugar industry and energy conservation act 2001.	Understanding

Description:		
Energy conservation is the effort to reduce wasteful energy consumption by using fewer energy services. This can be done by using energy more effectively (using less energy for continuous service) or changing one's behavior to use less service (for example, by driving less). Energy conservation can be achieved through efficient energy use, which has a number of advantages, including a reduction in greenhouse gas emissions and a smaller carbon footprint, as well as cost, water, and energy savings. Recently, concern over the effects of climate change and global warming has emphasized the importance of energy conservation.		
Prerequisites	1:	Basic details of the energy and forms of energy.
	2:	Students should aware about daily needs of energy and expenditure of energy.
	3:	Students should be aware about energy cost and future rise of cost.

Section – I		
Unit 1	**Energy conservation:**	
	An Introduction: Industrial energy use and economy, Need for planning energy, importance of energy in production and employment, Importance of energy cost in production, Energy and employment, (3 L) **Indian energy scenario**: Growth and demand of energy, Energy availability, Comparison ofspecific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Barriers.(3 L)	**6 Hrs**
Unit 2	**Energy available for industrial use and the role of conservation:**	
	Methodology for forecasting, Industrial energy supply and demand, Review of alternative approaches and major models and studies, Method for forecasting industrial energy price and availability, New energytechnologies and conservations. **(6 L)**	**6 Hrs**
Unit 3	**Energy management and policy:**	
	Comprehensive energy conservation planning (CECP), Motivation for Comprehensive energy planning, Principles of energy conservations, Procedure for Comprehensive energy conservation planning, Significance of CECP, Tasks required for CECP and application of CECP. **(6L)**	**6 Hrs**
Section – II		
Unit 4	**Principles of energy conservation:**	
	Definition of energy conservation, Principles of energy conservations, Economics of energy conservation policy, Optimum energy conservation, **(3L)** **Energy conservation technologies:** Waste heat recovery and utilization, Technologies, Cost and energy saving of waste heat recovery and utilization. **(3L)**	**6 Hrs**
Unit 5	**Cogeneration concept and scope:**	
	Introduction, Advantages, Constraints, Feasibility, Scope,Benefits and constraints. **(3L)** **Energy audit and management:** Types of audit, Responsibility of energy management, Targeting and monitoring energy consumption, Scope of energy audit **(3L)**	**6 Hrs**
Unit 6	Impact of climate change in India (3L) Energy conservation act 2001 (3L)	**6 Hrs**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	2					3	1								
CO2	1					2	1								
CO3	1					1	2								
CO4	2					1	3								
CO5	1					2	2								
CO6	1					2	3								

References:

	Text Books
1	Devid Hu. S, —Handbook of Energy Conservation, McGraw Hill Publication.
2.	Rao, Diwalkar P.L., —Energy Conservation Handbook, Utility Publication,Hydrabad.
	Reference Books
1	D. Mohan Singh, Col. S. K. Murthy (Retd.) and etc., —Energy Conservation inIndustries□, Module I and II, AICTE, CEP, Code 358.
2	D. A. Reay, —Heat Recovery Systems, E and F. N. Spon ltd., 11, New Fetter Lane,London, 1979.
3	The Bulletion on Energy Efficiency and Management by IRADA, MITCON, MEDHAetc.
4	Amit Tagi, —A Handbook Energy Audit, Tata McGraw Hill publication, 2000.
5	A Practical Guide to Energy Conservation, PCRA Publication, 2010.

