D. Y. Patil College of Engineering & Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

NBA Accredited

Accredited by NAAC with 'A' Grade

Structure and Syllabus

of

Final Year B. Tech. in Chemical Engineering

Department of Chemical Engineering

Academic Year: 2023 - 24

D.Y.PATIL COLLEGE OF ENGINEERING & TECHNOLOGY
KASABA BAWADA, KOLHAPUR-416006
An Autonomous Institute
B. Tech. in Chemical Engineering
Curriculum w.e.f. A.Y.2023-2024

D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY, KOLHAPUR
Teaching and Evaluation Scheme from Year 2023-24
Final Year B.Tech – Chemical Engineering SEMESTER – VII

Sr. No.	Course Code	Course Type	Name of The Course	Teaching Scheme Per Week				Total Marks	Evaluation Scheme			
				Lecture	Tutorial	Practical	Credits		Type	Max. Marks	Min. for Passing	
1	201CHL401	PCC	Chemical Reaction Engg. II	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
2	201CHL402	PCC	Chemical Process Design	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
3	201CHL403	PCC	Modeling and Simulation in Chemical Engineering	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
4	201CHL 404	PEC	Professional Elective II	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
5	201CHL 405		Professional Elective II						ISE	20	20	40
									MSE	30		
									ESE	50	20	
6	201CHL 406	OEC	Open Elective II	3	-	1	4	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
7	201CHL 407		Open Elective II						ISE	20	20	40
									MSE	30		
									ESE	50	20	
8	201CHP408	PCC-LC	Chemical Reaction Engg. II Laboratory	-	-	2	1	50	ISE	25	10	20
									ESE(POE)	25	10	
9	201CHP409	PCC-LC	Chemical Process Design Laboratory	-	-	2	1	50	ISE	25	10	20
									ESE(POE)	25	10	
10	201CHP410	PCC-LC	Modeling & Simulation in Chemical Engineering Laboratory	-	-	2	1	50	ISE	25	10	20
									ESE(POE)	25	10	
11	201CHP411	PROJ	Internship	-	1$	-	4	50	ISE	50	20	20

12	201CHP412	MC	Seminar	-	-	2	1	25	ISE	25	10	10
13	201CHP413	PROJ	Project Phase I	-	-	4*	2	100	ISE	50	20	20
									ESE(POE)	50	20	20
14	201CHMC414	MC	Comprehensive Test	-	-	2		50	ESE	50	20	20
			Total	**15**	**1**	**15**	**26**	**875**				
				31						**875**		

Professional Elective : II	**Open Elective : II**
1. Petroleum Refinery Engineering 2. Biochemical Engineering	1. Fuel Cell Technology 2. Industrial Behavior & Practices

Note: -

● $- Faculty workload of 1 hour for batch of 10 students per week will be considered for an internship to evaluate work done during internship after ESE of Semester IV / Semester VI

● *- For project phase I, consider work load of 2 hours per week for each project group consisting 5 students.

● Elective should be offered by the department, minimum number of students opting for particular elective must be at least 15 students and it should be taught by concerned teacher.

● Practical batch size should be considered as 15-25 students.

● ISE: In Semester Evaluation

● MSE: Mid Semester Examination

● ESE: End Semester Examination

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Semester – VIII- Student can choose any one track for the **Semester-VIII** from the following,

1. Regular Academic Track:

This is the regular academic track where lectures, practical and project work will be conducted regularly as per the time table in the department and college campus.

D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY, KOLHAPUR
Teaching and Evaluation Scheme from Year 2023-24
Final Year B.Tech – Chemical Engineering SEMESTER – VIII (Regular Track)

Sr. No.	Course Code	Course Type	Name of The Course	Teaching Scheme Per Week				Total Marks	Evaluation Scheme			
				Lectu	Tutori l	Practi cal	Credit		Type	Max. Mark s	Min. for Passing	
15	201CHL 415	PCC	Transport Phenomena	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
16	201CHL 416	PCC	Process Economics and Project Management	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
17	201CHL 417	PCC	Advanced Manufacturing Processes	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
18	201CHL 418	PEC	Professional Elective III	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
19	201CHL 419		Professional Elective III						ISE MSE ESE	20 30 50	20 20	40
20	201CHL 420	PEC	Professional Elective IV	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
21	201CHL 421		Professional Elective IV						ISE MSE ESE	20 30 50	20 20	40
22	201CHP 422	MC	Separation Processes	2	-	-	1	50	ESE	50	20	20
23	201CHP 423	HSMC-LC	Advanced Manufacturing Processes Laboratory	-	-	2	1	25	ISE	25	10	10
24	201CHP424	PCC-LC	Separation Processes Laboratory	-	-	2	1	25	ISE	25	10	10
25	201CHP 425	PROJ	Project Phase II	-	-	4	2	100	ISE ESE (POE)	50 50	20 20	20

			Total	**17**	**0**	**6**	**20**	**700**				
				24						**700**		

Professional Elective : III	**Professional Elective : IV**
1. Petrochemical Technology 2. Distillation	1. Energy Conservation & Recovery 2. Industrial Safety & Management

Note:

- Practical batch size should be considered as 20 to 25 students per batch
- For Project phase II, consider the workload of 2 hours per week for each project group consisting of 4 to 5 students.
- The elective should be offered by the department, if the minimum number of students opting for a particular elective must be 15 students and it should be taught by the concerned teacher.
- ISE: In Semester Evaluation
- MSE: Mid Semester Examination
- ESE: End Semester Examination

D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY, KOLHAPUR
Teaching and Evaluation Scheme from Year 2023-24
Final Year B.Tech – Chemical Engineering SEMESTER – VIII (Professional Track)

Sr. No.	Course Code	Course Type	Name of The Course	Teaching Scheme Per Week				Total Marks	Evaluation Scheme			
				Lecture	Tutorial	Practical	Credits		Type	Max. Marks	Min. for Passing	
1	201CHL 426	PROJ.	Project Phase II	-	-	4	2	100	ISE	50	20	40
									ESE(POE)	50	20	
2	201CHP 427	INTERN.	Professional Skill Development	-	1	26	4	100	ISE-I	100	80	240
							4	100	ISE-II	100		
							10	400	ESE(OE)	400	160	
			Total	**0**	**1**	**30**	**20**	**700**				
				31						**700**		

Following are the guidelines regarding Professional Track:

1. Student must submit his / her willingness for this track before the term end of semester VII
2. Head of the department will appoint one faculty coordinator to coordinate Professional Track Committee (PTC) work and manage all activities concerned with this track like assigning mentors to the students, organizing PTC meetings, monitoring the entire process concerned with Professional Track, etc.
3. Student can apply the Professional Track in following scenarios provided he/she obtains a letter accordingly from the concerned authority while applying for this track.

   a. If student is selected in the company with PPO (Pre-Placement Offer) program through the college TPO.

   b. If student has an opportunity to work on the sponsored projects in industry or Research Institute for a period of 5 to 6 months.

   C.If student is getting onsite Internship offer for a period of 5 to 6 months.

   d. If student is getting Company Training program of 5 to 6 months.

   e If student wants to do Innovation or Entrepreneurial activities for a duration of 5 to 6 months.
4. Students should submit the application along with all communication details to Professional Track faculty coordinator before the term end of semester VII.
5. The work concerned with this track should be worth 600-700 hours and completed during semester VIII.

6. All formalities of getting offer letter / permission of working in concerned organization (a-e) are to be completed from the concerned, authority (a-e) in Semester VII. writing before starting of ESE of semester VIII
7. Student should submit his/her application to the Professional Track Committee (PTC) along with details of communication done with the concerned authorities for its approval.
8. Professional Track Committee (PTC) comprises of HOD, Department. T. & P. coordinator. T & P officer, faculty coordinator and experts from Industry / Research Institute / Entrepreneur. The role of PTC in confined to assessment and approval of applications only
9. Professional Track Committee (PTC) will assess the applications based on the communications, kind of work that is expected to be done by the student in concerned organization (a-e), and allocation of concerned organization (a-e) supervisor, depth of the technical exposure, student's development and feasibility of work. Committee will accordingly approve application satisfying the guidelines for professional track and the decision of the committee will be final.
10. There should be a proper written communication between the concerned organisation, TPO, department T & P Coordinator and faculty coordinator mentioning the details clearly as per the syllabus structure.
11. Professional Track faculty coordinator should declare the list of students approved for, undertaking Professional Track before end of ESE of semester-VII.
12. It is mandatory for a student and his / her parent to submit an undertaking, mentioning completion of Professional Track as per concerned organisation requirements and guidelines as per syllabus structure.
13. If the student fails to complete above Professional Track as per the guidelines within the stipulated period of semester VIII, he / she will be declared as FAIL. Such candidate has to complete the said work in subsequent 4 to 5 months period and then ESE-OE examination will be conducted during the regular examination schedule of the college.

Following are the evaluation guidelines for Professional Skills Development Course,

1. The evaluation of the Professional Skills Development will be based on the work done by the student in concerned organisation.
2. The faculty mentor assigned will be responsible for monitoring and assessment of the student on the continuous basis.
3. Every faculty mentor will be assigned workload of 1 hour per week for each 4 student.
4. The ISE marks are to be given based on the continuous assessment done by the concerned organization (a-e) supervisor and faculty mentor.
5. Students must present their work to the faculty mentor every month in an online mode or onsite. (Minimum 3 presentations) in coordination with concerned organisation (a-e) supervisor for 100 marks taken together for all presentations and demonstration under ISE with 4 credits.
6. Concerned organisation (a-e) should provide certificate of completion of assigned task along with marks under ISE head for 200 marks with 8 credits, in coordination with the faculty mentor before the conduct of ESE-OE exam.
7. Students should complete NPTEL certification of Transport Phenomena & Project Economics and Management subjects which carries 100 marks out of 400 marks allotted to ESE-OE.
8. ESE-OE is to be conducted for 300 marks with total 10 credits in the concerned organisation (a-e) or Department where the student is doing his/her work. The ESE-OE will be conducted by faculty mentor, HOD and concerned organisation (a-e) supervisor.
9. Student may complete Professional Global Certification either assigned by the concerned Organisation (a-e), supervisor based on his / her assigned work as on his / her own, like Aspen Plus, E3D, Promax, UNISIM etc.
10. All credits will be earned by the students on completion of ISE and ESE-OE.

Course Plan

Course Title**: Chemical Reaction Engineering - II**	
Course Code :**201CHL 401**	**Semester: VII**
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE + MSE Marks: 20+30=50	ESE Marks: 50

Course Description: Chemical Reaction Engineering II subject deals with non-ideal reactors, different types of reaction system based on phases and heterogeneous catalysis. In this syllabus we will be discussing conversion in actual reactors, various types of reactors based on phases, heterogeneous catalysis, solid catalyzed reaction and deactivating catalyst.

Course Objectives:

1. To study non-ideal flow and finding of conversion in actual reactors from experiment and different models for finding non ideality in reactors.
2. To understand mixing of fluids, macro fluid concept and turbulent Mixing with chemical Reaction in Stirred Tanks.
3. To develop understanding of heterogeneous solid catalyst, isotherms, different industrial terms related to solid catalyst & finding different characteristics of solid catalysts with new trens in catalysis.
4. To develop understanding & designing of fluid particle reactions with different models for it.
5. To understand designing of fluid- fluid reaction and applications of fluid-fluid reactions rate equation to industrial equipment design.
6. To cover concepts, parameters, mechanisms, applications of catalyst with different catalytic reactors and deactivating catalyst & also describe recent trends in reaction engineering like scale up in reactor design.

Course Outcomes (COs): At the end of the course the student should be able to:

C401.1	**Explain & apply** knowledge of non-ideal flow and will find conversion in actual reactors from experiment and different models.
C401.2	**Explain & apply** basic concepts of mixing of fluids, macro fluid and applications of CFD in industries.
C401.3	**Describe & apply** working of catalyst &**understand** industrial terms related to solid catalyst& find different characteristics of solid catalysts.
C401.4	**Explain & apply** principles, **understanding** &**designing** of fluid particle reactions with different models for it.
C401.5	**Understand; explain** fluid-fluid reaction, its **design** and applications of fluid-fluid reactions rate equation to equipment **design**.
C401.6	**Explain, underline, use** basic concepts, important parameters, mechanism & applications of the catalysis and deactivating catalyst & also**describe** recent trends in reaction engineering.

