D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

Accredited by NAAC with 'A' Grade

Department of Chemical Engineering

Program Structure

Third Year Autonomous

To be implemented from A.Y. **2022-23**

Third Year B. Tech. Chemical Engineering

Semester V

Sr. No.	Course Code	Course Type	Name of the Course	Teaching Scheme per Week				Total Marks	Evaluation Scheme			
				Lecture Hours	Tutorial Hours	Practical Hours	Credits		Type	Max. Marks	Min. for Passing	
1	201CHL 301	PCC	Mass Transfer Operations-I	3	--	--	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
2	201CHL 302	PCC	Chemical Engineering Thermodynamics-II	3	1	--	4	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
3	201CHL 303	PCC	Chemical Equipment Design	3	--	--	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
4	201CHL 304	PCC	Chemical Process Instrumentation	3	--	--	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
5	201CHL 305	PEC-I	Environmental Engineering and Plant Utilities	3	--	--	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
6	201CHL306		Industrial Economics, Management & Entrepreneurship						ISE	20	20	40
									MSE	30		
									ESE	50	20	
7	201CHP 307	PCC-LC	Mass Transfer Operations-I Laboratory	-	--	2	1	50	ISE	25	10	20
									ESE(POE)	25	10	
8	201CHP 308	PCC-LC	Chemical Equipment Design Laboratory	--	--	2	1	50	ISE	25	10	20
									ESE(OE)	25	10	
9	201CHP 309	PCC-LC	Chemical Process Instrumentation Laboratory	--	--	2	1	50	ISE	25	10	20
									ESE(POE)	25	10	
10	201CHP 310	PROJ	Mini Project	--	--	2	1	50	ISE	50	20	20
11	201CHMC 311	MC	Applications of MATLAB in Chemical Engineering	2	--	--	-	50	ESE	50	20	20
			Total:	**17**	**1**	**8**	**20**	**750**		**750**		
				26								

Third Year B. Tech. Chemical Engineering **Semester VI**													
Sr. No.	**Course Code**	**Course Type**	**Name of the Course**	**Teaching Scheme per Week**				**Total Marks**	**Evaluation Scheme**				
				Lecture Hours	**Tutorial Hours**	**Practical Hours**	**Credits**		**Type**	**Max. Marks**	**Min. for Passing**		
12	201CHL 314	PCC	Mass Transfer Operations-II	3	1	--	4	100	ISE	20	20	40	
									MSE	30			
									ESE	50	20		
13	201CHL 315	PCC	Process Control	3	**--**	--	3	100	ISE	20	20	40	
									MSE	30			
									ESE	50	20		
14	201CHL 316	PCC	Chemical Reaction Engineering-I	3	--	--	3	100	ISE	20	20	40	
									MSE	30			
									ESE	50	20		
15	201CHL 317	PCC	Chemical Process Technology	3	--	--	3	100	ISE	20	20	40	
									MSE	30			
									ESE	50	20		
16	201CHL 318	OEC-I	Industrial Safety& Act	3	1	--	4	100	ISE	20	20	40	
									MSE	30			
									ESE	50	20		
17	201CHL 319		Energy Conservation & Audit						ISE	20	20	40	
									MSE	30			
									ESE	50	20		
18	201CHP 320	PCC-LC	Mass Transfer Operations- II Laboratory	--	--	2	1	50	ISE	25	10	20	
									ESE (POE)	25	10		
19	201CHP 321	PCC-LC	Process Control Laboratory	--	--	2	1	50	ISE	25	10	20	
									ESE (POE)	25	10		
20	201CHP 322	PCC-LC	Chemical Reaction Engineering-I Laboratory	--	--	2	1	50	ISE	25	10	20	
									ESE (POE)	25	10		
21	201CHMC 323	MC	Applications of MATLAB in Chemical Engineering Tutorial	--	1	--	--	50	ESE	50	20	20	
			Total:	**15**	**3**	**6**	**20**	**700**		**700**			
				24									

Open Elective:

Open elective courses are offered to gain the knowledge of multidisciplinary areas. Students must choose one open elective course from the list of courses offered by other departments (excluding open elective courses offered by their department).

Professional Elective I (Semester V)	**Open Elective-I (Semester VI)**
1. Environmental Engineering and Plant Utilities 2. Industrial Economics, Management & Entrepreneurship	1. Industrial Safety & Act 2. Energy Conservation & Audit

Following is the list of open elective courses. The detailed syllabus is available on to the college website under academic tab.

Sr. No.	**Department**	**Course Code**	**Open Elective-I Course**
1	Mechanical	201MEL313	Human Resource Management
		201MEL314	Electric Vehicle
2	Civil	201CEL330	Disaster Management
		201CEL331	Green Building
3	Architecture	201ARL318	Residential Gardening
		201ARL319	Role of Art & Technology in Interior Design
4	Electronics and Telecommunication	201ETL314	Sensor Technology
		201ETL315	Electronic Instrumentation
5	Computer Science & Engineering	201CSL319	E- Commerce & Digital Marketing
		201CSL320	Python Programming
6	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	201AIML320	Applications of AIML
		201AIML321	Augmented Reality and Virtual Reality
7	Computer Science & Engineering (Data Science)	201DSL319	Basics of Data Science
		201DSL320	Basics of Data base

Internship Guidelines

• The students are expected to undergo 4 to 6 week internship in the industry and work on the area as specified by the industry. The work should be assigned, monitored and evaluated by the concerned industry expert, based on their port by the students.

• The department has to assign one faculty mentor who has to communicate with industry and monitor the internship related work, periodically.

• The weightage of the evaluation will be a sunder.

Industry Expert \Supervisor:70%

Department and faculty:30%

The evaluation should include presentations and submission of reports to the department at the beginning of the subsequent semester.

• The internship can be availed by the students during the summer vacations after completion of Semester IV or Semester VI. The credits of internship will be considered in semester VII.

• The industry expert/supervisors expected to assign the work worth maximum 100 to 120 hrs. for 4 weeks duration and should monitor and evaluate periodically

• At the completion of the internship work the student is expected to prepare a report on the work done and get certified from the industry expert.

Theory course assessment:

The Theory course assessment is to be done on the basis of ISE (In Semester Evaluation), MSE and ESE. The weightage of components are as follows.

ISE	MSE	ESE
20%	30%	50%

In Semester Evaluation (ISE): Theory 20 marks

ISE–I and ISE–II can be conducted by using following parameters

1) Online test (on Moodle)
2) Surprise test
3) Open book exam
3) ICT based Active learning method
4) Self learning topic
5) Case study
6) Demonstrations
7) Seminars
8) Assignments

In Semester Evaluation (ISE): Lab Courses 25 marks:

Lab assessment is continuous assessment method in which faculty has to evaluate student's experiments based upon defined rubrics only and shown to the students.