PEC-CH-804-2 Elective-III
NANO TECHNOLOGY

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs / week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Tutorial	:	NA	**ISA**	:	25 Marks
Credits	:	-	**POE**	:	NA
Total Credits	:	3	**Total Marks**	:	125

Course Objectives: The students completing this course are expected to understand and learn
• Introduce fundamentals of Nanoscience and Nanotechnology.
• Study the concept of nanomaterials
• Explain the synthesis, purification and application of nanomaterials.
• Study the advances in nanotechnology
• Intellectual property rights of nanotechnology

Course Outcomes:

Cos	At the end of successful completion of the course	Blooms Taxonomy
CO1	To understand the application of Nanoscience in catalysis and green chemistry	Aware
CO2	Characterization of nanomaterials	Understand
CO3	Physico chemical aspects of different types of nanostructures	Understand
CO4	Demonstrate the understanding of length scale concepts, nanostructures and nanotechnology	Understand
CO5	Systematically solve scientific problems related specifically to nano-technological materials using conventional scientific and mathematical notation	Evaluate
CO6	Identify the principles of processing, and synthesis of nonmaterial's and nanostructures	Analyse

Description		
Prerequisites	1:	Basic Science & Engineering
	2:	Material Science & Engineering

Section – I		
Unit 1	Introduction to Nanoscience and Nanotechnology: History, Importance of Nanoscales, Fundamental concepts (Bottom-up and Top-down processes).	6 Hrs
Unit 2	Nanomaterials: Fundamental concept of nanomaterial, Materials used in nanotechnology, carbon nanotubes-properties	6 Hrs
Unit 3	Synthesis, Purification, Application of Nanomaterials	6 Hrs
Section – II		
Unit 4	Fabrication techniques and Application of Nanotechnology	6 Hrs
Unit 5	Recent Advances in Industrial Nanotechnology	6 Hrs
Unit 6	Intellectual property rights on Nanotechnology: Importance of IP Protection, copy rights and trade secrets	6 Hrs

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	1														
CO2		1													
CO3		1	2										1		
CO4		1					2							1	
CO5			1												
CO6							1								

References:

Text Books	
1	Principles of Nanotechnology, Phani umar
Reference Books	
1	"Nanomaterials", Vishwanathan
2	"The Nanoscope" Encyclopedia of Nanoscience and Nanotechnology Vol I to Vol 6, Edited by Dr.Parag Diwan and Ashish Bharadwaj

PEC-CH-804-3 Elective-III
DOWN STREAM PROCESSING

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	3 hrs per week	**ISE**	:	40 Marks
Credits	:	3	**ESE**	:	60 Marks
Practical	:	--	**ISA**	:	--
Credits	:	--	**POE**	:	--
Total Credits	:	3	**Total Marks**	:	100 Marks

Course Objectives: The objective of the course is to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on Downstream processes required in multi-factorial manufacturing environment in a structured and logical fashion

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Define the fundamentals of downstream Processing for process recovery.	Understand
CO2	Analyze methods of physical and chemical separation.	Analyze
CO3	Understand the requirements of successful operations of downstream processing.	Create
CO4	Apply principles of various unit operations used in downstream processing and enhance problem solving techniques	Apply

Description:		
Prerequisites	1:	Bio molecules, bio products
	2:	Mass Transfer
	3:	Instrumental methods of Analysis

Section – I		
Unit 1	**Introduction** Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilization of bio-products	9 Hrs
Unit2	**Methods Of Separation- I** Unit operations for solid-liquid separation insoluble products - filtration and centrifugation. basic principles, design characteristics, Ultracentrifuges: Principles and Applications.	8 Hrs.
Unit 3	**Methods Of Separation- II** Sedimentation, Flocculation cell disruption; Sonication Bead mills, Homogenizers, Chemical lysis, Enzymatic lysis	7 Hrs.
Section – II		
Unit 4	**Isolation Of Products** Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultra filtration and reverse osmosis, dialysis, precipitation of proteins by different methods.	7 Hrs.
Unit 5	**Product Purification** Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.	8 Hrs
Unit 6	**Final Product Formulation And Finishing Operations** Crystallization, drying and lyophilization in final product formulation.	5 Hrs.