Prerequisite:	Chemistry, Applied mathematics, Process Calculations, Thermodynamics, Fluid mechanics,chemical reaction engineering I

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C401.1	2	3	2	3	-	-	-	-	-	-	-	1	2	-	3
C401.2	3	2	1	1	-	-	-	-	-	-	-	1	2	-	3
C401.3	2	2	3	2	-	1	2	-	-	-	-	1	3	-	3
C401.4	2	2	3	2	-	-	-	-	-	-	-	1	2	-	3
C401.5	2	2	3	2	-	1	2	-	-	-	-	1	2	-	3
C401.6	2	2	3	1	-	1	2	-	-	-	-	1	3	-	3

Content	Hours
Unit 1 – Non Ideal Flow Basic concept: conversion in reactors having non ideal flow; The Residence Time Distribution Functions and their Relationships, Determining RTD from Experimental Tracer Curves, Stimulus Response technique , Mathematical tools in tracer study, Tubular Reactor, E- and F-Curves for a Stirred Tank Reactors, Analysis of RTD from Pulse Input and step input, Models for predicting conversion from RTD data; One Parameter: Dispersion model, Tank in Series model, Introduction to Multi parameter model	8
Unit 2- Mixing of fluids Self-mixing of single fluid. Early and late mixing of fluid, models for partial segregation, mixing of two miscible fluids, Model Effect of Micro mixing on Conversion Time-Dependent Turbulent Mixing and Chemical Reaction in Stirred Tanks, Product distribution in multiple reaction, Recent trends in mixing of Fluids .	5
Unit 3 – Heterogeneous processes and Solid catalysts Global rate of reaction, Catalysis, Nature of catalytic reactions, adsorption isotherms, Rates of adsorption. Determination of Surface area, Void volume and solid density, Pore volume distribution, Classification of catalysts, Catalyst preparation, Catalyst Poisoning, Catalyst Characterizations, Promoters, accelerators, Support, carrier and inhibitors. Recent trends in Heterogeneous catalysis.	6
Unit 4 - Fluid particle reactions (Non catalytic) Practical examples of fluid particle reaction, Selection of a model for gas-solid reactions Un-reacted core and Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Application of models to design problems.	6

Unit 5 – Fluid - fluid reaction Introduction to heterogeneous fluid - fluid reactions, Practical examples of fluid-fluid reaction, Rate equation for instantaneous , Fast and slow reaction, Equipment's used in fluid-fluid contacting with reaction, Application of fluid -fluid reaction, Rate equation to equipment design, Towers for fast and slow reactions. Industrial absorber design-case study, industrial applications of Fluid-fluid reaction.	5
Unit 6 – Solid catalyzed reactions Introduction, Rate equation, Film resistance controlling, surface area controlling , Pore diffusion controlling, Heat effects during reaction, Experimental methods for finding rates, , construction, operation and design of Catalytic reactors like Fixed bed reactor, Fluidized bed reactor, Multiphase reactors : Slurry reactor, Trickle bed reactor. Types of industrial catalytic reactors, Introduction to multiphase reactors, Recent trends in solid catalyzed reaction. Deactivating catalysts Types of Deactivation, Mechanisms of deactivation, Rate equation for deactivation, Regeneration of catalyst Scale-Up in Reactor Design, Factors affecting choice of reactor. Reactor stability, Development and Scale-Up of Reactors, Similarity Criteria in scale up.	6

Text Book:

1. Octave Leven spiel, "Chemical Reaction Engineering", 3 rd Edition, John Wiley, London.
2. S.H. Fogler," Elements of Chemical Reaction Engineering", PHI, 4 th Edition.
3. J.M. Smith, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, New York 1981.

Reference books:

1. T.T. Carbery, "Chemical and Catalytic reaction engineering", McGrawHill, New York - 2001.
2. Modeling of Chemical Kinetics and Reactor Design A. Kayode Coker, Gulf Publishing House New Delhi
3. Chemical Reactor Design
4. Peter Harriot Marcel Dekker, Inc. New York
5. Chemical Engineering Vol. III Pergamon Press, Oxford, 1989.
6. Introduction to Chemical Reaction Engineering and Kinetics Ronald W. Missen Charles A. Mims Bradley A. Saville
7. John Wiley & Sons, Inc. Chemical Reactor Design Optimization and Scaleup

Course Plan

Course Title :**Chemical Process Design**	
Course Code :**201CHL402**	**Semester : VII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Description: The aim of this course is to give up-to-date knowledge for designing the processequipmentsuchasheatandmasstransferequipmentusedinchemicalprocessplants.

Afterundergoingthiscoursethe students will have the knowledge to analyze a problem and finding a process design method for heat and mass transfer equipment used in chemical plants

Course Objective:

1. To understand knowledge of types of process diagrams and reading of P&ID diagrams.
2. To understand the process design of heat transfer equipment.
3. To study process design of cooling tower and evaporator
4. To knowledge of distillation column
5. To knowledge of basic mechanism of reactor and crystallization
6. To study of pipeline and its mechanism

Course Outcomes (COs):

At the end of the course the student should be able to:

C402.1	**Understand** the various types of process flow sheet and codes reading of P&ID diagrams.
C402.2	**Evaluate** the process equations of heat transfer equipment
C402.3	**Build** the process design and scale-up of cooling tower and evaporator.
C402.4	**Develop** the process design of distillation column and sieve tray
C402.5	**Estimate** the process design of reactor and crystallization
C402.6	**Understand** the process parameters of pipeline in industries

Prerequisite:	Heat Transfer Operations, Reaction Engineering, Mass Transfer Operation

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs) / Program Outcomes (POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C402.1	2	-	-	-	-	-	-	-	-	-	-	-	2	1	2
C402.2	2	2	2	2	-	-	-	-	-	-	-	-	2	1	3
C402.3	2	2	2	2	-	-	-	-	-	-	-	-	2	1	3
C402.4	2	2	2	2	-	-	-	-	-	-	-	-	2	1	3
C402.5	2	2	2	2	-	-	-	-	-	-	-	-	2	1	3
C402.6	2	2	2	2	-	-	-	-	-	-	-	-	2	1	2

Content	Hours
Unit 1–.The nature and function of process design Flow sheet preparation and drawing: Sketching techniques, Equipment lettering andnumbering, Equipment symbols, Instruments symbols, Stream designations for processandutility.ProcessPlanningSchedulingandFlowSheetDesign– Organizationalstructure,Processdesignscope,Typesofflow sheets,PandIdiagrams	6
Unit2-HeatexchangerDesign Introduction Codes and standards for heat exchangers, Overall heat transfer coefficient, Shell and tube heat exchangers: Tubes, Shell, Tube sheet layout. (Tube count), Shelltypes(Passes),Baffles,tierods,tubejoiningmethods,Flowpatterns,Kern'sMethods, U tube and floating and heat exchanger, industrial based examples.	6
Unit3–Cooling Tower and Evaporator Cooling tower design consideration, prevention of fog, cooling water corrosion, cross flow induced draft cooling tower, packed bed cooling tower, Criteria for selection of evaporator, Factors related to mechanical design, economy of multiple effect evaporation system, and optimum number of effect on cost basis.	6

Unit 4–Distillation column & Sieve tray IntroductionColumnsinternals,SelectionofKeycomponentformulticomponentdistillation, Advantages and limitation of vacuum distillation, Determination of number of theoretical stages of binary distillation, Using McCabe Thiele Method, Selection oftrays,Checkingofconditionsforweeping,downcomerfloodingandliquidentrainment Industrial based examples.	6
Unit 5– Reactors and Crystallization Reactor classification, Design equation for batch reactor, Design equation for plug flow reactor, Design equation for CSTR, Mechanism of crystallization, Mier's super saturation theory, Material balance over crystallizer, Crystallization equipments, Batch crystallizer design.	6
Unit 6–Pipeline Pipe thickness, pipe diameter, condensate piping, pipe diameter for steam, pipe supports, design of pipeline for natural gas, pipeline design on fluid dynamics parameters	6

Text Book:

1. D.Q. Kem, "Process Heat Transfer", Tata McGraw Hill Company, New York, 1997.
2. E.E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol.I,II,III, Gulf Publication, 3rd edition London, 1994.
3. S. D. Dawande, "Process Design of Equipments Volume 2, Central Techno Publications Nagpur

Reference books:

1. G.D.Ulrich,"AGuidetoChemicalEngineeringProcessDesignandEngineering",JohnWileyandSons, NewYork,1984.
2. M.S. Peters&K.D.Timmerhaus, "PlantDesignandEconomics forChemicalEngineers", 5thedition, McGrawHillInternationalBookCo.,2003
3. McCabeW.L.andSmithJ.C. 'UnitoperationsofChemicalEngg.'7thed.McGrawHillBookCo. Internationaled.2005.

4. R.E.Treybal,"MassTransferOperations",3rdEdition,McGrawHillCompany,Singapore,1980.
5. R.H.Perry&DonW.Gress,"Perry'sChemicalEngg.",Hand-book,7thEditionMcGrawHillCompany, NewYork,1997.
6. S.D.Dawande, "ProcessDesignofEquipment", DennetPublication, Vol. I andII, 5thEdition2005.9.

Link:https://www.youtube.com/watch?v=d2-D8dTrEWM

https://www.youtube.com/watch?v=rpfqPAM_k

Course Plan

Course Title : **Modeling and Simulation in Chemical Engineering**	
Course Code :**201CHL403**	**Semester : VII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20 + 30=50	ESE Marks : 50

Course Description: Modeling and Simulation in Chemical Engineering course provides the detail information of modeling the chemical process. This course focuses on developing mathematical modeling and simulation of chemical process.

Course Objectives:

1. To study the basic concepts of modeling and fundamental equations of chemical system.
2. To study the basic equations required for modeling the chemical systems.
3. To develop the model equations of tank reactors.
4. To study the modeling of mass transfer operations.
5. To develop the model equations of dynamic system.
6. To study the basics of simulation software used in chemical engineering.

Course Outcomes (COs): At the end of the course the student should be able to

C403.1	**Explain** the basics of modeling and physical and chemical laws for the given system.
C403.2	**Memorize** the model equations used for chemical systems.
C403.3	**Execute** mathematical model of tank reactors.
C403.4	**Execute** model equations for the mass transfer operations.
C403.5	**Execute** model equations for the dynamic systems.
C403.6	**Operate** simulation software used in chemical engineering.

Prerequisite	Chemical Engineering Thermodynamics, Chemical Reaction Engineering, Chemical Process Calculations, Heat Transfer, Mass Transfer.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs) / Program Outcomes (POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C403.1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C403.2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	1
C403.3	2	-	2	-	-	-	-	-	-	-	-	-	2	-	3
C403.4	2	-	2	-	-	-	-	-	-	-	-	-	2	-	3
C403.5	2	-	2	-	-	-	-	-	-	-	-	-	2	-	3
C403.6	2	-	2	-	2	-	-	-	-	-	-	-	2	2	3

Contents	Hours
Unit 1: Basic modeling Introduction, Chemical engineering modeling, Types of models, Dependent & Independent variables, Application of modeling and simulation, Principles of formulation, Fundamental laws, Modeling approach, General modeling procedure, Lumped& Distributed system.	05
Unit 2:Formulation of dynamic models Balancing procedure, Case studies: CSTR, Tubular reactor, Coffee percolator, Total mass balance – Case studies: Tank drainage, Component balances - Case Studies: Waste holding tank, Energy balance - Case Studies: Heating in a filling tank, Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – Case Studies: Gravity flow tank, Dimensionless model equations - Case Studies: CSTR.	07

Content	Hours
Unit 3: Modeling of stage wise processes Introduction, Stirred tank reactor - Reactor Configurations, Generalized model description, 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, Stirred tank reactor cascade, Bubble column reactor, Reactor stability.	07
Unit 4: Stage wise mass transfer models Liquid-liquid extraction, distillation, multi component separation, multi component steam distillation, absorber- stage wise absorption.	05
Unit 5: Dynamicmodeling Plugflowreactor – Liquid phase & Gas phase tubular reactor, Plugflowreactor contactors – Liquid-liquidextraction column dynamics, Co-current & counter current heat exchanger**.**	06
Unit 6: Simulation of chemical engineering Introduction to software's used in chemical industry, 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, Integrated process simulation, Simulation tools, ISIM, Case studies: Studies of integrated process simulation, ICAS – Integrated Computer Aided System, Sequential modular method.	06

Text Books:

1. C. L. Smith, R. L. Pike and P. W. Murill, "Formulation Optimization of Mathematical Models", International Text, Pennsylvania, 1970.
2. John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, "Chemical Engineering Dynamics", VCH Publishers Inc., New York, 1974.
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.

2. Roger G. E. Franks, "Modeling and Simulation in Chemical Engineer", Wiley Inter

Course Plan

Course Title :**Petroleum Refinery Engineering (Professional Elective – II)**	
Course Code **: PEC-201CHL 404**	**Semester : VII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Description: Petroleum Refinery Engineering subject deals with study of various survey methods for crude oil along with all essential practices to explore the crude oil by using various drilling methods to derive various cuts of hydrocarbons at respective temperature and pressure by using atmospheric and vacuum distillation.

Course objective –Objectiveofthiscourseisto:

1. To understand what is crude oil, petroleum resources & scenario of petroleum refineries in India as well across the world.
2. To understand origin of petroleum, exploration techniques and drilling techniques in details.
3. To explain composition, classification, distillation & separation techniques including pre-treatment.
4. To understand properties & specification of petroleum products and overall separation processes.
5. To describe various conversion processes, Treatment methods and post production operations of Petroleum refineries.
6. To study recent trends, advancement in Petroleum refineries.