ISE: In Semester Evaluation

MSE: Mid Semester Examination

ESE: End Semester Examination

End Semester Examinations (ESE) -50 marks

ESE will be conducted on entire syllabus for 100 marks 3 hours duration and converted to 50 marks.

Theory Examination will be conducted for 100 marks and then it will be converted into 50 marks for evaluation.

*** OE: Oral Examination** ***POE: Practical Oral Examination**

Course Plan

Course Title : Mass Transfer.-I (Lecture Work)	
Course Code :201CHL301	**Semester : V**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50

Course Description:

This course also explain concept of steady state & unsteady state diffusion operations studied for controlling parameters in actual industrial process. Mass transfer-I course provides knowledge to design equipment's form as transfer operations. After learning this course, student can able to implement the knowledge of various operations in the real plants and to understand the troubleshooting problems in actual operation.

Course Objectives:

1. To understand classification of industrial mass transfer operations, molecular diffusion in fluids and solids.

2. To understand fundamentals of mass transfer coefficient, theories of mass transfer, Inter-phase mass transfer concepts, designing of stages in it.

3. To study industrially important gas and liquid dispersed equipments for gas-liquid operations in industries.

4. To understand fundamentals of gas absorption with design of industrial tray and packed tower absorber.

5. To understand fundamentals of adsorption, ion exchange, material balance and break through curve, design of adsorption.

6. To study theory of simultaneous mass transfer and chemical reaction with its kinetic regimes

Course Outcomes (COs):

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

C301.1	**Explain** & **determine** diffusivity, flux in fluids and solids.
C301.2	**Understand, explain & apply** mass transfer coefficient, inter phase mass transfer concepts, designing of stages in it.
C301.3	**Understand, explain & select** gas and liquid dispersed equipments for gas-liquid operations,**understand** the trouble shooting problems in industries.
C301.4	**Understand &applies** fundamentals of gas absorption with **design** of tray and packed tower absorber.
C301.5	**Understand** fundamentals, material balance, **design** of adsorption, ion exchange to **apply** the knowledge gained in the real plants.
C301.6	**Explain & select** mass transfer with Chemical reaction & its kinetic Regimes.

Prerequisites	Chemistry, Applied mathematics, Physics, Process Calculations, ,Thermodynamics, Fluid mechanics

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			
C301.1	2	2	2	3	-	-	-	-	-	-	-	1	2	-	3
C301.2	2	2	2	3	-	-	-	-	-	-	-	1	3	-	3
C301.3	1	1	2	2	-	1	1	-	-	-	-	1	2	-	4
C301.4	2	2	3	2	-	1	1	-	-	-	-	1	3	-	4
C301.5	2	2	3	2	-	1	1	-	-	-	-	1	3	-	4
C301.6	2	1	1	-	-	1	1	-	-	-	-	1	1	-	2
C301	**1.83**	**1.67**	**2.167**	**2.4**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**2.33**	-	-

Contents	Hours
Unit 1: Introduction to Mass Transfer Operations, Diffusion of Fluids and Solids Classification & Applications, Molecular diffusion in fluids, Concept of diffusivity, Knudson diffusion ,Flux transfer equations for gas and liquid phase based on steady and unsteady state equation, empirical equations used to determine diffusivity through gas and liquid phase, equation of continuity and its application in the form of Navier -Stoke equation. Experimental diffusivity measurement equipments – Arnold cell, Stefan tube, Diaphragm cell, Industrial applications of diffusion & these equipments.	06
Unit 2: Mass Transfer Coefficients & Inter-phase Mass Transfer Relation between different mass transfer coefficients, its relation, Determination of mass transfer coefficient through contacting equipment. Eddy diffusion, film theory,penetration theory, surface renewal theory, New theories of Mass transfer, Viz Surface stretch theory, Dobbins theory, analogy of mass transfer, heat Transfer and its significance, mass transfer coefficient in laminar flow and turbulent flow, Simultaneous mass & heat transfer, industrial applications of mass transfer coefficient. **Inter-phase Mass Transfer** Equilibrium, Study of Rault's law, Dalton's law, Henrys law, Two Film Theory - Concept of individual and overall mass transfer coefficient, operating line, driving force line. Cascades, material balance – co-current, cross current, counter current stages. Operating &driving force line concept. Stage efficiency, solved examples on stages and driving force lines with interfacial composition Kremser-Brown equation, Industrial applications of liquid dispersed equipment's.	08
Unit 3: Industrial Equipment's for Gas–Liquid Operations a) Gas dispersed: Multistage absorption tray towers, mechanical difficulties in tray tower, Type oftrays, flow arrangements on tray, Tray efficiency, sparged vessels. Gas holdup– concept of sleep velocity, Mechanically agitated vessels, vortex formation & prevention, fluid mechanics of agitation, Industrial applications of gas dispersed equipments.	06
b)Liquid dispersed: Ventury Scrubber, Wetted wall tower, Spray tower, Spraychamber, Packedtower & its internals,MassTransfer coefficientsforpacked tower, Random &	

Stacked(Structured) packing, End effectsandaxial mixing,Traytower Versespackedtower.Liquidhold up – determination of interfacial area based on holdup and Mass Transfer Coefficients. Industrial applications of gas dispersed equipments.	
Unit 4: Gas Absorption (Scrubbing) Ideal & non ideal liquid solutions, Choice of solvent, Material balance on concurrent, crosscurrentandcountercurrentabsorptionorstripping,Absorptionfactor and stripping factor, Tray efficiency ,Design equationfor packed tower ,HETP,NTU,HTU calculation for packedtower, Industrial applications of absorption (Scrubber)	07
Unit 5: Adsorption & Ion Exchange Types of adsorption, Nature of adsorbents, adsorption isotherms, Types of adsorbents, Adsorption equipments, Adsorption hysteresis, Heat of adsorption, break through curves, design of packed bed absorber, Single and multistage adsorption operation material balance, calculations, Principle of Ion Exchange, Principles, structure, types & Techniques of Ion Exchange, regeneration of ion exchange, Industrial applications of adsorption & IE.	06
Unit 6: Mass Transfer with Chemical Reactions Industrial applications of mass transfer with reaction, theory of simultaneous mass transfer and chemical reaction, Mass transfer reaction operations considering heterogeneous and homogeneous slow reaction, fast reaction, and Enhancement factor.	03

Text Books

1. Robert E. Treybal, “Mass Transfer Operations”, Third Edition, McGraw Hill, 1980.
2. Richardson & Coulson, “Chemical Engineering”,Vol.2, Pergamon Press, 1970
3. Richardson & Coulson, “Chemical Engineering”,Vol.4, Pergamon Press, 1970

Reference Books:

1. Thomas-K-Sherwood, Robert L, Pigford, Chorles R. Wilke, “Mass transfer” International Student Edition, McGraw Hill, Kogakusha Ltd.,1975.
2. McCabe and Smith, “Operation of Chemical Engineering”, 5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3. C.J. Geankolis, Transport Processes and operations, 3rdEdition, prentice hall, India,

1993.B.KDatta, Principles of mass transfer & separation process.