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1												
CO2				2											
CO3								1							
CO4					2						3				

References:

Text Books	
1	Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing for Biotechnology", John Wiley, 1988.
2	P.M. Doran, Bioprocess Engineering Principles, Academic press
3	Sivasankar, B. "Bioseparations: Principles and Techniques". PHI, 2005.
Reference Books	
1	Asenjo, Juan A. "Separation Processes in Biotechnology". CRC / Taylor & Francis, 1990.
2	Ghosh, Raja "Principles of Bioseparations Engineering". World Scientific, 2006
3	"Product Recovery in Bioprocess Technology". (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

PCC-CHE – 805P
ADVANCED SEPARATION PROCESSES

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	1 hrs per week	**ISE**	:	--
Credits	:	1	**ESE**	:	--
Practical	:	2 hrs per week	**ISA**	:	25 Marks
Credits	:	1	**POE**	:	25 Marks
Total Credits	:	2	**Total Marks**	:	50

Course Objectives: The objective of the course is to
1. Learn novel separation techniques
2. Research potential commercial applications.
3. Learn how to estimate the separation parameter.

Course Outcomes:		
Cos	**At the end of successful completion of the course the student will be able to**	**Blooms Taxonomy**
CO1	Understanding of new developments in separation methods.	Recall
CO2	Ability to distinguish between various chemical substances	Understand
CO3	Being able to use various advanced tools.	Understand
CO4	Knowledge of the main topic that is significantly more in-depth.	Understand
CO5	Greater understanding of experimental techniques	Apply
CO6	Apply of the manufacturing techniques used in the separation procedures.	Apply

Description:		
.		
Prerequisites	1:	Water Chemistry
	2:	Basis upstream water treatments
	3:	Membrane Technology

Section – I	
Principle, Mechanism, Design parameters, Applications.	
Unit 1	Ultra filtration, Micro filtration, Nano filtration
Unit 2	Reverse Osmosis
Unit 3	Ion Exchange, Pervaporation
Section – II	
Unit 4	Pressure swing Adsorption, Gas Permeation
Unit 5	Electrostatic Precipitator, Dialysis and Electrodialysis
Unit 6	Supported Liquid Membranes, Supercritical Fluid Extraction etc

List of Practical's:

1. Ion Exchange Column
2. Ion Exchange resin
3. Ion Exchange Equilibria
4. Electro coagulation
5. Ultrafiltration of some dilutes solutions.
6. Reverse osmosis
7. Pressure Swing Adsorption
8. Microfiltration of waste water.
9. Paper Chromatography.
10. Electro dialysis.

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1	1												1		
CO2				3											
CO3										2					
CO4							2								1
CO5			1												
CO6											1			2	

References:

	Text Books
1	J.D. Seader, Ernest J. Henley, "Separation Process Principles"2nd Edition, Wiley India, 2007.
2	C.J.King "Separation Processes" 2nd Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1986.
3	Sirkar K. & Winston H.O. "Membrane Hand Book" Van Nostrand Reinhold, New York, 1992
	Reference Books
1	McCabe & Smith "Unit Operations of Chemical Engineering" 5 th Ed., McGraw Hill
2	Richardson and Coulson,—Chemical Engineering Volume –II,Pergamon Press,1970
3	Schweitzer P.A , —Handbook of Separation Techniques for Chemical Engineeringl2nd edn.,McGraw Hill Book Co.,1986.
4	SouriRajan S. "Reverse Osmosis" Logos Press Ltd.