Course Outcomes (COs):

At the end of the course the student should be able to understand:

C404.1	**Explain** basic information about crude, resources and overall scenario of refineries in India as well across the world.
C404.2	**Describe** about origin, exploration techniques, Drilling Rigs and Drilling techniques in detailed manner.
C404.3	**Discuss** composition, Classify crude oil and able to **explain** various distillation processes& separation methods.
C404.4	**Compare** properties and specification of petroleum products and **relate** Overall separation processes.
C404.5	**Differentiate** various steps in conversion processes, treatments and post operations in refinery.
C404.6	**Judge** recent trends as well capable to **enlist** capacities of petroleum refineries.

Prerequisite:	Mass Transfer, Distillation

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs) and Program specific outcome (PSOs)

Course Outcomes (COs) / Program Outcomes(POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C404.1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
C404.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	1
C404.3	3		-	-	-	-	-	-	-	-	-	-	-	-	3
C404.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
C404.5	2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
C404.6	3	-	1	-	-	2	-	-	-	-	-	-	2	-	3
C404	**2.6**	**2.3**	**1**	**2**	-	**2**	-	-	-	-	-	-	**2**	-	-

Content	Hours
Unit –I 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	05
Unit –II Natural Gas Introduction, Processing, Properties, Uses, gas Hydrates, Shell gas, Purification. 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. distillation, transportation of crude.	08
Unit –III Properties and specifications of petroleum products 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.	06
Unit –IV Conversion process Thermal cracking, Vis breaking, coking, catalytic cracking, thermal reforming, catalytic reforming, hydro-cracking, hydro processing, alkylation, Isomerization and polymerization. Treatment methods, Sweetening process, hydrodesulphurization, smoke point improvement.	07
Unit –V Post production operations Blending of additives (ETBE, MTBE, Ethanol, Lead), storage of products, transportation of products, housekeeping, marketing of petroleum and petroleum products, safety and pollution considerations in refineries.	06
Unit –VI 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. Note: A Case study on the petroleum refineries may be taught.	04

Text Books:

1. Dr.Ram Prasad Petroleum Refinery Engineering
2. B.K.Bhaskara Rao Modern Petroleum Refining Processes

References Book:

1. Gary J H, Handwerk G E, _Petroleum refining
2. Nelson W. L., ―Handbook of Petroleum Refinery Engg.‖, McGraw Hill, International, Auckland,1982
3. Hobson G.D., Phol W., ―Modern Petroleum Technology-I‖, 5th ed., Halsted Division of Wiley Eastern New York, 1984.
4. Guthre, V.B., ―Petroleum Products‖, Hand-Book McGraw Hill.
5. Kobe, K.Q. Mcketta, J.J. ―Advances in Petroleum Chemistry and Refining ‖ Interscience.
   J. M. Spight, ―The chemistry and technology of petroleum

D.Y.PATIL COLLEGE OF ENGINEERING & TECHNOLOGY
KASABA BAWADA, KOLHAPUR-416006
An Autonomous Institute
B. Tech. in Chemical Engineering
Curriculum w.e.f. A.Y.2023-2024

Course Plan

Course Title :**Biochemical Engineering (Professional Elective – II)**	
Course Code :**PEC-201CHL405**	**Semester : VII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20 + 30=50	ESE Marks : 50

Course Description: Biochemical engineering course provides the knowledge of biotechnology and chemical engineering.. This course focuses on developing kinetics and design of biological reactors.

Course Objectives:

1. To study the basic concepts of biochemical engineering.
2. To study the activities of microorganism.
3. To study the kinetics enzymatic reactions.
4. To study the kinetics of substrate utilization.
5. To design the biological reactors.
6. To study the advanced topic.

Course Outcomes (COs): At the end of the course the student should be able to

C405.1	**Memorize** the basics of biochemical engineering.
C405.2	**Describe** the kinetics of reaction.
C405.3	**Describe** the kinetics of substrate.
C405.4	**Explain** the design of biological reactors.
C405.5	**Explain** the downstream processing.
C405.6	**Discuss** the modeling and simulation in biochemical engineering.

Prerequisite	Biotechnology, Chemical Reaction Engineering, Chemical Process Calculations, Heat Transfer, Mass Transfer.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs) / Program Outcomes(POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C405.1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	1
C405.2	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C405.3	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C405.4	2	2	2	-	-	-	-	-	-	-	-	-	2	-	2
C405.5	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C405.6	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C405	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-

Content	Hours
Unit 1: Introduction to biochemical engineering The interaction of two disciplines, Comparison of chemical and biochemical process, Role of biochemical engineers in development of modern formation industry, Future development, Applications of engineering advances.	6
Unit 2: The kinetics of enzyme catalyzed reactions Simple enzyme kinetics with one and two substrates, Determination of elementary step rate constant, Substrate activation and inhabitation, Multiple substrate, Modulation and regulation of enzyme activity, Enzyme deactivation, Effect of PH, Temperature, inhibitors on enzyme activity.	6
Unit 3: Kinetics of substrate utilization Ideal reactors for kinetics measurement, Kinetics of balanced growth, Transient growth kinetics, structured kinetics model, Product formation kinetics.	7

Unit 4: Design and analysis of biological reactors Ideal bioreactors, Reactor dynamics, Microbial dynamics in chemostat culture, Mass balance in a series vessel, Mass balance with recycle, Comparison between batch and continuous cultivation, Sterilization reactors, Animal and plant cell reactor technology, Examples of design calculations. Design and construction of fermenter, Multiphase reactors.	6
Unit 5: Downstream Processing Introduction, Solid-Liquid Separation – Filtration, Centrifugation, Cell Rupture, Recovery, Extraction - Single-stage Extraction, Multistage Extraction, Adsorption - Adsorption Isotherm, Adsorption Operation, Purification – Precipitation, Chromatography, Electrophoresis, Membrane Separation.	7
Unit 6: Introduction of advanced topics Bioprocess simulation, Molecular modeling for protein synthesis and drug design, Protein engineering, manufacturing process for typical pharmaceutical products.	4

Text Books:

1. J. E. Bailley and D. F. Olis,"Biochemical Engineering Fundamentals", 2nd Ed., McGraw Hill, New York, 1977.
2. Rajiv Dutta, "Fundamentals of Biochemical Engineering", Springer Berlin Heidelberg New York, Ane Books India, 2008.
3. S. Aiba, A.E. Humphrey and N.R. MHH,"Bio-chemical Engineering□, Second Edn. Academic Press, 1973.
4. F. C. Web, "Biochemical Engg.", Van Nostrand, 1964.
5. B. Atkinson, "Biochemical Reactors", Plon Ltd., 1974.
6. Henry C. Vogel and Celeste M. Todaro, "Fermentation and Biochemical Engineering Handbook Principles,Process Design, and Equipment", 3rd Ed., William Andrew is an imprint of Elsevier, New York, 2014.

Reference Books:

1. Desai A.V.,"Bio-energy", Willey Eastern Ltd. New Delhi, 1990.
2. Lehninger A.L., "Bio-Chemistry", Worth Publication, Inc., New York, 1972.
3. Bungay H. R., Belfort G.,"Advanced Bio-Chemical Engineering", John Willey And Sons, New York, 1987.

Course Plan

Course Title **:Fuel Cell Technology (Open Elective – II)**	
Course Code :**OEC-201CHL406**	**Semester : VII**
Teaching Scheme : L-T-P : 3-1-0	Credits :4
Evaluation Scheme: ISE + MSE: 20+30=50Marks	ESE: 50 Marks

Course Description: A fuel cell is an electrochemical device which combines a fuel and an oxidant, typically oxygen from air, to deliver power. Unlike a battery, which is closed, a fuel cell is open on at least one side, the air side being invariably open. Like a battery, individual cells can be combined together to form a stack and hence delivering whatever power is needed for the given application.

Course Objectives:

1. To provide with a fundamental understanding of fuel cells and their applications.
2. To know the fuel cell components, electrocatalysis, mass transport and fuel cell efficiencies.
3. To impart the basic knowledge of the operating principles and reaction kinetics in a fuel cell
4. To characterize a fuel cell and know about the hydrogen storage and safety measures to be taken for proper storage and maintenance.
5. To develop fuel cell for hydrogen storage
6. To understand the application of fuel cell.

Course Outcomes (COs): At the end of the course the student should be able to

C406.1	**Demonstrate** their understanding about a fuel cell and it's applications in automotives.
C406.2	**Develop** various fuel cells by proper combination of the basic components involved toincrease the performance of a fuel cell.
C406.3	**Calculate** cell efficiencies of different fuel cells and know their performance.
C406.4	**Apply** the reaction kinetics involved in the operation of a fuel cell for variousapplications.
C406.5	**Design** a fuel cell and make provision for hydrogen storage and safety during its storage.
C406.6	**Find** the applications of fuel cell in day-to-day life.

Prerequisite:	Engineering Chemistry

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs) / Program Outcomes(POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C406.1	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406.2	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406.3	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406.4	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406.5	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406.6	-	1	-	1	-	1	-	-	1	-	1	1	-	-	2
C406	-	**1**	-	**1**	-	**1**	-	-	**1**	-	**1**	**1**	-	-	

Contents	**Hours**
Unit 1: Introduction to Fuel Cells Introduction –types of fuel cells – low, medium and high temperature fuel cell, working of a fuel cell, principles of electrochemical energy conversion, basic electrochemistry, fuel cells for automotive applications – technology advances in fuel cell vehicle systems.	6
Unit 2: Fuel Cell Components Electrolytes, catalysts, current collector/bipolar plate, exchange current, electrocatalysis, fuel cell charge and mass transport.	4

Unit 3: Fuel Cell Thermodynamics Gibb's free energy, reversible and irreversible losses, EMF of thehydrogen fuel cell, efficiency and fuel cell voltage, cell efficiency,Gibbs free energy and idealperformance, Nernst equation, effect of temperature, pressure, concentration on Nernstpotential,fuelCrossover, ohmic Losses, charge double layer, fuel cell equations and concept ofelectrochemical potential.	7
Unit 4: Fuel Cell Reaction Kinetics Introduction to electrode kinetics, activation polarization-conceptof electrochemical kinetics, reaction rate, surface coverage, activation polarization for chargetransfer reaction, butler-volmer equation, tafel equation, ways to improve kinetic performance,concentration polarization - diffusion transport in electrodes - limiting current density,derivation, transport through flow channels (bipolar plate), ohmic polarization – ionicconductivity, electronic conductivity, current-voltage predictions.	7
Unit 5: Fuel Cell Characterization and Safety Ways of characterization, in-situ(Electrochemical impedance spectroscopy and cyclic voltammetry) and ex-situ characterization, current interruption technique, hydrogen production and storage, safety issues, cost issues and life cycle analysis of fuel cells.	6
Unit 6: Fuel Cycle Analysis Introduction to fuel cycle analysis – application to fuel cell and other competing technologies like battery powered vehicles, SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.	7

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Collecting fuel cell history	1
2	What is a fuel cell?	1
3	How do fuel cells work?	1
4	why can't I go out and buy a fuel cell?	1
5	Different types of fuel cells.	1
6	Phosphoric Acid fuel cells	1
7	Proton Exchange Membrane	1
8	Solid Oxide fuel cells	1
9	Molten Carbonate Fuel Cell	1
10	Alkali Fuel Cell	1

Text Books:

1. Viswanathan, B and AuliceScibioh, M., Fuel Cells: Principles and Applications., CRC
2. O 'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY

Reference Books:

1. Basu, S.,Fuel Cell Science and Technology, Springer, N.Y., 2007.
2. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y., 2006.

Course Plan

Course Title :**Industrial Behavior and practices (Open Elective – II)**	
Course Code: **OEC- 201CHL407**	**Semester: VII**
Teaching Scheme: L-T-P: 3-1-0	Credits: 3 + 1 = 4
Evaluation Scheme: ISE + MSE Marks: 20+30=50	ESE Marks: 50

Course Description: Industrial-organizational psychologists use psychological principles and research methods to solve problems in the workplace and improve the quality of life. They study workplace productivity and management and employee working styles. They get a feel for the morale and personality of a company or organization.

Course Objectives (COs):

1. To define industrial behavior and practices
2. To learn change in structure, culture and change on industrial behavior.
3. To learn important development such as globalization and advances in technology.
4. To understand industrial behavior theories, models and concepts.
5. To learn the knowledge about the processes about training.
6. To understand history about industrial-organizational behavior.

Course Outcomes (COs): At the end of the course the student should be able to:

C407.1	**Learn** the behavior of individuals and groups in industry in terms of the key factors that influence industrial behavior.
C407.2	**Understand** the potential effects of industrial-level factors (such as structure, culture and change) on industrial behavior.
C407.3	**Understand** the potential effects of important developments in the external environment (such as globalization and advances in technology) on industrial behavior.
C407.4	**Learn** industrial behavioral issues in the context of industrial behavior theories, models and concepts.
C407.5	**Demonstrate** knowledge about the processes about training and performance appraisal.

C407.6	**Aware** of the brief history and various related fields of industrial- organizational behavior.