4. B.K. Datta, Principles of mass transfer & separation process
5. K. D. Patil, Mass Transfer Operation Vol.I & II, Nirali Prakashan.

Links: https://nptel.ac.in/courses/103103035

https://www.classcentral.com/course/swayam-mass-transfer-i-23043

https://www.udemy.com/course/mass-transfer-diffusion-and-convection/

Course Plan

Course Title: Chemical Engineering Thermodynamics – II (Lecture Work)	
Course Code: 201CHL302	**Semester: V**
Teaching Scheme: L-T-P: 3-1-0	Credits: 4
Evaluation Scheme: ISE + MSE:20+30=50 Marks	ESE: 50 Marks

Course Description:

Thermodynamics sets hard limits on performance of processes and equipment. This course gives students the formalism and insights necessary to do a preliminary thermodynamic analysis of a chemical process.

Course Objectives (COs):

1. Describe the terminologies associated with engineering thermodynamics.
2. Calculate properties of ideal & real mixtures based on thermodynamics principles.
3. Explain underlying principles of phase equilibrium in bi component & multi component systems.
4. Communicate effectively, both orally & in writing, regarding scientific & engineering principles and thermodynamics aspects of engineering design.
5. Apply knowledge of problem solving to thermodynamics.
6. Recognize the need for life-long learning in order to remain effective as scientist or an engineer.

Course Outcomes (COs):

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

C302.1	**Estimates** and **analyze** vapor liquid equilibrium data
C302.2	**Understand** various derived thermodynamic properties
C302.3	**Relate** different thermodynamic properties of gases and liquid
C302.4	**Apply** the knowledge of properties and principles in Chemical Process calculations.

C302.5	**Calculate** analyze phase equilibrium and reaction equilibrium data
C302.6	**Communicate** about thermodynamic principles and properties.

Prerequisite:	Chemical Engineering Thermodynamics – 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			
C302.1	2	3	1	1	-	-	-	-	-	-	-	-	1	-	3
C302.2	1	1	1	2	-	-	-	-	-	-	-	-	1	-	2
C302.3	2	1	1	1	-	-	-	-	-	-	-	-	1	-	3
C302.4	1	2	1	1	-	-	-	-	-	-	-	-	1	-	3
C302.5	2	1	1	1	-	-	-	-	-	-	-	-	1	-	3
C302.6	1	1	1	1	-	-	-	-	-	-	-	-	1	-	2
C302	**1.5**	**1.5**	**1**	**1.67**	-	-	-	-	-	-	-	-	**1**	-	-

Contents	Hours
Unit 1:Vapor-Liquid Equilibrium The nature of equilibrium, The phase rule & Duhem's Therom, VLE: Qualitative Behavior, Azeotropes, Simple models for Vapor / Liquid Equilibrium, Raoults law, Dew point and Bubble point calculations with Raoults law, Henry's law, VLE by modified Raoults law, Problems.	06
Unit 2:Basics of Solution Thermodynamics Fundamental Property Relation, Chemical Potential & Phase Equilibria, Partial Properties, Equations relating molar & partial molar Properties, Partial Properties in Binary Solutions, Relations among partial Properties, Ideal Gas Mixtures model, Problems.	06

Unit 3: Solution Thermodynamics Fugacity & Fugacity Coefficient, pure Species & species in Solution, Fundamental Residual Property relation, The ideal Solution, The Lewis Randall Rule, Excess properties, The excess Gibbs Energy and Activity Coefficient.	06
Unit 4: Applications of Solution Thermodynamics Liquid Phase Properties from VLE Data, fugacity, Activity & Activity Coefficient, Excess Gibbs Energy, Data Reduction, Thermodynamic consistency, Models for Excess Gibbs Energy, Property Changes of Mixing, Heat effects of mixing process.	06
Unit 5: Chemical Reaction Equilibrium The Reaction Coordinate, Application of Equilibrium Criteria to Chemical reactions, The Standard Gibbs Energy change & Equilibrium Constant, Effect of Temperature on the equilibrium Constant, Evaluation of Equilibrium Constants. Relation of Equilibrium Constants to Compositions, Equilibrium Conversions For Single Reactions, Phase Rule & Duhem's Therom For Reacting Systems, Case studies.	06
Unit 6: The Phase Equilibria & Thermodynamic Analysis Criteria of Phase equilibrium, Criterion of Stability .Phase Equilibrium in Single component system, Non ideal Solutions. Liquid - Liquid Equilibrium (LLE), Solid - Liquid Equilibrium (SLE), Solid - Vapor Equilibrium (SVE).	06

Text Books:

1. J.M.Smith, H.C.Vanness," Introduction to Chemical Engineering Thermodynamics" 8 th Edition, Tata McGraw Hill Publishing Co.
2. Thomas E Daubert, "Chemical Engineering Thermodynamics "McGraw Hill International Edition.

References Books:

1. K.V. Narayanan "Chemical Engineering Thermodynamics", Prentice Hall, India
2. B.F.Dodge "Chemical Engineering Thermodynamics, International Student Edition, McGraw Hill Publication.

3. O.A.Hougen, K.M.Watson& R.A. Rogatz "Chemical Process Principles", Vol – II, Asia Publishing House.
4. Kenneth Denbigh, the Principles of Chemical Equilibrium", Cambridge University Press.
5. S. I. Sandler "Chemical Engineering Thermodynamics" Wiley 2nd Edition.

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Numerical of Vapour Liquid Equilibrium (Unit 1)	1
2	Numerical of Phase rule (Unit 1)	1
3	Numerical of Basics of solution Thermodynamics (Unit 2)	1
4	Numerical of partial properties (Unit 2)	1
5	Numerical of fugacity and fugacity coefficients (Unit 3)	1
6	Numerical of Excess Gibbs energy and activity coefficient (Unit 3)	1
7	Numerical of Property change of mixing (Unit 4)	1
8	Numerical of Reaction coordinate (Unit 5)	1
9	Numerical of Equilibrium constant (Unit 5)	1
10	Numerical of The phase equilibrium & thermodynamic analysis (Unit 6)	1

Minimum 10 tutorials should be conducted.

Links: Chemical Engineering Thermodynamics II

https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch13

https://archive.nptel.ac.in/courses/103/103/103103144/

Course Plan

Course Title : **Chemical Equipment design(Lecture work)**	
Course Code : 201CHL303	**Semester : V**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE : 50 Marks

Course Description:

The present course enables one to learn about the complete process design of pressure vessel, storage vessel, reactor Heat Exchanger, Evaporator, Packed column and Distillation column.