CHE 806P
PROJECT WORK

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	NA	**ISE**	:	-
Credits	:	NA	**ESE**	:	-
Practical	:	6	**ISA**	:	100Marks
Credits	:	4	**POE**	:	150 Marks
Total Credits	:	4	**Total Marks**	:	250 Marks

Course Objectives: The objective of the course is to
1 Student will able to apply &adapt a variety of problem –solving strategies to solve problems .
2 Student will improve thinking skills.
3 P.w will promote effective mathematical communication, simulation etc
4 To develop positive attitude towards engineering.
5 Studens will able do the design, cost estimate ,plant layout ,etc

Course Outcomes:

Cos	At the end of successful completion of the course the student will be able to	Blooms Taxonomy
CO1	Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Projects offer the opportunity to apply and extend material learned throughout the program.	Understand
CO2	Personal competences of students are reinforced most during the FYP process, including the preparation, elaboration, presentation and defense stage.	Analyze
CO3	Students will learn , a seminar presentation, submission of a thesis, and a public demonstration of work undertaken.	Understand
CO4	Students will learn and experience the process of conducting a good research project. Projects offer the opportunity to apply and extend material learned throughout the program Undertaken.	Create
CO5	Students will understand socio-economic process	Understand
CO6	Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Personal competences of students are reinforced most during the FYP process, including thepreparation, elaboration, presentation and defence stage	Apply

Description:		
Prerequisites	1:	Student must have knowledge of basics/fundamentals of chemical Engg.
	2:	Student must have computer literacy
	3:	Student must have presentation skills &analytical skills

Project Guidelines

The project work is to be completed under the guidance of a guides and /or External guides and submit a typed report in duplicate.

The Project Report consists of

1. Certificate
2. Acknowledgement
    a. Statement of Problem
3. Synopsis / Abstract.
4. Index.
5. Introduction.
    a. Importance of Project
    b. Market Situation
    c. Consumption Data
    d. Need of such Plant
6. Literature survey – Process Selection.
7. Theoretical conditions – Process Parameters, Composition.
8. Process Description – Process Floe-sheet (Block Diagram)
9. Basic Engg. Data.
    a. Physical
    b. Chemical
    c. Thermodynamic
    d. Analytical Methods
10. Details of Experimental Set up & Experimental Work.- Purpose method, Chemicals, Calculations, Analysis of Data, Results, Discussion.
11. Material Balance & Energy Balance.
12. Selection of Equipments& Specifications.
13. Design of Specific Equipment.
    a. Process design
    b. Mechanical Design
14. Control & Safety of Process.
15. Plant layout & Location.
16. Cost Estimation & Economic Analysis
17. Pollution Control, Safety, Marketing
18. Conclusion & Remarks.
19. References.
    a. Books
    b. Journals
20. Appendix.
21. List of Tables
        i. Sample Calculation
        ii. DataTables, etc

Each group should consist of maximum 3 to 4 students. For term-work (ISE) 100 marks,the assessment should be by conducting frequent, PPT, seminars during the year & an oral exam at the end of the year conducted by all the faculty members of the dept.The Head of the Dept. should see that the assessment procedure should be the same for all the students of the class. For external 150 marks, the project work shall be assessed by an oral exam to be held by at least two examiners, one internal and one external preferably fromIndustry at the end of the year. The object of the VIVA VOCE examination (Internal and External Orals) is to determinewhether the objectives of the project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the project work.

IMPLEMENTATION PROCEDURE FOR CONDUCTING FINAL YEAR PROJECT

The main objective of the Final Year Project is to learn and experience the process of conductinga good research project. The following points serve as a guideline of activities that take place in the process.

Problem Statement

A problem statement is a concise statement of the problems which initiate/spark the research questions or design ideas. Some of the points that could be highlighted are:

a. What is the issue that we want to address (problem or question)?
b. Why need to address the issues?
c. How the project can solve the issues?
d. Who get benefits from the project?

Objective sets a clear goal of what we want to accomplish by doing the research work. It should not include the objective of doing the Final Year Project (e.g. to learn how tomanage a project etc.). Student should only state the technical objective of the project (e.g. to evaluate the performance of the design, to test a hypotheses, to study the relationship betweenvariable x and variable y etc.). Use measurable action verbs when defining an objective (e.g. define, design, identify, describe, analyze, evaluate etc).