Prerequisite:	Professional Skill Development

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C407.1	1	-	-	-	-	-	-	-	1	1	-	1	1	-	2
C407.2	1	1	1	-	-	-	-	-	-	-	-	1	1	-	2
C407.3	-	-	-	1	-	-	-	-	1	1	-	1	1	-	2
C407.4	-	-	1	-	-	-	-	-	-	1	-	1	1	-	2
C407.5	1	1	1	-	-	-	-	-	-	-	-	1	1	-	2
C407.6	1	1	1	1	-	-	-	-	-	-	-	1	1	-	2
C407	0.6	0.5	0.6	0.3	-	-	-	-	0.3	0.5	-	1	1	-	2

Contents	**Hours**
Unit 1 –Concept of organization & organizational Behavior. Personality: meaning, concept, determinants, personality theories (psychoanalytic Theory, Trait Theory and Self Theory. Perception: meaning, concept, process of perception, significance of perception. Leaning- meaning, concept, nature, component of leaning process. Attitude- meaning, concept, factors in attitude formation, method of finding Employee's attitude. Value - Meaning and types, value and attitude – similarity and difference. Motivation- meaning, theory of motivation (Maslow's Theory & Herzberg's Theory)	6

Unit 2- Group & Group Dynamics concept, importance, classification of groups, reason for group, formation, group cohesiveness. Team work: meaning, concept, types, creating, an effective team.	6
Unit 3 – Communication concept, process, importance, barrier. Organizational conflict- meaning, concept, types, stages of conflict, resolution of conflict. Power & politics- nature and concept, Ethics of power & politics, types of power. Leadership- concept, qualities and functions of a leader, approaches to the analysis of leadership	6
Unit 4 - Concept of organization theory concept of organization structure, form of organizational structure, form of organizational culture. Organizational effectiveness - concept, approaches, criteria of effectiveness. Organizational change - meaning, factors in Organizational change, process of planned change. Organizational Development - concept, need of organizational development, difference between organizational development & management development.	6
Unit 5 – Training and appraisal techniques Principles of learning and training.Training methods for non-supervisory employees: - on the job training, vestibule training, apprenticeship, programmed instruction, computer assisted instruction. Performance Appraisal- definition; purpose of performance appraisal; evaluation techniques- ranking technique, paired comparison technique, 360-degree feedback, 6 sigma, merit rating,computerized performance monitoring and MBO	6
Unit 6 – -Job analysis and selection Job Analysis – definition, methods-questionnaire, checklist, individual interview, observation interview, group interview, technical conference, diary method, work participation and critical incident method. Selection and Interviews – Application blanks, psychological testing-purpose and characteristics and advantages and disadvantages ofpsychological tests, types of tests.	6

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Importance and scope of Industrial behavior	1
2	Functions of a Manager	1
3	Industrial behaviour learning	1
4	Industrial behaviour personality	1
5	Industrial behaviour motivation	1
6	Industrial behaviour group	1
7	Industrial behaviour leadership	1
8	Conflict Management	1
9	Industrial behaviour culture	1
10	Industrial behaviour change	1

Text Book:

1. Organizational behavior by Stephen P. Robbin &SeemaSanghi- pearson

2. Organizational behavior by L.M. Prasad-S Chand & sons

References Book:

1. Newstrom, J. W, and Davis, K. (2015). Organizational Behavior – Human Behavior at Work, 14th edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.

2. Bhagwatwar, P.A, Psychology of Industrial Behavior. (1980). Sheth Publishers, Bombay.

Laboratory Course Plan

Course Title :**Chemical Reaction Engineering II (Laboratory work)**	
Course Code **: 201CHP408**	**Semester : VII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks : 25	ESE (POE) Marks : 25

Course Description:

The course includes experiments based on industrial chemical reaction engineering operations including kinetic study in batch, semi batch reactors, adsorption isotherms, determining catalyst properties, kinetic study of catalytic reactors and resistance time distribution (RTD) study in different reactors.

Course Objectives:

The purpose of this course is to introduce the undergraduate students with the non ideal reactors, heterogeneous catalysts, mixing of fluids, theory and design of fluid-particle, fluid-fluid, solid catalyzed reactions, deactivating catalyst with recent trends in scale up of reactor design.

1. To study the fundamental/basics of non ideal reactor & mixing of fluids.

2. To introduce the undergraduate students with the heterogeneous catalysts which play vital role in process industry.
3. To provide proper understanding of theory and design of fluid-particle, fluid-fluid, and.
4. To study solid catalyzed reactions, deactivating catalyst & the recent trends in scale up of reactor design.

Course Outcomes (COs): At the end of the course the student should be able to:

C408.1	**Understand & apply** the concept of non ideal reactor & mixing of fluids.
C408.2	**Describe & apply** knowledge of heterogeneous catalysts in industries
C408.3	**Understand, describe & apply** theory and design concepts of fluid-particle, fluid-fluid, and solid catalyzed reactions, deactivating catalyst.
C408.4	**Understand, describe & apply** knowledge of solid catalyzed reactions, deactivating catalyst& the recent trends in scale up of reactor design in industries.

Prerequisites	Chemistry, Applied mathematics, Process Calculations, Thermodynamics, Fluid mechanics, Chemical reaction engineering I

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C408.1	2	2	1	2	-	-	-	-	-	-	-	-	2	-	3
C408.2	2	2	1	2	-	1	2	-	-	-	-	-	2	-	3
C408.3	2	2	2	2	-	1	2	-	-	-	-	-	2	-	3
C408.4	2	2	2	2	-	1	2	-	-	-	-	-	2	-	3
C408	2	2	1.5	2	-	1	2	-	-	-	-	-	2	-	-

Expt. No.	Name of Experiment	Type	Hours
1	Semi batch Reactor: To find out variation of NaOH concentration with respect to time in a semi batch reactor.	O	2
2	Batch Reactor I: To calculate the value of rate constant K for the saponification of ethyl acetate with NaOH in batch reactor with initial molar ratio M=1	O	2
3	Batch Reactor II: To calculate the value of rate constant K for the saponification of ethyl acetate with NaOH in batch reactor with initial molar ratio M=2	O	2
4	Batch Reactor III: To calculate the value of rate constant K for the saponification of ethyl acetate with NaOH in batch reactor & also to find activationenegy of reaction.	O	2
5	Verification of Frendliuch&Temkin adsorption isotherms: To study catalytic activity of Charcoal & to verify Frendliuch&Temkin adsorption isotherms.	O	2
6	Catalyst Properties: To determine the value of bulk density, true density, pore volume, porosity of catalyst by benzene adsorption method.	O	2
7	RTD Studies in tubular flow reactor: To find out the resisdeance time distribution (RTD) of step and pulse inputs in straight tube reactor.	O	2
8	RTD Studies in CSTR: To find out the residence time distribution (RTD) of step and pulse inputs in CSTR.	O	2
9	RTD Studies in Packed bed reactor: To find out the residence time distribution (RTD) of step and pulse inputs in Packed bed reactor.	O	2
10	Packed bed Resin Reactor: To study the kinetics of hydrolysis of ethyl acetate with an acid catalyst.	O	2

11	Catalytic Esterification Reaction: To study the kinetics of esterification reaction& to determine reaction rate for same using cation resin as a catalyst..	O	2
12	Porosity Measurement: To determine apparent porosity of refractory materials using boiling water method.	O	2

- S-STUDY, O-OPERATIONAL
- Minimum 10 Experiments should be conducted

Text Book:

1.Octave Levenspiel, "Chemical Reaction Engineering", 3 rd Edition, John Wiley, London.

2. S.H. Fogler," Elements of Chemical Reaction Engineering", PHI, 4 th Edition.

3. J.M. Smith, "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, New York 1981.

Reference books:

1. T.T. Carbery, "Chemical and Catalytic reaction engineering", McGrawHill, New York - 2001.

2. Modeling of Chemical Kinetics and Reactor Design A. Kayode Coker, Gulf Publishing House New Delhi

3. Chemical Reactor Design

4. Peter Harriot Marcel Dekker, Inc. New York

5. Chemical Engineering Vol. III Pergamon Press, Oxford, 1989.

6. Introduction to Chemical Reaction Engineering and Kinetics Ronald W. Missen Charles A.Mims

Bradley A. Saville

7. John Wiley & Sons, Inc.

8. Chemical Reactor Design Optimization and Scaleup

9. E. Bruce Nauman McGraw Hill, New York - 2001.

Heterogeneous Reactions, Vol. I and II – L. K. Doraiswamy, M. M. Sharma

Web Links/Video Lecturesare to be provided for Theory and Practical/Experiments Lectures by NPTEL

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An Autonomous Institute
B. Tech. in Chemical Engineering
Curriculum w.e.f. A.Y.2023-2024

Laboratory Course Plan

Course Title :**Chemical Process Design (Laboratory work)**	
Course Code **: 201CHP409**	**Semester : VII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks : 25	ESE (POE) Marks : 25

Course Description: : Afterundergoingthiscoursethe students will have the knowledge to draw and find the solution in various simulation software's.

Course Objective:

1. The knowledge for designing the process equipment
2. To analyze a problem and finding a process design method for heat and mass transfer equipment used in Chemical plants.

Course Outcomes (COs):

At the end of the course the student should be able to:

C409.1	Understand various types of process flow sheet and symbols.
C409.2	Develop process design with the help of design software.

Prerequisite	Chemical Process Technology, Chemical Reaction Engineering, Heat transfer Operations, Fluid Flow Operations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C409.1	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
C409.2	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
C409	**2**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	-	**2**	**2**	-

List of Experiments

Expt. No.	Name of Experiment	Type	Hours
1	Drawing of Flow Sheets Symbols	O	2
2	Drawing of Instrumentation Symbols	O	2
3	P&ID Flow system	O	2
4	P&ID Separator Vessel	O	2
5	Process Flow diagram of manufacturing of benzene by dealkylation of toluene	O	2
6	Design of double pipe heat exchanger	O	2
7	Design of horizontal condenser process design	O	2
8	Design of triple affect forward feed evaporator [Problem & AutoCAD]	O	2
9	Property set of distillation heat exchanger problem in Aspen Plus	O	2
10	Design of Cyclone Separator	O	2
11	Design of reaction vessel	O	2

- S-STUDY, O-OPERATIONAL
- Minimum 10 Experiments should be conducted

Text Books:

1. 1. D.Q. Kem, “Process Heat Transfer”, Tata McGraw Hill Company, New York, 1997.
2. E.E. Ludwig, “Applied Process Design for Chemical and Petrochemical Plants”, Vol.I,II,III, Gulf Publication, 3rd edition London, 1994.
3. G.D.Ulrich, “A Guide to Chemical Engineering Process Design and Engineering”, John Wiley and Sons, New York, 1984.
4. M.S. Peters & K.D. Timmerhaus, “Plant Design and Economics for Chemical Engineers”,
5. 5th edition, McGraw Hill International Book Co., 2003.
6. McCabe W.L. and Smith J.C. ‘Unit operations of Chemical Engg.’ 7thed.McGraw Hill Book Co., International ed. 2005.

Link:https://onlinecourses.swayam2.ac.in/aic20_sp08/unit?unit=5&lesson=11

Laboratory Course Plan

Course Title : **Modeling and Simulation in Chemical Engineering (Laboratory work)**	
Course Code : **201CHP410**	**Semester : VII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks : 25	ESE (POE) Marks : 25

Course Description: The course includes experiments based on modeling and simulation of chemical unit operations.

Course Objectives:

1. To develop the knowledge of modeling and simulation of chemical engineering systems.
2. To develop the knowledge of modeling and simulation of tank & plug flow reactor.

Course Outcomes (COs): At the end of the course the student should be able to

C410.1	**Execute** modeling and simulation of chemical engineering systems.
C410.2	**Execute** modeling and simulation of tank & plug flow reactors

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C410.1	2	2	-	2	2	-	-	-	-	-	-	-	2	2	3
C410.2	2	2	-	2	2	-	-	-	-	-	-	-	2	2	3
C410	2	2	-	2	2	-	-	-	-	-	-	-	2	2	3

List of Experiments

Expt. No.	Name of Experiment	Type	Hours
1	To Model and simulate the Tank drainage.	O	2
2	To Model and simulate the Gravityflow tank.	O	2
3	To Model and simulate the Batch reactor.	O	2
4	To Model and simulate the Semi batch reactor.	O	2
5	To Model and simulate the Continuous stirrer tank reactor.	O	2
6	To Model and simulate the Batch liquid-liquid extraction.	O	2
7	To Model and simulate the Continuous liquid-liquid extraction.	O	2
8	To Model and simulate the Over head distillation.	O	2
9	To Model and simulate the Batch distillation.	O	2
10	To Model and simulate the Continuous distillation.	O	2
11	To Model and simulate the Plug flow reactor.	O	2
12	To Model and simulate the Co current heat exchanger.	O	2
13	To Model and simulate the Counter current heat exchanger.	O	2
14	Simulation of Chemical system by software.	O	2

- **S-STUDY, O-OPERATIONAL**
- **Minimum 10 Experiments should be conducted.**

Text Books:

1. C. L. Smith, R. L. Pike and P. W. Murill, “Formulation Optimization of Mathematical Models”, International Text, Pennsylvania, 1970.