Course Objectives (COs):

1. To acquire basic understanding of design parameter commonly used in design of process equipment's and their attachments
2. To design pressure vessels subjected to internal and external pressures
3. To design special vessels (e.g. tall vessels) and various parts of vessels (e.g. supports)
4. To acquire knowledge of shell & tube heat exchanger Design.
5. To demonstrate design of reactor and agitator system
6. Understand equipment testing methods related to process hazard & its safety

Course Outcomes (COs):

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

C303.1	**Identify** various design preliminaries.
C303.2	**Evaluate** and **design** various parts of Pressure Vessel.
C303.3	**Design** storage vessel and Tall Vessel.
C303.4	**Calculate** mechanical design formulae for Heat Exchanger and Evaporator.
C303.5	**Formulate** reactor systems and agitator system.
C303.6	**Express** different safety majors.

Prerequisite	Fluid Flow Operations, Mass transfer, Heat Transfer Operations and Chemical

	Reaction Engineering.

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			
C303.1	2	2	-	2	-	2	-	-	-	-	-	-	2	-	2
C303.2	2	2	2	2	-	2	-	-	-	-	-	2	2	2	3
C303.3	2	2	2	2	-	2	-	-	-	-	-	2	2	2	3
C303.4	2	2	2	2	-	2	-	-	-	-	-	2	2	2	3
C303.5	2	2	2	2	-	2	-	-	-	-	-	2	2	2	3
C303.6	2	2	2	-	-	2	-	-	-	-	-	2	2	-	2
C303	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	-

Contents	Hours
Unit 1: Design Preliminaries Design codes, Maximum working pressure, Design pressure, Design temperature, Various mechanical properties of material, Different methods of fabrication, Different types of welding joints, Joint efficiency, Weld joint efficiency factor ,Radiography,Design stress, & factor of safety, Corrosion allowance & their types, Design wall thickness	04
Unit 2: Design of Pressure Vessel Classification of pressure vessels, Codes and Standards for pressure vessels, Design of pressure vessels under internal and external pressures, Design of thick walled high pressure vessels, Design of Gasket, Flanges, Nozzle, Design of spherical vessels, Numerical ,Storage of fluids, Different types of storage vessels, Design of cylindrical storage vessels with roof, Numerical, (IS-2825 design of pressure vessel)	08

Unit 3:Tall Vessels & Support for Process Vessels Define tall vessel & their types, Stress distribution in design of tall vessel, Support & their classifications, Design of Bracket Support, Lug Support, Skirt Support & Saddle support	06
Unit 4:Mechanical Design of Heat Exchanger and Evaporator Types of heat exchangers, Special type of heat exchangers, Design of Shell & Tube Heat Exchanger, Types of evaporators, Entrainment Separators, Design of Standard Short Tube, Vertical Evaporator, Numerical, (IS-4503-1967 design code)	06
Unit 5:Design of Reaction Vessel and Agitator Classification of reaction vessel, Heating systems, Design consideration, Types of agitators, Baffling, Power requirements for agitation, Design of agitation system components, Numerical	06
Unit 6:Equipment testing methods, Process Hazards & Safety Hydrostatic Pressure test, Pneumatic pressure test, Dye penetrant test, Magnetic test, Ultrasonic test, Freon test, Radiography test, Hazards in Process Industry, Analysis of Hazards, Safety Measures, Safety measures in Equipment Design, Pressure Relief Devices	06

Text Books:

1. B. C. Bhattacharya, "Introduction to chemical equipment design" (Mechanical accepts)1985.
2. M. V. Joshi, "Process equipment design" McMillan India Ltd. 1981.Coulson J. M. and Richardson J. F.,"Chemical Engg." Vol. 2 & 6, Pergamum Press,1970.
3. Dr. S.D. Dawande, "Process Design of Equipment", Central Techno Publication, 1st Edition 1999.

References Books:

1. L. E. Brownel and E. H. Young "Process equipment design", Wiley Eastern Ltd.1977.

Course Plan

Course Title : **Chemical Process Instrumentation(Lecture Work)**	
Course Code : 201CHL304	**Semester : V**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20 + 30=50 Marks	ESE: 50 Marks

Course Description:

This course is divided into two sections. Section-I contains Process Instrumentation & Section-II contains Instrumental Analysis. Section-I focuses on basic characteristics of instruments and their applicability in chemical processes whereas the section II describes different instrumental analysis and modern analytical techniques like gas chromatography, HPLC,FTIR, Mass spectroscopy, XRD,SEM,TEM,FESEM and its applications.

Course Objectives:

1. To understand classification, parts and characteristics of instruments.
2. To understand basic principle behind measurements and their applicability in chemical processes.
3. To understand differences between various analytical methods.
4. To understand correct analytical method for sample analysis.
5. To understand modern analytical technique like chromatography, its types like gas chromatography, HPLC and its applications.

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

C304.1	**Classify and identify** parts of instruments with its characteristics. Also impart ability to measure pressure by using various instruments.
C304.2	**Select** appropriate instruments for a given chemical parameter. Also impart ability to calibrate instruments.
C304.3	**Measure** Temperature, Flow, Pressure & level by using various instruments and realize importance of data analysis.
C304.4	**Describe** various analytical methods for analysis of various industrial samples.

C304.5	**Analyze** the chemical industrial samples by using modern techniques like flame photometry, chromatography, gas chromatography, HPLC, FTIR, Mass spectroscopy.

Prerequisite:	Chemical Process Calculations, Industrial Engineering Chemistry

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			
C304.1	1	1	1	-	-	-	1	-	-	-	-	-	1	-	1
C304.2	1	1	1	-	-	-	1	-	-	-	-	-	2	-	1
C304.3	1	1	1	-	-	-	1	-	-	-	-	-	1	-	1
C304.4	1	1	1	-	-	-	1	-	-	-	-	-	2	-	2
C304.5	1	1	1	-	-	-	1	-	-	-	-	-	2	-	3
C304	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1.33**	**-**	**-**

Contents	Hours
Unit 1:Characteristics of Measurement System Basic Concepts and characteristics of measurement system, various elements of instrument, performance characteristics. Pressure Measurement: Introduction, methods of pressure measurement by manometers, elastic pressure transducer, force balance pressure gauges, electrical pressure transducers and vacuum measurement. Pressure switches. Recent advances in pressure measurement systems used in Chemical Industry.	06
Unit 2:Temperature Measurement, Flow Measurements	06