Scope

Scope sets a clear boundary (time, geography, environment, function etc.) of our work to providea common understanding of the project among stakeholders (in FYP the stakeholders are students, lecturer, panels etc.). Scope makes our project achievable and realistic by defining the limits and constrains of the study.

Literature review

A literature review discussed published information in a particular subject area. The purpose of aliterature review is to summarize and synthesize the ideas of others. When we write a literature review, it usually consists of 3 main sections:

a. Introduction section that describe the topic of the review.
b. Body section which contains the discussion of sources.
c. Conclusions from the discussion of sources and recommendations (if any). The main point inthe conclusion of the literature review would be the clarification and emphasis of the gaps (unexplored/unsolved problem in the field) and the contribution of the student's project.

The discussion of the sources could be arranged chronologically, thematically or methodologically or in combination of any of them. In the discussion, students should:

a. Be clear of the items that need to be discussed. It can be a variable or a technique or different design decisions.
b. Make comparisons and give technical comments. Summary of the comparison could be tabulated or shown in graphs to clarify the differences.
c. For engineering design, discuss on the tradeoff of a particular design decision.

ISE-ASSESMENT METHODS (Project Progress)

Marks						
	First Review			Second Review		
Examination Panel	Presentation	ProjectProgress report (actual work done)	Total	VIVA VOCE (INTERNAL)	*Draft Final Report	Total
Total	70	30	100	70	30	100

* indicates, students has to submit the final typed report by making correction suggested in second review.

Note – For final Marks , average marks of two reviews must be considered.

Draft Report

This document is a working version of the final report. You should send it to your supervisor /guide at least 3 weeks before the final report submission deadline, in order to allow your supervisor sufficient time to read it and suggest improvements. Bear in mind that your supervisor is only expected to read one draft of your report.

In your own interests, the draft report should be as complete as possible so that your supervisor/guide can give you useful feedback. Your supervisor/guide will be the examiner on other projects, and will tell you what they are looking for from the projects they examine. If your report does not conform to their expectations you will be able to rectify it in time.

This document draft is not formally assessed and should be sent directly to your supervisor./**guide**

Mapping of POs & COs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	If applicable		
													PSO1	PSO2	PSO3
CO1			1					2							
CO2				2											
CO3				2			3								
CO4											1				
CO5					2										
CO6			3				2								

II – CH 807P
INDUSTRIAL INTERNSHIP

Course Details:					
Teaching Scheme			**Evaluation Scheme**		
Lectures	:	NA	**ISE**	:	--
Credits	:	--	**ESE**	:	--
Practicals	:	6 hrs per week	**ISA**	:	100 Marks
Credits	:	6	**POE**	:	150 Marks
Total Credits	:	6	**Total Marks**	:	250 Marks

Guidelines

After the end of the seventh semester examination and before the start of the seventh semester, every student will have to undergo an internship. The Internship would be of 6 credits.

The internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head, Chemical Engineering Department.

The total duration of the internship would be for a period equivalent to 12 Calendar weeks. This period typically start from 1st Jan and end before 30th May every year. This means the end semester examination of B.Tech. Engg. (Semester-VIII) should be completed by before 8th semester examination every year.
The internship may be completed in one or more organizations as described below.

The internship could be of the following forms:
(i) industrial internship in a company (within India or Abroad) involved in R&D / design / manufacturing (QA/QC/Plant Engineering/Stores and Purchase) / marketing / finance / consultancy / Technical services / Engineering / Projects, etc.

(ii) research internship in reputed Institutes (within India or Abroad) like, ICT, IITs, NITs, IISC, NCL, IICT etc.
At the end of the internship, each student will submit a written report based on the work carried out during the Internship.

The report will be countersigned by the Supervisor from Industry / Institute as the case may be. Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Chemical Engineering Department.

Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

Member Secretary
Board of Studies

Chairman
Board of Studies

Academic Dean
T.K.I.E.T, Warananagar

Principal
T.K.I.E.T, Warananagar

Seal of Institute