2. John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, “Chemical Engineering Dynamics”, VCH Publishers Inc., New York, 1974.

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.

2. Roger G. E. Franks, "Modeling and Simulation in Chemical Engineer", Wiley Inter Science, New York, 1972.

Course Plan

Course Title: **Internship**	
Course Code: **201CHP 411**	**Semester: VII**
Teaching Scheme: L-T-P:0-1-0	Credits: 4
Evaluation Scheme: 50	Total Marks: 50

Course Objectives: The course is designed so as to expose the students to industry environment and to take up onsite assignment as trainees or interns.

Course Outcomes:

1. Have an exposure to industrial practices and to work in teams

2. Communicate effectively

3. Understand the impact of engineering solutions in a global, economic, environmental and societal context

4. Develop the ability to engage in research and to involve in life-long learning

5. Comprehend contemporary issues

6. Engage in establishing his/her digital footprint

Contents 4 Weeks (Four weeks) of work at industry site. Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Internship Evaluation: The students are required to undergo at least four weeks of In-plant training during summer vacation between S.Y. B.Tech Part –II and T.Y. B.Tech Part -II. 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) 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.) 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) Students will present their work before a panel of teachers in the Institute which will be assessed internally at B.E. Part -I. Out of 30% marks; the report would carry 50% weightage and the presentation would carry 50% weightage.

In case, due to illness or any other reasonable problems the student fails to undergo above said training, he/she may be allowed to visit/ tour some industries and submit a report.

Course Plan

Course Title: **Seminar**	
Course Code:**201CHP412**	**Semester: VII**
Teaching Scheme: L-T-P: 0-0-2	Credits: 0+0+1 = 1
Evaluation Scheme: 25	Total Marks: 25

The objective of this Seminar course is improved presentation and communication skills. The course objective and its outcome for the students are described below,

Course Objective: In this course, students need to select two topics, the first one is a general science or technology-based topic, and the second one is based on advanced chemical engineering. Once the topic is finalized, the student must go through literature reviews and prepare two reports separately. Students should prepare the presentation and present it to the respective committee. The presentation time of 30 minutes is allowed, followed by discussion and conclusions. A question and answer (Q&A) session is to be conducted to check students' deep knowledge and ability. The committee evaluates the student's ability from these presentations. Students need to submit the two reports separately on both topic reports in a standard typed format to the committee.

The prepared report should include following points,

1. Introduction: Maximum 2 pages
2. Literature review (including tables and figures): 10-12 pages
3. Critical analysis of literature: students should make analysis of literature available: 4-5 pages.
4. Comments on the analysis: based on method used in literature/suggestion.

Evaluation based on the following points,

1. Students will be required to make oral presentations of the seminar report on both topics.
2. Students should deliver the seminar in front of the internal judge committee and students and the committee will evaluate the performance.
3. Q&A session during the seminar.

4. The committee will evaluate seminar reports prepared by students.
5. Students' full attendance during the seminar will be counted.
6. The committee will decide how to distribute the 25 marks.

The faculty members shall guide to students with respect to the following points,

1. Selection of both seminar topics. (One general and one related to Chem. Engg).
2. Literature survey- (a) Source of Information like Magazines, journals, reports, books, Websites, etc.
(b) Searching for the information i.e. referring to chemical abstracts for Chem. Engg. Topic.
3. Preparing both seminar reports based on their work with references used.
4. Delivering the seminar, both general and related to Chem. Engg.

Course Outcomes (COs):

At the end of the course, the student should be able to:

C413.1	Opportunity to improve how to search scientific articles/reports.
C413.2	How to do the literature review of various research papers? Articulating all the research papers in single scientific report writing.
C413.3	Self-assessment in scientific depth.
C413.4	Improving presentation and communication skills.

Course Contents:

This gives a broad idea about the content for presenting the two seminar topics,

Seminar 1 (non-chemical engineering topic)- general topic in science and technology.

Seminar 1 (chemical engineering topic)- Advanced topics in chemical engineering are chosen.

Course Plan

Course Title: **Project Work (Phase -1)**	
Course Code: **PW-201CH413**	**Semester : VII**
Teaching Scheme : L-T-P : 0-0-4	Credits : 2
Evaluation Scheme: 100	Total Marks: 100

The main objective of the Final Year Project work is to learn and experience the process of conducting a good research project. The course titled "**Project Work**" is designed combined for VIIth and VIIIth semester B. Tech. in Chemical Engineering. The detail of the course objective and its outcome on students is described below.

Course Objective:

The aim of this course is to apply an individual's ability in solving advanced Chemical Engineering problems. This course will provide a platform to independently think, identify, formulate and design the problem. The following objective should be considered to progress in project work.

1. To apply technical knowledge of mathematics, science, and engineering, studied in class to solve an actual problem.
2. To design and conduct experiments, as well as to analyze, interpret data and fundamentals of chemical engineering. How to implement the core courses like heat transfer, mass transfer, chemical reaction engineering, and transport phenomena for bringing the new scientific insights.
3. An ability to design a system, component, or process to meet the needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. To understand the function on multidisciplinary teams.
5. To identify, formulate and solve engineering problems.

6. To understand of professional and ethical responsibilities.

7. How to communicate and transform scientific information effectively?

8. To understand the impact of engineering solutions in a global, economic, environmental and societal context.

9. To understand the recognition of the need for, and an ability to engage in, life- long learning.

10. To understand the knowledge of contemporary issues.

11. To implement the techniques, skills and modern engineering tools those are necessary for engineering practice.

In the end, the students should provide a feasible solution, and how the project done students group will be beneficial for the development of common people and society.

Course Outcomes (COs):

At the end of the course the student should be able to:

C413.1	Opportunity to apply the fundamentals of Chemical Engineering.
C413.2	Self assessment by critical thinking and applying technical knowledge in problem solving.
C413.3	Self assessment for improving the writing report and abstracts, demonstrating the work, public presentation and speaking skills.
C413.4	Personal competences of students are reinforced most during the FYP process, including the preparation, elaboration, presentation and defense stage.

Prerequisite	Core courses in second and third year of B Tech Chemical Engineering

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs) and Program Specific outcomes (PSOs)

Course CO	POs												PSO1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C413.1	2	2	2	2	1	-	1	2	2		2	1	2	-	2, 3
C413.2	3	2	2	2	1	-	1	2	2	2	2	1	2	-	2,3,4,5
C413.3	2	2	2	2	1	-	1	2	2	2	2	1	2	-	2,3,4,5
C413.4	2	2	2	2	1	-	1	2	2	2	2	1	2	-	4,5

Course Contents:

The project work course is to be completed under project phase I (VIIth sem.) and project phase II (VIII sem.) under the guidance of a faculty of the department. A group of a maximum of 5 students is to be prepared by the Department Research Committee (DRC) and Institute Committee. The assessment of individual groups should be conducted frequently through their independent thinking ability, report writing, presentation skill and oral viva during both semesters. The DRC and the Head of the Department should work collectively for student assessment for the development of each and individual student.

The project work shall be assessed by an oral exam to be held by at least two examiners, one internal and one external preferably from Industry 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.

It has been decided that 70-80% of project work must be done by end of VIIth semester. It possibly involves the experiments, design and necessary analysis and investigation. The following main keywords or points should serve as activities to be performed during project work under Phase I and Phase II as follows,

Project Phase 1:

Introduction to B. Tech. project, selection of topics in advanced Chemical Engineering, literature review, finding research gap and problem identification, formulation of objective and motivation of project work, abstract and report writing and overview presentation to guide/committee of proposed work. Planning and execution of proposed work, experimental and theoretical work, analysis, testing and evaluation of results, data analysis, explanation of results, results and discussion, application to society, full report and synopsis writing and presentation to guide/committee, final viva.

The following points provide the details information that needs to be performed in the overall project work,

1. Literature review

A literature review discussed published information in a particular subject area. The purpose of a literature 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 describes 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 in the conclusion of the literature review would be the clarification and emphasis of the gaps (unexplored/unsolved problems) and that becomes objective for the student's project work.

2. Problem statement

A problem statement is a concise statement of the problems which initiate the research questions and then planning and designing ideas. Some of the points that could be highlighted are:

a. What are the issues that are to be addressed? (Objective)

b. Why need to address the issues? (Motivation)

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.). Students should only state the technical objective of the project (e.g. to evaluate the performance of the design, to test a hypothesis, to study the relationship between variable x and variable y etc.). Use measurable action verbs when defining an objective (e.g. define, design, identify, describe, analyze etc

3.Results and discussion

This part highlights the form methodology, testing, investigation and evaluation consisting of experimental or theoretical work or both the works that should be carried out. The discussion should logically discuss the results and inferences to conclude the outcome of the project works

4. Conclusion and future scope

Based on the above part, results should be concluded in 1-2 paragraphs. The future scope should be written in 1 paragraph to continue the research at a later time. Scope makes our project achievable and realistic by defining the limits and constraints of the study.

Students should prepare a report in the following format. The main content of the report must consists,

1. Certificate
2. Acknowledgement
3. Statement of the problem
4. Synopsis / Abstract
5. Table of Content (Index)
6. Introduction
7. Literature survey
8. Motivation and Objective
9. Theoretical conditions – methodology, process parameters, composition.
10. Details of experimental setup & experimental work.- purpose method, chemicals, Calculations, Analysis of Data, Results and Discussion
11. Process Description – process flow sheet
12. Basic Engg. Data analysis – physical and chemical properties, thermodynamic properties

13. Mass & Energy Balance
14. Selection of Equipments& Specifications
15. Design of Specific Equipment - Process and Mechanical Design
16. Control & Safety of Process
17. Plant layout & Location
18. Cost Estimation & Economic Analysis
19. Pollution Control, Safety, Marketing
20. Conclusion & Future Scope
21. References - Journals articles, scientific letters and textbooks

A Appendix

A1 List of Tables

A2 List of Figures

A3 Sample

A4 Calculation Data

Course Plan

Course Title :**Comprehensive Test**	
Course Code :**201CHP414**	**Semester : II**
Teaching Scheme : L-T-P : 0-0-2	Credits :0
Evaluation Scheme : ESE- 50	Total Marks :50

Course Description: The objectives of the comprehensive test are to assess the overall level of proficiency of the student in the various subject‘s studies during the degree course by conducting weekly tests.

Course Objective (COs):
Objective of this course: Students are expected to understand the importance of basic concepts in chemical engineering and how these concepts are asked in competitive examinations.

Course Outcomes (COs):
At the end of the course the student should be able to:

CO	Course Outcome
C414.1	Use basic concepts of all Chemical Engineering subjects to solve Chemical Engineeringproblem.
C414.2	Apply the knowledge of Chemical Engineering to appear for entrance examinationsconfidently.
C414.3	Use the basic knowledge of Chemical Engineering to perform batter in placement drives.

Prerequisite:	Engineering Mathematics, Mechanical Operation, Fluid Mechanics, Heat Transfer, Process Calculations, Mass Transfer, Chemical Reaction Engineering, Instrumentation & Process Control, Chemical Technology, Process design.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program specific outcome (PSOs)

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C414.1	2	2	2	2	-	-	-	-	-	-	-	2	1	1	3
C414.2	2	2	2	2	-	-	-	-	-	-	-	-	1	1	3
C414.3	2	2	2	2	-	-	-	-	-	-	-	-	1	1	3

List of Experiments

Expt. No.	Name of Experiment	Type	Hours
1	**Mathematics**:- Linear Algebra, Calculus, Differential equations, Complex variables, Probability and Statistics, Numerical Methods	S	2
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.	S	2
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	S	2
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.	S	2
5	**Process Calculations**: - Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.	S	2

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-liquid extraction, drying, humidification, dehumidification and adsorption.	S	2
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.	S	2
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.	S	2
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.	S	2
10	**Process design** 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.	S	2

Text Books:

1. A text book of Applied Mathematics: Vol. I, II and III by J. N. Wartikar& P. N. Wartikar, Vidyarthi GrihaPrakashan, Pune.

2. McCabe W.L. and Smith J.C. _Unit operations of Chemical Engg.' VII ed. Mcgraw Hill Book Co., International ed. 1993

Reference Books:

1. Himmelblau D.M., ―Basic Principles and Calculations in Chemical Engineering‖, Sixth
2. Edition, Prentice-Hall of India Pvt. Ltd., 2004.
3. J.M. Smith and H.C. Van Ness, ―Introduction to Chemical Engg.‖, Thermodynamics 6th Edition, International student edition, McGraw Hill publication.
4. Eckman D. P. ―Industrial Instrumentation‖, Willey Eastern Ltd, New Delhi, 1984. Robert E. Treybal, Mass Transfer Operations‖l, Third Edition, McGraw Hill, 1980.
5. Stephanopoulos G ,―Chemical Process Control and introduction to theory and practice‖
6. S.H. Fogler,‖ Elements of Chemical Reaction Engineering‖, PHI, 3rd Edition.
7. George T. Austin, ―Shreve's Chemical Process Industries‖, 5th edn. , McGraw Hill Book Company,1985.
8. M.S. Peters &K. D. Timmerhaus, ―Plant Design and Economics for Chemical Engineers‖, 3rd edition, McGraw Hill International Book Co., 1980. 6.
9. McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7ed.McGrawHill Science/Engineering/ Math, Boston.