Introduction, methods of temperature measurement by expansion thermometers, filled system thermometers, electrical temperature instruments, pyrometers. Calibration of Thermometers, Introduction, methods of flow measurements by inertial flow meters, quantity flow meters, and mass flow meters. Recent Temperature & flow measurement systems used in Chemical Industry.	
Unit 3:Liquid Level Measurement, P & I Diagram Introduction, Methods of liquid level measurements by direct methods, indirect methods, electrical methods. Servicing of liquid level measuring instruments, Introduction to P & I Diagram. Recent liquid measurement systems used in Chemical Industry.	06
Unit 4:Introduction to Instrumental Methods of Analysis General Introduction, classification of instrumental methods, spectroscopy, properties of electromagnetic radiation, electromagnetic spectrum, Deviation from Beer's law, instrumentation applications. Molar compositions of complexes, examples, Introduction, principles of flame photometry, instrumentation, interferences in flame photometry, limitations, and industrial applications.	06
Unit 5:Application of Conductometry, Turbidity meter, Refractometry Introduction, laws, conductance, measurements, types of conductometric titrations, applications-Karl Fisher Titration Equipment, advantages and disadvantage, Introduction &application of nephhelometry & turbidity ,Introduction, Abbe refractometer, instrumentation, , optical exaltation, numerical, industrial applications	06
Unit 6:Advanced Analytical Methods Chromatographic and other separation methods – GC &HPLC-Introduction, principles, instrumentation, apparatus & materials, industrial applications. Introduction to Mass Spectrometry, Nuclear Magnetic Resonance, FTIR,XRD,SEM,TEM,FESEM & their industrial application.	06

Text Books:

1. S.K.Singh, "Industrial Instrumentation & Control", Tata McGraw Hill publishing company ltd, New Delhi, 2000
2. D. Pastranabis, "Principals of industrial instrumentation", 2nd edition, Tata McGraw Hill publishing company ltd, New Delhi, 2003

Reference Books:

1. Eckman D.P. "Industrial Instrumentation", Willey Eastern Ltd, New Delhi, 1984.
2. A.C. Shrivastav "Techniques in Instrumentation", New Delhi, 1984.
3. W.Boltan, "Instrumentation and Process Measurement", Orient Longman Ltd, Hyderabad, 1st Edition, 1993.
4. Ray Choudhuri and Ray Choudhuri "Process Instrumentation, Dynamics and control for Engineers", 1st Edition, Asian Books Pvt Ltd, New Delhi, 2003.

Course Plan

Course Title : **Environmental Engineering and Plant Utilities(Lecture Work)**	
Course Code : 201CHL305	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE: 20+30=50 Marks	ESE : 50 Marks

Course Description:

This subject deals with understanding of various aspects of pollution control, prevention methods, solid waste disposal, steam generators, and its various mountings and accessories.

Course Objective:

1. Write a rate law; define reaction order and activation energy.
2. Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models.
3. Demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system.
4. Design a commercial reactor using the knowledge of Chemical Reaction Engineering.

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

C305.1	**Apply** air pollution control technologies in chemical industry.
C305.2	**Describe** waste water treatment technologies effectively to reduce the water pollution in the industry.
C305.3	**Develop** better product and process to mitigate the problem of pollution in chemical industry.
C305.4	**Understand** impurities in water, treatment of boiler feed water and water softening methods.
C305.5	**Understand** types of steam generators, boiler mountings and accessories, boiler act and boiler calculations.
C305.6	**Understand** insulations, compressor air and refrigeration system as utility.

Prerequisite:	Thermodynamics and 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	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C305.1	2	2	2	-	-	-	3	-	-	-	-	-	3	-	2
C305.2	3	3	3	3	-	-	3	-	-	-	-	-	3	-	3
C305.3	2	2	-	3	-	-	-	-	-	-	-	-	-	3	2
C305.4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	1
C305.5	2	2	2	-	-	-	-	-	-	-	-	-	2	-	2
C305.6	2	2	2	-	-	-	-	-	-	-	-	-	2	-	2
C305	**2.33**	**2.33**	**2.4**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Contents	Hours
Unit 1:Air Pollution Control Sources and effect of air pollution, air pollution monitoring system, theory, design and operating principles of the air pollution control equipments, dry collectors, wet collectors, electrostatic precipitators, thermal combustion techniques, control of air pollution in industry viz. Iron and Steel industries, paper and pulp industries, cement industries. Thermal power plants. Analysis of NOx and Control Measures. Demonstration of air pollution control devices in chemical industry.	6
Unit 2:Primary and Secondary Waste Water Treatment Theories and practices of equalization, neutralization, screens, grit removal, floatation, settling & Coagulation. Trickling filters, activated sludge process and its modification and anaerobic sludge treatment, low cost waste treatment methods such as stabilization ponds, Oxidation & aerated lagoons, roots zone technologies etc. Application of waste water treatment technologies in chemical industry.	6
Unit 3:Solid Waste Disposal and Advance Oxidation Process Sources and effects of solid waste, Characterization, resources consumption and	6

recovery, treatment and disposal method, Sludge handling and disposal.Photo catalytic treatment. Treatment with H_2O_2 and ozone. Wet Oxidation Process. Supercritical Oxidation. Application of advance oxidation process in chemical industry.	
Unit 4:Water as Utility Sources of water, impurities in water, hardness and its types, pretreatment of boiler feed water, methods of purification of water, colour codes of water, air and process streams. Demonstration (with example) of pretreatment of boiler feed water in chemical industry.	5
Unit 5:Steam Generators Properties of steam, Use of steam tables, Steam generators, Classification, Indian act of Boiler, Mountings and accessories, Types of Steam, Super heaters, Injectors, Condensers, Performance of Boilers & Boiler Calculations with energy balance.Distribution of steam in plant, Efficient use of steam, application of steam traps and steam recovery in chemical industry.	7
Unit 6:Air as a Utility and Refrigeration System Introduction, Compressed Air, Blower Air, fan air, types of Compressor, industrial applications of air, Instrument Air System, Process Air System, Vacuum producing devices. Refrigeration system, various refrigerants and its applications. Cooling tower and its types. Application of air for control pneumatic control in chemical industry.	6

Text Book:

1. Ashutosh Pande, Plant Utilities, Vipul Prakashan, Mumbai, D.B. Dhone , " Plant Utilities "Nirali Prakashan ,Pune.
2. B.I.Bhatt ,S.M. Vora, "Stoichiometry",Tata McGraw Hill Publishing Company Ltd.
3. S. P. Mahajan, "Pollution Control in Process Industries", Tata McGraw hill, 1985. Matcalf and Eddy,"Waste Water Engineering Treatment", Tata.

References Book:

1. Waren Viessman and Mark J. Hammer, "Water supply and pollution control", Harper & Row,New York, 1985.
2. M.V. Rao and A. K. Datta : "Waste Water Treatment"

3. D. J. Hagertyet. al. “Solid Waste Management”, Van Nostrand Reinhold 1973.
4. C. S. Rao “Environmental pollution control engineering” Wiley Eastern, Ltd 1994.