Course Plan

Course Title **: Transport Phenomena**	
Course Code :**201CHL415**	**Semester : VIII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Objective (COs):

Objective of this course is to:

1. To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.
2. To be able to understand the chemical and physical transport processes and their mechanism.
3. Ability to do heat, mass and momentum transfer analysis.
4. To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Course Outcomes (COs):

CO No.	Course Outcomes	BTL
	At the end of the course the student should be able…	
C415.1	To **relate** the similarity between momentum, heat and mass transport and their analogy.	BTL 4
C415.2	To **develop** the ability to formulate and solve mathematical problems for momentum transport.	BTL 6
C415.3	Able to know about **applying** fundamental knowledge to solve momentum and heat transport problems.	BTL 3
C415.4	To **evaluate** different parameters affecting on the mathematical formulation of heat transfer problem and it numerical solution.	BTL 5
C415.5	To **analyse** the mass transfer problem, its mathematical formulation and the numerical simulation and to outline the fundamentals of computational	BTL 4

	fluid dynamics.	
C415.6	To **develop** the practical skill, team work and ethical thinking to choose right career in industry or higher studies.	BTL 6

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program specific outcome (PSOs)

Course Outcomes (COs)	POs												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
C415.1	2	2	2	-	-	-	-	-	-	-	-	-	1	-
C415.2	3	3	3	3	-	-	-	-	-	-	-	-	1	-
C415.3	3	3	3	3	-	-	-	-	-	-	-	-	1	2
C415.4	3	3	3	3	-	-	-	-	-	-	-	-	1	-
C415.5	3	3	3	3	-	-	-	-	-	-	-	-	1	2
C415.6	-	-	-	-	1	1	-	1	1	1	-	1	1	-
C415	**2.8**	**2.8**	**2.8**	**3.0**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**2.0**

Prerequisites	Fluid Flow operations, Mass Transfer operations, Heat Transfer Operations

Content	Hours
Unit-1 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.	06

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.	05
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.	09
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.	07

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.	07
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 solvingengineering problems.	03

Text Book:

1. R.B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena‖, John Wiley & Sons, Inc

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 Operations‖,2nd edn., 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 Applications‖, McGraw Hill.1995

Course Plan

Course Title :**Process Economics and Project Engineering**	
Course Code :**201CHL 416**	**Semester : VIII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Description: Process Economics and Project Engineering subject deals with process design, development, general design considerations, and economics essential for chemical engineer. In this syllabus we will be discussing process commercialization, contracting, licensing, project conception & project engineering.

Course Objectives:-

1. To study, understand & apply concept of process design & development, general design considerations in industries.
2. To study, understand & apply concept of cost accounting, estimation & BEP analysis used in industries.
3. To learn, understand & apply types of interest, taxes, insurances, annuity, depreciation, profitability, alternative investment, replacement and optimum design.
4. To study, understand process development and commercialization in industries.
5. To understand selection of contractor with its scope, licensing & its types with concept of plant start-up.
6. To study, understand concepts of project conception and project engineering, PERT,CPM to apply in industries.

Course Outcomes (COs): At the end of the course the student should be able to:

C416.1	**Apply** knowledge of process design & development, general design consideration in industries.
C416.2	**Understand, explain & apply** the concept of cost accounting, estimation & BEP analysis in industries.
C416.3	**Explain & apply** knowledge of types of interest, taxes, insurances, profitability, alternative investment, replacement and optimum design in industries.
C416.4	**Describe & apply** knowledge of process development and commercialization.
C416.5	**Understand & apply** knowledge of selection of contractor with its scope & types with concept of plant start-up.
C416.6	**Describe & apply** knowledge of project conception and project engineering, PERT, CPM in industries.

Prerequisite:	Applied mathematics, Project Management & smart technology, Industrial economics, management & entrepreneurship

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C416.1	2	1	2	1	-	2	2	-	1	-	-	1	3	-	2
C416.2	3	3	2	3	-	-	-	-	-	-	-	1	3	-	3
C416.3	3	2	3	2	-	-	-	-	-	-	-	1	3	-	3
C416.4	1	2	2	2	-	-	-	-	-	-	-	1	2	-	3
C416.5	2	1	2	2	-	-	-	-	-	-	-	1	2	-	2
C416.6	3	2	3	2	-	-	-	-	-	-	1	1	2	-	3

Content	Hours
Unit 1 – Process design & development, General design considerations Introduction, plant design project, practical considerations in design. Process Design Development, Design project procedure, Scale up in design, Safety factor, Specification, General design considerations like solid waste disposal, plant location layout, HAZOP, FTA, SIL, QRA Health & Safety hazards, Patent, royalty.	6
Unit 2- Cost & Asset accounting, Cost estimation, BEP analysis Cost and Asset accounting, Different ratios in accounting, Journal, Ledger, Analysis of Cost estimation, cost index, cost estimation by scaling, different cost, methods for estimating capital investment, and break even analysis.	9
Unit 3 – Interest, Taxes & Insurance, Depreciation, Profitability & Optimum design: Interest, Time value of Money, Annuity, capitalized cost, Taxes and Insurance, Depreciation, Profitability, Alternative investments and replacements, Optimum design and Design strategy.	12
Unit 4 – Process development and commercialization, Licensing Process development and commercialization: Introduction, Exploratory research and its types, development for final process design,Process Licensing: Licensing principles, License agreement, and Agreementimplementation.	4
Unit 5 – Contracting, Plant start up 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, Log sheets and calculations, Plant startup, Operating the plant, Battery limits, Offsite facilities. Procurement and Construction.	5

Unit 6 – Project Conception, Project Engineering 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 Engineering: Management and Organization, Greenfield projects, Project Planning, Scheduling and Controlling ,Feasibility Report, Use of bar and milestone chart, Fulkerson rule, dummy activity, PERT/ CPM - Introduction, Activity Sequencing, Network building, Time estimates, Slack, Critical path calculations.	9

Textbooks:

1. M.S. Peters & K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", 5thedition, McGraw Hill International Book Co., 2003.
2. Lundu, "The Chemical Plant".
3. J.M. Coulson & J.F Richardson, "Chemical Engineering", Vol.6, 5th edition Pergamon& ELES, 2003.
4. Modes J. & Philips, "Project Engineering with C.P.M. & PERT", Reinhold.
5. Srinath L.S. "PERT & C.P.M. Principles and Applications"3rd edition, East-West Publication 2003.
6. GAEL D. ULRICH, "A Guide to Chemical Engineering Process Design and E" John Wiley &Sons, 1984.
7. N. D. Vohra, "Quantitative Techniques in Management", 2nd edition Tata McGraw Hill Publishing company Ltd., New Delhi2005.
8. Chemical Project Economics, Mahajani V. V. and Mokashi S M.

References:

1. Rase, H.F. Barrow, M.H. "Project Engineering of Process Plants", John Wiley.

2. Schewayer, H.E. "Process Engineering Economics", McGraw Hill

3. Chilton, C.H., "Cost Engineering in Process Industries", McGraw Hill

4. Happel J. Jordan, D.G. "Chemical Process Economics".

5. Tacmin A,J. Blank L.T. "Engineering Economy"

6. V.W. Wani. & A.W. Hankins, "Technical Economics for Chemical Engineers" (AICHE) 1971

Course Plan

CourseTitle:**AdvanceManufacturingProcesses**	
Course Code :**201CHL417**	**Semester : VIII**
Teaching Scheme:L-T-P:3-0-0	Credits: 3
EvaluationScheme: ISE+MSEMarks:20+30=50 Marks	ESEMarks :50

Course Description: Introduction to manufacturing systems and manufacturing processes andto impart knowledge and develop skills of modern and advanced manufacturing techniques.

Course Objectives:

1. The knowledge of synthesis process of food and explosive industries
2. To study the manufacturing of paper and pulp.
3. To study the synthesis of pharmaceutical and dye products
4. The knowledge of principles of green chemistry
5. To study challenges of green chemistry
6. The knowledge of green fuel and its sustainability

CourseOutcomes(COs): Attheend ofthecoursethestudentshouldbeableto:

C417.1	**Understandanddevelop** manufacturingprocessesforfoodandexplosiveindustries
C417.2	**Explain** the manufacturingprocessesofpaper&plasticindustries
C417.3	**Develop** manufacturingprocessesforpharmaceuticalsanddyes industries.
C417.4	**Understand**theprinciplesofgreenchemistryandtechnology.
C417.5	**Explain** the various ecological treats and various green chemistrychallenges
C417.6	**Explain** thevariousgreenfueltechnologiesandsustainabledevelopment

Prerequisite	ChemicalProcessTechnology, Industrial engineering chemistry I&II, Environmental studies

CourseArticulationMatrix: MappingofCourseOutcomes(COs)withProgramOutcomes(POs)and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C417.1	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417.2	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417.3	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417.4	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417.5	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417.6	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C417	2	2	-	-	-	-	2	-	-	-	-	-	2	-	-

Content	Hours
Unit 1 –Explosives& Food Industries Types of explosives, explosive characteristic, Industrial explosives, propellants, missiles. Types of food processing, preservation methods, Food byproducts. Future scope	6
Unit 2-Pulp and paper industries Manufacturing of pulp, Manufacturing of paper. Plastic industries: Raw materials, General polymerization processes, Manufacturing processes. future scope	6
Unit 3 – Pharmaceutical industries Classification of pharmaceutical products. Manufacture of antibiotics, Isolates from animals. Dyes and Pigments: Types of dyes, manufacturing of dyes, Manufacturing of pigments.	6

Unit 4 –Green Chemistry Twelve principles of green chemistry, Green technology-definition, importance, factors affecting green technology. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology	6
Unit 5 – Ecological Threats & Green Chemistry Role of chemical processes and products Ecology Role & Responsibilities of Chemical Engineers Evaluating and improving environmental performance of Chemical processes 4R Principles LCA and its application. Old Technology vis-à-vis Green Technology with Suitable examples to understand comparative advantage of Green Technology over Old one, Renewable resources, Process intensification.	6
Unit 6 – Green Chemistry & Nonconventional Fuels Emerging green materials for chemical industries Fuel cell and electric vehicles, Renewable energy, Solar energy and hydrogen production, biodiesel, bio-hydrogen Green Chemistry. Hydrogen as green fuel Industrial case studies. Best practices in Green Chemistry for sustainable development with suitable examples	6

TextBook:

1. GeorgeT.Austin,—Shreve'sChemicalProcessIndustries‖, 5th edn.,McGrawHillBookCompany,1985.
2. Paul T. Anastaj; —Green Chemistry – Theory and Practice‖ 3. Albert S. Matlack Introduction toGreen Chemistry

Referencebooks:

1. S.D.Shukla, G.N.Pandey.—ATextbookofChemicalTechnology, 3rdEdition.
2. C.E.Dryden, —OutlinesofChemicalTechnology,AffiliatedEast-WestPress, 1973.
3. D. Venkteshwaralu,—ChemicalTechnology,I &IIImanualsofChemicalTechnologyChemicalEngg. Ed.Dev.IIIMadras,1977.
4. Anastas,P.;Warner,J.GreenChemistry:Theoryand Practice;OxfordUniversityPress: London,
5. Zimmerman, J.B.;Anastas, P.T.—The12PrinciplesofGreenEngineeringasaFoundation forSustainability‖ in Sustainability Science and Engineering: Principles. Ed.Martin Abraham, ElsevierScience.Available2005

Course Plan

Course Title: **Petrochemical Technology (Professional Elective – III)**	
Course Code: **PEC- 201CHL418**	**Semester: VIII**
Teaching Scheme: L-T-P : 3-0-0	Credits: 3
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	ESE Marks: 50

Course Descriptions:

The details for course titled "Petrochemical Technology" as an elective course is designed, for the students of VIIIth semester B. Tech. in Chemical Engineering. The detail of course objective and its outcome on students is described below.

Course Objective:

The aim of this course is to familiarize the students with specifically petrochemicals industries. The main objectives of this course are,

1. To understand them the worldwide historical existence, petrochemical compounds, various processes and their flow-diagram those are carried out in petrochemical industry.
2. To understand the import and export of heavy feedstock.
3. To understand the manufacturing processes of low molecular weight compounds, such as methane, ethane and their other derivative products.
4. To understand the manufacturing processes of high molecular weight compounds, such as butane, pentane and other related products, aromatic compounds like benzene and its derivative products.
5. To understand the polymer manufacturing processes of elastomers, synthetic fibers and nylons.
6. To discuss and understand market trend in petrochemical industries.

Course Outcomes (COs): At the end of the course the student should be able to:

C418.1	**Understand** the petrochemical industries, **Classification** and sources of petrochemical.
C418.2	**Understand**,**Remember**: Able to distinguish the processes carried out particularly in petrochemical Industries.
C418.3	**Understand**,**Remember**: Able to draw with neat sketch of process flow diagram of petrochemical compounds, like polymers, alkanes and alkynes.
C418.4	Able to **understand** of latest petrochemical technologies in the world.

Prerequisite	Petroleum Refinery Engineering, Chemical Process Technology

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program specific outcome (PSOs)

Course CO	PO												PSO		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
C418.1	2	-	-	-	-	-	1	-	-	-	-	-	2	-	2
C418.2	2	-	-	-	-	-	1	-	-	-	-	-	2	-	2
C418.3	2	-	-	-	-	-	1	-	-	-	-	-	2	-	2
C418.4	2	-	-	-	-	-	1	-	-	-	-	-	2	-	2

Content	Hours
Unit 1 - Introduction to petrochemical industries Definition and classification 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 versus foreign know-how, economics of R&D, sources of petrochemicals, natural gas and petroleum.	5
Unit 2- Raw materials in petrochemical industries Organic chemicals, coal, biomass petroleum. Chemicals from Methanol and Synthesis gas: Steam reforming, Oxo-Products, Methanol, Formaldehyde, Carbon-di-sulphide, Hydrogen cyanide.	8
Unit 3 – Low molecular weight alkanes Chemicals from Ethane, Ethylene & Acetylene: Synthesis of Ethanol, Acetaldehyde, Acetic acid, Vinyl acetate, Ethylene oxide, Ethylene glycols, Acrylonitrile, Chemicals from Propane & Propylene: Isopropanol, Acetone, Glycerol, Propylene oxide, Propylene Glycols, Isoprene, Cumene.	8
Unit 4 – High molecular weight alkanes Chemicals from Butanes & Pentanes: Butadiene, Butone epoxides & Butanol amines, Butyl acetate, Methyl-Ethyl Ketone, MTBE, TAME. Chemicals from aromatics: BHC, Nitrobenzene, Do-decyl benzene, Benzoic acid, Nitrotolune, Pthalic anhydride, Isopthalic acid, TPA, DMT, Maleic anhydride, Adipic acid, Hexamethylenediamine, Aniline and Caprolactum.	9
Unit 5 – Role of polymers in petrochemical industries Polymers, elastomers, synthetic fibers, PVC, Nylon and Polyesters.	5

Unit 6 – Future of Petrochemicals Integrated Petrochemical complex, Energy crises in Petrochemical industry, Natural gas as Petrochemical feedstock, Import of heavy feedstock on Petrochemicals, Ecology and energy crises, coal as an alternative to oil, Synthetic fuels, Trends in Petrochemical Industry, latest technologies developed in Petrochemical industry.	6

Textbooks:

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. Ram Prasad, ―Petroleum Refinery Technology, Khanna publications.
4. J. H. Gary, G. E. Handwerk and M. J. Kaiser - Petroleum Refining Technology and Economics, 5th Edition, CRC press Taylor & Francis Group, 2007.
5. A.V.G. Halm - The Petrochemical Industry, McGraw Hill 1970.
6. A.L. Waddams - Chemicals from Petroleum, Chemical publishing Co.
7. M.J Astle - The Chemistry of Petrochemicals, Reinhold.
8. C.E. Dryden - Outlines of Chemical Technology, Affiliated East-West Press, 1973.
   F. Keys - Industrial Chemicals.
9. https://chemicals.nic.in/petrochemicals

Course Plan

Course Title :**Distillation (Professional Elective –III)**	
Course Code :**PEC- 201CHL419**	**Semester : VIII**
Teaching Scheme : L-T-P : 3-0-0	Credits :3
Evaluation Scheme : ISE + MSE Marks : 20 + 30	ESE Marks :50

Course Description: Distillation course provides basics of distillation operation, its types and industrial importance. This course also focus on design of various types of distillation columns for binary and multi component mixture.

Course Objective (COs): Objective of this course: Students are expected to

1. Get the knowledge of principalsvapour liquid equilibrium and various types of distillation.
2. Use methods of design of distillation column for binary and multicomponent mixture.
3. Become familiar with recent advances in the distillation operations use in industry.

Course Outcomes (COs):
At the end of the course the student should be able to:

CO	Course Outcome
C419.1	Understand basic principles of vapour liquid equilibrium
C419.2	Understand concepts of distillation operation and various types of distillation
C419.3	Use various design methods for design of fractionating column.
C419.4	Use various design methods for design of packed bed distillation column.
C419.5	Use multi component distillation technique for separation of mixture of chemicals
C419.6	Understand basic concepts of advance distillation operations in chemical industry

Prerequisite:	Heat Transfer, Mass Transfer, Process Calculations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program specific outcome (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C419.1	3	2	2	-	-	-	-	-	-	-	-	-	3	-	2
C419.2	3	3	2	2	-	-	-	-	-	-	-	-	2	-	2
C419.3	3	3	3	3	1	-	-	-	-	-	-	-	3	3	3
C419.4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
C419.5	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
C419.6	3	3	3	3	-	-	-	-	-	-	-	-	3	-	2
C419	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Content	Hours
Unit 1 –Introduction to basic concepts of distillation 1. Definition, Vapour liquid equilibrium, boiling point diagram of binary mixture, 2. Raults Law, Relative volatility, Henrys Law, Positive and negative deviation from Raults law, 3. vapour pressure, phase diagram, degree of freedom, industrial applications of distillation.	06

Unit 2 – Types of Distillation 1. General distillation operation, Equilibrium/flash distillation, Fractional distillation/ rectification. 2. Types of fractionating column used in industry, A) Plate column B) Packed column 3. Tray hydraulic parameters, selection of tray type, effect of vepour flow condition on tray design – flooding, weeping, relation between tower diameter and tray specing, provisional plate design.	06
Unit 3 - Design of tray column 1. McCabe Thiele method of design of distillation column – determination of operating line of rectifying and stripping section, determination of feed condition, determination of number of theoretical stages, reflux ration and types of reflux, tray efficiency, Industrial examples. 2. Ponchon- saverit method of design of distillation column – Enthalpy concentration diagram, step wise procedure to find number of theoretical trays, industrial examples. 3. Introduction to Lewis sorelmethos of design of distillation column.	06
Unit 4 – Design of packed bed distillation column 1. Introduction to packed bed distillation, types of packing- random packing regular packing, effect of packing on various process parameters, Height equivalent to theoretical plate (HETP), Height of transfer unit (HTU), Number of transfer unites (NTU). 2. Advantages and disadvantages of packed bed distillation, purpose of distribution plates, effect of vapour flow rate, packing support, determination of column diameter, industrial examples.	06
Unit 5–Multicomponent Distillation 1. Introduction to multicomponent distillation, degree of freedom in multicomponent distillation, key components, column operating conditions. 2. Approximate method of distillation calculation, a. Fenske's equation of minimum number of stages b. Underwood method for minimum reflux c. Gilliland equation for finding number of stages. 3. Regrous method of distillation calculation and industrial examples.	06

Unit 6– Recent advances in distillation operation in chemical industry 1. Divided wall column, reduced pressure/ vacuum distillation, molecular distillation, Industrial scale distillation of azeotrop mixture, reactive distillation, extractive distillation, solvent extraction, steam distillation.. 2. Types of condenser, reboiler, preheater, column turn around, distillation column control – temperature control, pressure control 3. Introduction to distillation column design by using ASPEN Plus software.	06

References:

1. Distillation, Van Winkle.
2. Distillation Design, J. H. Kister
3. Distillation Operations, J. H. Kister

Text Book:

4. Design of Equilibrium Stages, B. D. Smith
5. Richardson, J. F., Coulson, J. M., Harker, J. H., Backhurst, J. R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth - Heinemann, Woburn, MA.
6. McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7ed. McGrawHill Science/Engineering/ Math, Boston.
7. Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.

Course Title : Energy Conservation & Recovery (Professional Elective -IV)	
Course Code : **PEC-201CHL420**	**Semester : VIII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20 + 30=50	ESE Marks : 50

Course Description: Energy conservation and recovery course provides the detail information of energy conservation and recovery. This course focuses on Indian energy scenario, role of energy conservation, implementation of energy conservation in industry, energy audit in detail and energy conservation act 2001.

Course Objectives:

1. To study the importance of energy and Indian energy scenario.
2. To study the energy available for industrial use and role of energy conservation.
3. To study in detail energy management and policy.
4. To know basic principles of energy conservation and equipments used for heat recover.
5. To know basic of cogeneration & energy audit.
6. 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 the course the student should be able to

C420.1	Describe the importance of energy in production & employment & what is energy scenario in India?
C420.1	Understand how to forecast industrial energy supply, demand? and what is role of energy conservation in industry?
C420.1	Implement comprehensive energy conservation planning.
C420.1	Explain basic principles of energy conservation and selection of equipments for heat recover.
C420.1	Explain cogeneration concept & implement energy audit.
C420.1	Understand the effect of climate change on energy in India, saving of energy in sugar industry and energy conservation act 2001.

Prerequisite	Chemical Engineering Thermodynamics, Chemical Process Calculations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C420.1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C420.1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C420.1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	3
C420.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
C420.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2, 3
C420.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
C420	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-

Content	Hours
Unit 1: Energy conservation and Indian energy scenario An Introduction: Industrial energy use and economy, importance of energy in production and employment, The mystery of conservation. Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Barriers.	06
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 energy technologies and conservations.	03
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.	05
Unit 4: Principles of energy conservation and Energy conservation technologies Definition of energy conservation, Principles of energy conservations, Economics of energy	08

conservation policy, Optimum energy conservation, Observation on energy conservation by industry. Waste heat recovery and utilization, Technologies, Cost and energy saving of waste heat recovery and utilization.	
Unit 5: Cogeneration concept and scope and Energy audit and management Introduction, Advantages, Constraints, Feasibility, Scope, Benefitsand constraints. Types of audit, Responsibility of energy management, Targeting and monitoring energy consumption, Scope of energy audit, General questionnaire, Case study of energy audit.	06
Unit 6 Impact of climate change in India, Energy conservation in Sugar Industry, Energy conservation act 2001.	08

Text books:

1. S. Devid Hu., "Handbook of Industrial Energy Conservation", Van NostrandReinhold Company Inc., New York.
2. Rao, Diwalkar P. L.,"Energy Conservation Handbook", Utility Publication, Hydrabad
3. The Bulletion on Energy Efficiency and Management by IRADA, MITCON, MEDHA etc.
4. Amit Tagi, "A Handbook Energy Audit", Tata McGraw Hill publication, 2000
5. A Practical Guide to Energy Conservation, PCRA Publication, Ministry of Petroleum & Natural Gas, 2010

Reference books:

1. D. Mohan Singh, Col. S. K. Murthy (Retd.) and etc., "Energy Conservation in Industries", 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.

Course Plan

Course Title : **Industrial Safety & Management (Professional Elective -IV)**	
Course Code : **PEC-201CHL421**	**Semester : VIII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3

Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Description: The course deals with objectives for work with Health, Safety and Environment (HSE),Regulations and guidelines, Risk Assessment, Fire protection-theory, importance of hygiene, use material safety data sheet for safe working in the industry and avoid accidents.

Course Objectives:

At end of this course students will

1. To study the basics of industrial safety.
2. To study the hazard in industry.
3. To study the industrial hygiene and its implementation.
4. To prevent accidents in the industry.
5. To study the hazardous chemicals.
6. To study the industrial safety act.

Course Outcomes (COs):
At the end of the course the student should be able to:

C421.1	**Understand** the concept and importance of industrial safety
C421.2	**Identify** the hazard in industry and control it.
C421.3	**Understand** the importance of industrial hygiene and effectively implement.
C421.4	**Understand** the prevention of accidents in the industry with help of various case studies.
C421.5	**Identify** the hazardous chemical in industry and able to handle hazardous chemical safely.
C421.6	**Understand** the various industrial safety acts and work accordingly.