Course Plan

Course Title : **Industrial Economics, Management & Entrepreneurship(Lecture work)**	
Course Code : 201CHL306	**Semester : V**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE : 50 Marks

Course Description:

This course provides an introduction to current theory and empirical work in Industrial economics. It starts by examining the internal structure of firms. It then moves on to the analysis of various aspects of strategic interaction between firms and the determinants of industrial structure.

Course Objective (COs):

1. To understand economic aspects in chemical industry.
2. To understand and introduce general common terms related to economics, management and entrepreneurship.
3. To make students to develop skills required for entrepreneurship development and leadership.
4. To make students aware of different managerial techniques in the area of marketing, finance, production and material management
5. To develop different managerial skills in areas of production, finance and material management
6. To ensure principles of management like planning, organizing, directing controlling etc.

Course Outcomes (COs):

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

C306.1	**Identify** different aspects of economics like demand, supply, cost curves and national income
C306.2	**Discuss** importance of nature and characteristics of Indian economy also their market research

C306.3	**Express** required qualities, importance and various incentives available to become entrepreneurs.
C306.4	**Predict** importance of principles of management like planning, organizing , directing controlling etc.
C306.5	**Describe** and apply different managerial skills in areas of production and finance management
C306.6	**Recognize and apply** different managerial skills in areas of marketing management

Prerequisite	The student should have basic understanding of economics and their basic laws and concepts

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			
C306.1	-	-	-	-	-	1	-	1	1	-	1	2	-	-	2
C306.2	-	-	-	-	-	1	-	1	1	1	1	2	-	-	1,2
C306.3	-	-	-	-	-	1	-	1	2	2	2	2	-	-	1
C306.4	-	-	-	-	-	1	-	1	2	2	2	2	-	-	2
C306.5	-	-	-	-	-	1	-	1	2	1	2	2	-	-	2,3
C306.6	-	-	-	-	-	1	-	1	2	1	2	2	-	-	2,3
C306	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**1.67**	**1.4**	**2.167**	**2**	**-**	**-**	-

Contents	Hours
Unit 1:Micro & Macro Economics Introduction of Macroeconomics, Law of Demand, Equilibrium between demand and supply,concepts of costs, cost curves and revenue curves of a firm, Size and structure of firms, the technological view of the firm; the transaction costs-property rights approach; equilibrium of a firm under perfectcompetition, break-even analysis and break-even point, Balance Sheet. National income: Concept of national income, estimation of national income, difficulties in measurement of national income, Current year Indian Budget	07
Unit 2:Market & Inflation Market and Inflation Market: Meaning, types of market –Monopoly, Oligopoly, Monopolistic Competition. Inflation: Causes, measurement, effects, controlling of inflationNature and characteristics of Indian economy: Nature and characteristics of Indian economy, Privatization –meaning, merits and demerits. Globalization of Indian economy – merits and demerits. Concepts of VAT, WTO, GATT & TRIPS agreement, Banking, Foreign exchange.	07
Unit 3:Entrepreneurship Need of entrepreneurship, Various Assistance Programmer for Small Scale and large Scale, Industries through agencies, like IDBI, IFC, NSIC SFC, SIDCO and DIC.	04
Unit 4:Concept and Functions of Management Basic concepts and functions of Management, Personal Management. Production Management: Definition, Objectives, Functions and Scope, Production Planning and Control; its significance, stages in production planning and control. Concepts of material management, inventory control; its importance and various methods.	06

Unit 5:Production & Financial Management Production management: Election of site, plant layout, its type, functions of P.P.C. Materials management: purchase,inventory control, production and quality control Financial Management: Introduction, Objectives of Financial Management, Functions and Importance of Financial Management. Concept of capital structure and various sources of finance, circular economy.	06
Unit 6:Marketing Management Definition of marketing, marketing concept, objectives and functions of marketing. Marketing Research – Meaning; Definition; objectives; Importance; Limitations; Process. Advertising – meaning of advertising, objectives, functions, criticism.	06

Text Book:

1. Modern Economic Theory – K.K. Dewett, S.Chand
2. Principles and Practice of Management: R.S. Gupta, B.D.Sharma,N.S. BhallaKalyani Publishers

Reference Book:

1. Principles of Economics: P.N. Chopra (Kalyani Publishers).
2. Micro Economic Theory – H.L. Ahuja (S.Chand)
3. Indian Economy: RudarDutt& K.P.M. SundhramPrinciples & Practices of Management – L.M. Prasad (Sultan Chand & Sons)

Course Plan

Course Title : **Mass Transfer-I (Laboratory work)**	
Course Code : 201CHP307	**Semester : V**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE: 25 Marks	ESE (POE) : 25 Marks

Course Description:

The course includes experiments based on industrial mass transfer operations including separation of gas- liquid, gas-solid, liquid-liquid and solid-liquid phases.

Course Objectives:

The purpose of this course is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of mass transfer operations.

1. To study the fundamental/basics of diffusion operation.
2. To introduce the undergraduate students with the most important separation equipments in the process industry.
3. To provide proper understanding of mass transfer operations.
4. To study the equipments used for separation and purification in chemical industries.

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

C307.1	**Understand**the concept of diffusion mass transfer.
C307.2	**Describe**most important separation equipments in the process industry.
C307.3	**Understand and describe**industrial mass transfer operations.
C307.4	**Demonstrate**& study working of equipments used for separation and purification in chemical industries by absorption, adsorption & ion exchange.

Prerequisites	Chemistry, Applied mathematics, Physics, Process Calculations, Thermodynamics, Fluid mechanics

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			
C307.1	2	2	1	2	-	-	-	-	-	-	-	-	2	-	3
C307.2	2	2	1	2	-	1	-	-	-	-	-	-	2	-	3
C307.3	2	2	-	2	-	1	1	-	-	-	-	-	2	-	3
C307.4	2	1	1	1	-	1	1	-	-	-	-	-	2	-	2
C307	**2**	**1.75**	**1**	**1.75**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Expt. No.	Name of Experiment	Type	Hours
1	Diffusivity of acetone: To determine diffusivity of acetone in air at various temperatures.	O	2
2	Surface Evaporation: To determine the constant characteristic equation for surface evaporation.	O	2
3	Batch adsorption: To study the adsorption of acetic acid on activated charcoal.	O	2
4	Ion Exchange: To find degree of saturation and capacity of ion exchange bed.	O	2
5	Wetted wall tower: To determine mass transfer coefficient for the diffusion of vapour into the gas stream with the help of wetted wall column.	O	2
6	Humidification: To determine volumetric mass transfer coefficient for air -water system in cooling tower	O	2
7	Gas absorption: To determine values of gas side or liquid side mass transfer coefficient for CO2 absorbed into NaOH System in packed column.	O	2
8	Vapour- Liquid Equilibrium: To determine vapour liquid equilibrium data for given system.	O	2
9	Liquid hold up in packed Column: To determine liquid hold up in packed Column.	O	2
10	Liquid-Liquid Diffusion: To study liquid- liquid diffusion.	S	2
11	Membrane Separation: To study diffusion by using membrane.	O	2

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

Text books:

1. Robert E. Treybal, “Mass Transfer Operations”, Third Edition, McGraw Hill, 1980.
2. Richardson & Coulson, “Chemical Engineering”,Vol.2, Pergamon Press,1970

3. Richardson & Coulson, "Chemical Engineering",Vol.4, PergamonPress,1970

Reference Books:

1. Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke,"Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd.,1975.
2. McCabe and Smith,"Operation of Chemical Engineering",5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3. C.J Geankolis, Transport Processes and operations, 3rd Edition, Prentice hall, India, 1993.B.K. Datta, Principles of mass transfer & separation process.
4. B.K Datta, Principles of mass transfer & separation process
5. K. D. Patil, Mass Transfer Operation Vol.I & II.

Course Plan

Course Title : **Chemical Equipment design (Laboratory Work)**	
Course Code : 201CHP308	**Semester : V**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE: 25 Marks	ESE (OE) : 25 Marks

Course Description:

The present course enables one to learn about the complete process design of pressure vessel, storage vessel, reactor Heat Exchanger, Evaporator, Packed column and Distillation column.

Course Objectives (COs):

1. To learn basic Standard equipment symbols and instrumentation symbols used in the chemical process industry
2. To study how to design and draw Heads and closures, Keys and couplings, supports forvessels
3. To understand the design details of operations for systematic drawing

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

C308.1	**Identify** equipment and process involved in process flow diagrams
C308.2	**Design and draw** Heads and closures, Keys and couplings, Supports for vessels
C308.3	**Understand** the basic concepts and operations of various chemical equipment's and flow sheets related to chemical engineering design and drawing

Prerequisite	Materials of construction, Mass Transfer, Heat transfer

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			
C308.1	2	2	3	1	2	2	-	-	-	-	-	1	2	1	2
C308.2	2	2	3	1	2	2	-	-	-	-	-	1	2	2	3
C308.3	2	2	3	1	2	2	-	-	-	-	-	1	2	2	2
C308	**2**	**2**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1.67**	-

Expt. No.	Name of Experiment	Type	Hours
1	Standard equipment symbols , Standard instrumentation symbols	O	2
2	Heads or closures and Flanges	O	2
3	Design of Pressure Vessel	O	2
4	Design of Storage Vessel	O	2
5	Design of Supports-Bracket, Lug, skirt and Saddle support	O	2
6	Design of Fractional distillation column	O	2
7	Design of heat exchangers- Shell and tube heat exchanger	O	2
8	Design of reaction vessel	O	2
9	Design of evaporator	O	2
10	Design of agitation system	O	2
11	Design of Absorption tower	O	2

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

Text Books:

1. B. C. Bhattacharya, “Introduction to chemical equipment design” (Mechanical accepts)1985.
2. M. V. Joshi, “Process equipment design” McMillan India Ltd. 1981.Coulson J. M. and Richardson J. F.,“Chemical Engg.” Vol. 2 & 6, Pergamum Press, 1970.
3. Dr. S.D. Dawande, “Process Design of Equipment”, Central Techno Publication, 1st Edition 1999.

Reference Books:

1. L. E. Brownel and E. H. Young “Process equipment design”, Wiley Eastern Ltd.1977.

Course Plan

Course Title : **Chemical Process Instrumentation (Laboratory Work)**	
Course Code : 201CHP309	**Semester : V**
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 instruments used for measurement of Pressure, Temperature, and Flow& Level in chemical processes. Analyze repeatability, precision and accuracy of instruments.

Course Objectives:

1. To understand the principles of different instrumental techniques.
2. To understand the method how to experimentally find normality by using conductometric titration
3. To understand how to estimate the RI of sample using Abbe Refractometer & coefficient of discharge of rota meter
4. To understand the calibration of thermocouple, RTD, pressure gauge

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

C309.1	**Determine** the normality of given acid by Conductometry titration.
C309.2	**Understanding** calibration of thermocouple, RTD, pressure gauge.
C309.3	**Determine** the RI of sample using Abbe Refractometer& coefficient of discharge of rotameter.
C309.4	**Find** out the turbidity of a given sample.
Prerequisite	Chemical Process Calculations, Industrial Engineering Chemistry

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			
C309.1	2	2	-	2	-	-	-	-	-	-	-	-	2	-	3
C309.2	2	2	-	2	-	-	-	-	-	-	-	-	2	-	2
C309.3	2	2	-	2	-	-	-	-	-	-	-	-	2	-	3
C309.4	2	-	-	-	-	-	-	-	-	-	-	-	2	-	3
C309	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Expt. No.	Name of Experiment	Type	Hours
1	To determine the normality of given acid by titrating it conducts metrically against strong base.	O	2
2	To determine strength of KCL by titrating it against a standard solution of $AgNO_3$conductometrically.	O	2
3	To determine the Refractive Index of sample using Abbe Refractometer	O	2
4	To determine coefficient of discharge of rotameter.	O	2
5	To calibrate thermocouple.	O	2
6	To find out the turbidity of a given sample.	O	2
7	To determine or measure the intensity of light emitted by introducing a metal in to flame	O	2
8	To determine the amount of nickel in given unknown sample by spectrophotometer	S	2
9	To calibrate Resistance Temperature Detectors(RTD)	O	2
10	Calibration of Pressure gauge under test	O	2
11	To study the level sensors in level measurements	O	2

12	Determination of percentage composition with help of RI measurement	O	2
13	Estimation of total solids ,volatile solids , suspended solids and dissolved solids	O	2
14	Industrial waste water analysis.	O	2

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

Text Books:

1. S.K.Singh, "Industrial Instrumentation & Control", Tata McGraw Hill publishing company ltd, New Delhi, 2000
2. D. Pastranabis, "Principals of industrial instrumentation", 2nd edition, Tata McGraw Hill publishing company ltd, New Delhi, 2003

Reference Books:

1. Eckman D.P. "Industrial Instrumentation", Willey Eastern Ltd, New Delhi, 1984.
2. A.C. Shrivastav "Techniques in Instrumentation", New Delhi, 1984.
3. W.Boltan, "Instrumentation and Process Measurement", Orient Longman Ltd, Hyderabad, 1st Edition, 1993.
4. Ray Choudhuri and Ray Choudhuri "Process Instrumentation, Dynamics and control for Engineers", 1st Edition, Asian Books Pvt Ltd, New Delhi, 2003.
5. Willard H.H, "Instrumental methods of analysis", 6th Edition, CBS Publication New Delhi 1986

Course Plan

Course Title: **Mini Project**	
Course Code : 201CHP310	**Semester :V**
Teaching Scheme: L-T-P:0-0-2	Credits: 01
Evaluation Scheme: ISE =50 Marks	

Course description:

This course enables students to gather scientific information on a particular topic, analyze the information from scientific principles, and present a written and oral summary on that topic. This course enables the students to function in a professional environment later on in their career.