Prerequisite:	Industrial Engineering Chemistry

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			

/ Program Outcomes (POs)															
C421.1	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421.2	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421.3	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421.4	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421.5	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421.6	2	2	2	-	-	1	2	-	-	-	-	-	1	-	2
C421	2	2	2	-	-	1	2	-	-	-	-	-	1	-	-

Content	Hours
Unit 1 –Concept of industrial safety History and development of safety movement, Safety programs, Need for safety, Accident sequence theory, Nature of Accident, Process of accident, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid, Financial costs-direct and indirect, social costs of accidents.	6
Unit 2-Hazard identification, risk assessment and control Fire triangle, roll of national fire protection association (NFPA), Hierarchy of hazard control (LOPA), Hazard Identification and Risk Assessment (HIRA), Hazard Analysis (HAZAN), Hazard and operability (HAZOP) studies Maximum Credible Accident Analysis (MCAA)/Quantitative Risk Assessment (QRA) Hazard identification and risk control approaches and techniques: Reactive approach: Incident recall technique (after-the-event approach), Proactive approaches: Critical incident review technique (before-the-event approach), Deductive technique, Inductive technique.	6
Unit 3 - Industrial Hygiene Definition of Industrial Hygiene, Phases of industrial hygiene Industrial Hygiene: Control Methods, Substitution, Changing the process, isolation, wet method, local exhaust ventilation, personal hygiene, housekeeping and maintenance, waste disposal, special	6

control measures. Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, vapors, smoke and aerosols, use of MSDS(Material Safety Data Sheets)	
Unit 4 - Process Safety Management Purpose of PSM, its elements and Risk-Based Process Safety Management (RBPSM), Flammability characteristics of liquids and gases, Major Industrial Disasters (Case Studies) Bhopal disaster (1984), Chernobyl Disaster, Fukushima Daiichi Disaster etc.	5
Unit 5 - Safe Handling of Chemicals Safety in receiving, storage and handling of chemicals Nitrogen blanketing of flammable liquid storage tanks, Hazardous material classification, Use of Material Safety Data Sheets (MSDS) and understanding the terminology used in MSDS, Chemical compatibility considerations Transportation of hazardous materials, HAZMAT placards, Safety Precautions for transporting hazardous/ toxic/ flammable/explosive/ radioactive substances by all modes, U.N. classification of dangerous goods Transfer of chemicals by pipelines within and outside the installation (aboveground, underground and submarine), Pigging operation of pipelines including intelligent pigging, Cathodic protection of underground pipelines	7
Unit 6 - Industrial Safety Legislations Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. Legislative measures in industry: Factories Act, 1948, the factories rules, History, Provisions under the factories Act and rules made there under with amendments, Electricity act 2003, Functions of safety management. Workman's Compensation Act, 1943, Employees State Insurance Act, 1948, Air Pollution (Prevention and control) Act, 1981, Water Pollution (Prevention and Control) Act, 1974, Boiler Vessels Act, Child Labor and Women Employee Act., EPA 1986.	6

Text Book:

1. Industrial Accident Prevention, H.W. Heinrich, Dan Petersen, and Nestor Roos, McGraw Hill Book Company, New York / New Delhi White, F. M. (1979). Fluid mechanics, 1999Mc Graw-Hill.

2. Industrial Safety and Environment, A. K. Gupta, Laxmi Publications, New Delhi

3.Techniques of Safety Management (ISBN: 978-18-8-558139-6), Dan Petersen, McGraw-Hill Book

Co. Ltd., New York, N.Y. USA,

4. Industrial Accident Prevention, H.W. Heinrich, Dan Petersen, and Nestor Roos, McGraw-Hill Book company, New York / New Delhi

References Book:

1.Hazardous Chemical Data Book ISBN: 081-551072-1), G. Weiss, Noyes Data Corporation, Park Ridge, New Jersey, N.Y. (USA)

2. The Factories Act, 1948 & Factory Rules

Course Plan

Course Title :**Separation Processes**	
Course Code :**MC-201CHL422**	**Semester : VIII**
Teaching Scheme : L-T-P : 2-0-0	Credits :1
Evaluation Scheme : ESE Marks : 50	Total Marks : 25

Course Description: Advanced Separation Processes subject deals with study of advanced separation processes which are used to make process eco friendly and most economical. Conventional processes are expected to get replaced by using membrane and advanced separation processes.

Course Outcomes (COs):
At the end of the course the student should be able to understand:

C422.1	**Describe** knowledge about various aspect of membrane Separation
C422.2	**Recognize**Pressure swing Adsorption, Electrostatic Precipitator.
C422.3	**Explain** Supported Liquid Membranes, Supercritical Fluid Extraction as well process conditions in optimistic way.
C422.4	**Demonstrate** Nano filtration and its applications for separation of various mixtures.

Prerequisite:	Mechanical Operation, Mass Transfer, Fluid Flow Operations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs) and Program specific outcome (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C422.1	2	2	2	1	-	-	-	-	-	-	-	-	1	-	-
C422.2	2	2	2	1	-	-	-	-	-	-	-	-	1	-	-

C422.3	2	2	2	1	-	-	-	-	-	-	-	-	1	-	-
C422.4	2	2	2	1	-	-	-	-	-	-	-	-	1	-	-
C422	2	2	2	1	-	-	-	-	-	-	-	-	0.6	-	-

Contents	Hours
Unit –I Membrane Separation Processes Reverse Osmosis –what is osmosis, introduction to reverse osmosis Ultra filtration –Introduction to Ultra filtration introduction to ultrafiltration Micro Filtaration- Introduction to microfiltaration processes	06
Unit –II Pressure swing Adsorption, Electrostatic Precipitator	06
Unit –III - Supported Liquid Membranes, Supercritical Fluid Extraction etc.	06
Unit –IV - Nanofiltration: introduction to nanofiltration processes, equilibrium partitioning,pore models for neutral solute rejection, effects of membrane charge, confinement issues and effects on physical properties, pore size distributions	06

Text Books:

1. C.J.King "Separation Processes" 2nd Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1986.
2. Sirkar K. & Winston H.O. "Membrane Hand Book" Van Nostrand Reinhold, New York, 1992.
3. McCabe & Smith "Unit Operations of Chemical Engineering" 5 thEd.,McGraw Hill
4. Richardson and Coulson,—Chemical Engineering Volume –II□,Pergamon Press,1970.
5. Schweitzer P.A , —Handbook of Separation Techniques for Chemical Engineering‖2nd edn.,McGraw Hill Book Co.,1986.SouriRajan S. "Reverse Osmosis" Logos Press Ltd..

Laboratory Course Plan

Course Title : **Advance Manufacturing Process (Laboratorywork)**	
Course Code : **HSMC-201CHP423**	**Semester : VIII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks - 25	Total Marks : 25

Course Description:

The course shall bring out concepts forming the basis of the Chemical Process Industry and to give a solid background for innovative process development. It shall discuss the actual industrial processes that present opportunities and challenges for chemical engineers for the development of these processes.

Course Objective:

1. To study the basic manufacturing various chemicals.
2. To study the process variables and control in unit operation.

Course Outcomes (COs): At the end of the course the student should be able to:

C423.1	Understanding of various parameters affecting chemical process development.
C423.2	To develop a chemical process for various chemical reactions.

Prerequisite	Industrial Engineering Chemistry, Process Calculation etc.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C423.1	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C423.2	2	2	-	-	-	-	2	-	-	-	-	-	2	-	2
C423	**2**	**2**	-	-	-	-	**2**	-	-	-	-	-	**2**	-	-

Expt. No.	Name of Experiment	Type	Hours
1	To prepare chrome yellow pigment.	O	2
2	To prepare a greenish blue pigment from CuSO4 and Na2CO3.	O	2
3	To prepare Azo dye from aniline and B-Naphthol.	O	2
4	To prepare soap by cold process.	O	2
5	Preparation of phenol formaldehyde resin.	O	2
6	Preparation of nitrobenzene by nitration of benzene.	O	2
7	To find out C.O.D. of given Sample.	O	2

8	To prepare aspirin.	O	2
9	To prepare paracetamol.	O	2
10	To determine the alkali content of a given soap sample	O	2
11	To determine the fat content in a given food stuff sample	O	2

- S-STUDY, O-OPERATIONAL
- Minimum 10 Experiments should be conducted

Text Books:

1. George T. Austin, Shreve's Chemical Process Industries, 5th edition. , McGraw Hill Book Company, 1985.
2. C.E. Dryden, Outlines of Chemical Technology, Affiliated East-West Press, 1973.

Reference Books:

1. S.D. Shukla, G.N. Pandey, A Text book of Chemical Technology, 3rd Edition
2. D. Venkteshwaralu, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977
3. Perry R. H. Green D. W., Perry's chemical Engineer's Handbook, McGraw Hill, New York, 2007.1. Foust A. G. et.a- Principles of Unit Operations, 3nd ed. John, Wiley & Sons, New York 1979.
4. G. C. Sekhar, unit Operations in Chemical Engineering, Pearson education (Singapore) Pte. Ltd

Laboratory Course Plan

Course Title : **Separation Processes (Laboratory work)**	
Course Code :**PCC-LC-201CHP424**	**Semester : VIII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks : 25	ESE (POE) Marks : 25

Course Description:

The course includes experiments based on advanced methods of separations by using advanced

membranes. Practical aspects on various advanced separation processes like Reverse Osmosis, Ultra filtration, Ion Exchange Process, Electrostatic Precipitator, Hollow Fiber membranes etc is incorporated in this lab work.

Course Objectives:

The purpose of this course is to introduce the undergraduate students with the various advanced separation processes like Reverse Osmosis, Ultra filtration, Ion Exchange Process, Electrostatic Precipitator , Hollow Fiber membranes etc

Course Outcomes (COs): At the end of the course the student should be able to:

C424.1	Describe knowledge about various aspect of membrane Separation
C424.2	Recognize Pressure swing Adsorption, Electrostatic Precipitator.
C424.3	Explain Supported Liquid Membranes, Supercritical Fluid Extraction as well process conditions in optimistic way.
C424.4	Demonstrate Nano filtration and its applications for separation of various mixtures.

Prerequisite:	Mechanical Operation, Mass Transfer, Fluid Flow Operations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
C424.1	3	2	3	1	-	-	-	-	-	-	-	-	1	-
C424.2	3	2	3	1	-	-	-	-	-	-	-	-	1	-

Expt. No.	Name of Experiment	Type	Hours

1	Reverse Osmosis	O	2
2	Ultra filtration of Sugar Solution	O	2
3	Ultra filtration of Milk Solution	O	2
4	Water Flux	O	2
5	Hollow fibres Membrane	O	2
6	Electrostatic Precipitator	S	2
7	Ion Exchange	O	2

❖ S-STUDY, O-OPERATIONAL

Text Books:

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

Web Links/Video Lecturesare to be provided for Theory and Practical/Experiments Lectures by NPTEL

Course Plan

Course Title: **Project Work (Phase -II)**	
Course Code**: PR-201CHP-425**	**Semester : VIII**
Teaching Scheme : L-T-P : 0-0-2	Credits : 2
Evaluation Scheme: ISE + ESE Marks= 50 + 50	Total Marks: 100

The main objective of the Final Year Project work is to learn and experience the process of conducting a good research project. The course titled "**Project Work**" is designed combined for VIIth and VIIIth semester B. Tech. in Chemical Engineering. The detail of the course objective and its outcome on students is described below.

Course Objective:

The aim of this course is to apply an individual's ability in solving advanced Chemical Engineering problems. This course will provide a platform to independently think, identify, formulate and design the problem. The following objective should be considered to progress in project work.

1. To apply technical knowledge of mathematics, science, and engineering, studied in class to solve an actual problem.

2. To design and conduct experiments, as well as to analyze, interpret data and fundamentals of chemical engineering. How to implement the core courses like heat transfer, mass transfer, chemical reaction engineering, and transport phenomena for bringing the new scientific insights.

3. An ability to design a system, component, or process to meet the needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

4. To understand the function on multidisciplinary teams.

5. To identify, formulate and solve engineering problems.

6. To understand of professional and ethical responsibilities.

7. How to communicate and transform scientific information effectively?

8. To understand the impact of engineering solutions in a global, economic, environmental and societal context.

9. To understand the recognition of the need for, and an ability to engage in, life-long learning.

10. To understand the knowledge of contemporary issues.

11. To implement the techniques, skills and modern engineering tools those are necessary for engineering practice.

In the end, the students should provide a feasible solution, and how the projects will be beneficial for the development of common people and society.

Course Outcomes (COs):

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

C425.1	Opportunity to apply the fundamentals of Chemical Engineering.
C425.2	Self-assessment by critical thinking and applying technical knowledge in problem solving.
C425.3	Self-assessment for improving the writing report and abstracts, demonstrating the work, public presentation and speaking skills.
C425.4	Personal competences of students are reinforced most during the FYP process, including the preparation, elaboration, presentation and defense stage.

Prerequisite	Core courses in second and third year of B Tech Chemical Engineering

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course CO	PO												PSO		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
C425.1	2	2	2	2	1	-	1	2	2		2	1	2	-	2, 3
C425.2	3	2	2	2	1	-	1	2	2	2	2	1	2	-	2,3,4,5
C425.3	2	2	2	2	1	-	1	2	2	2	2	1	2	-	2,3,4,5
C425.4	2	2	2	2	1	-	1	2	2	2	2	1	2	-	4,5

Course Contents:

Students should continue project work from where, it was finished in phase I. The assessment of individual groups should be conducted frequently through their independent thinking ability, report writing, presentation skill and oral viva during both semesters. The project work shall be assessed by an oral exam to be held by at least two examiners, one internal and one external preferably from Industry 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.

Project Phase II:

As per decided by Institute Committee and DRC that 70-80% of project work must be done in VIIth semester, therefore, only necessary experiments and analysis should be performed by respective project groups in VIIIth semester. Project report writing and finishing, synopsis report and paper publication must be done successfully.

Every student in groups showcases their project research work in national/international level conference/workshops. This will provide a platform to present and discuss your research work to scientific community.

Note: Individual roles, teamwork, technical knowledge, presentation and communication will be counted for evaluating purposes.

Head of Department **Dean - Academics** **Principal**