Course Objectives (COs):

1. Development of ability to define and design the problem and lead to its accomplishment withproper planning.
2. Learn the behavioral science by working in a group.
3. Develop student's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
4. Understand the importance of document design by compiling technical report on the mini project work carried out

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

C310.1	**Define and design** the problem and lead to its accomplishment with proper planning.
C310.2	**Learn** the behavioral science by working in a group.
C310.3	**Develop** student's abilities to transmit technical information clearly and test the same delivery of Seminar based on the Mini Project.
C310.4	**Understand** the importance of document design by compiling Technical report on the Mini Project work carried out

Prerequisite:	Design, Material & Energy balance, Heat Transfer, Mass Transfer.

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			
C310.1	-	-	-	2	-	-	-	-	-	-	1	-	1	-	3
C310.2	1	1	-	2	-	-	-	-	2	-	1	-	1	-	2
C310.3	-	-	-	-	-	-	-	-	-	1	-	-	1	-	3
C310.4	2	2	2	-	1	-	-	-	-	-	-	2	1	-	2
C310	**1.5**	**1.5**	**2**	**2**	**1**	**-**	**-**	**-**	**2**	**1**	**1**	**2**	**1**	**-**	

Contents	Hours
Various research topics can be taken by group of 4 students and detailed information along with literature review, research methodology and experimental set up as well experimental work done may be conducted through mini project. Group of students undergoing for Mini project have allotted a faculty as guide or they may opt Co-guide from outside the department/institute/ company. Example: You can select the topic for mini project as any chemical products like Phenol, Benzene, Toluene, Ethanol, Acetic Acid or any other chemical product. Then carry out.. Literature surveys, various processes, select best process, various properties, design the whole process, flow diagram, P&ID diagram, cost estimation, payback period. Evaluation procedure:Report Abstract, Introduction, Literature survey, design, experimental work, result & discussion, conclusion. 1. PPT Presentation Evaluation by the committee.	

Course Plan

Course Title : **Application of MATLAB In Chemical Engineering (Lecture work)**	
Course Code : 201CHMC311	**Semester : V**
Teaching Scheme : L-T-P : 2-0-0	Credits : 1
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE : 50 Marks

Course Description:

This course also explains basic of MATLAB and Its Application in Chemical Engineering. Also explain by using Advance software how we replace manual chemical Engineering calculations with high-tech technology. The data obtained are very reliable and effective.

Course Objective

1. To familiarize the student in introducing and exploring MATLAB software.
2. To enable the student on how to approach for solving Engineering problems using simulation tools.
3. To prepare the students to use MATLAB in their project works.
4. To provide a foundation in use of this software for real time applications.

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

C311.1	**Explain** programming & simulation for engineering problems
C311.2	**Find** importance of this software for Lab Experimentation.
C311.3	**Construct** basic Chemical Engineering problems in MATLAB & to use in research work
C311.4	**Show** how connect programming files Chemical engineering Application

Prerequisite:	Mathematics, Mass Transfer, Heat Transfer ,Chemical Reaction Engineering

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			
C311.1	-	2	2	2	2	-	-	-	-	-	2	-	-	2	2
C311.2	-	2	2	2	2	-	-	-	-	-	2	2	-	2	3
C311.3	2	2	3	2	3	-	-	-	-	-	2	2	3	2	3
C311.4	-	-	2	2	2	-	-	-	-	-	-	-	-	-	3
C311	**2**	**2**	**2.25**	**2**	**2.25**	-	-	-	-	-	**2**	**2**	**3**	**2**	**-**

Contents	Hours
Unit 1:Basic of MATLAB Introduction of MATLAB ,Basic Command Operation with Variable ,Characters and String Linear models, Graphing data in MATLAB , Loops & Function	3
Unit 2:Array and MATLAB Internet of Things Array definition, Types of Array, Matrix Arithmetic operations, Array Arithmetic operations, operators and special characters, mathematical and logical operators, matrix operations, Access and preprocess streaming and archived data, Design custom IoT analytics and algorithms, Develop data-driven and physics-based models	3
Unit 3:Programming with MATLAB by Using Numerical Method Solution of linear algebraic equations: Gauss elimination method, LU decomposition, Gauss-Jordan Solution of non-linear algebraic equations (single variable): Iterative methods - bisection, false position, Newton –Raphson, successive substitution methods, comparison of iterative methods	5
Unit 4:Application of MATLAB Heat Transfer Heat exchanger, co current heat exchange, Counter current heat exchanger, shell and tube Heat exchanger, program development and numerical solutions of above Process	4

Unit 5:Application of MATLAB in Mass Transfer Binary Batch distillation, Continuous Distillation steam distillation, liquid- liquid extraction, continuous extraction, Absorption.	4
Unit 6:Application of MATLAB in Chemical Reaction Engineering Batch reactor, semi batch reactor, PFR ,CSTR, Series of isothermal CSTR,	5

Text Book:

1. Amos Gilat MATLAB: "An Introduction With Application"Wiley
2. Dr. Rudra Pratap, Getting started with MATLAB", Oxford University Press.
3. David Houcqe, "Introduction to MATLAB for Engineering students", Northwestern University (version 1.2Aug 2005)
4. S. J. Chapman, "Essential of MATLAB programming".

References:

1. Process Optimization in Chemical Engineering by Edger Himmelblau
2. Applied Mathematics and Modeling for Chemical Engineers, R. G. Rice, D. D.Do, John Wiley & Sons, 1995.

Link: https://onlinecourses.nptel.ac.in/noc21-ge10/preview

Course Plan

Course Title : **Mass Transfer-II (Lecture Work)**	
Course Code : 201CHL314	**Semester : VI**
Teaching Scheme : L-T-P : 3-1-0	Credits : 3+1+0=4
Evaluation Scheme : ISE + MSE: 20+30=50 Marks	ESE : 50 Marks

Course Description:

This course also explain concept of steady state & unsteady state diffusion operations studied for controlling parameters in actual industrial process. Mass transfer-II course provides knowledge to design equipments for industrial mass transfer operations; after learning this course, student can able to implement the knowledge of various operations in the real plants and to understand the troubleshooting problem in plants.

Course Objectives:

1. To study & determine basic knowledge of binary distillation by understanding types, methods of design & applications of it in industries.
2. At the end of course student should understands calculation, types, material balance, coordinate systems and industrial equipments in extraction.
3. To study basic principle, calculation & methods, and equipments of leaching to apply in industries.
4. Students should be able to apply basic knowledge of humidification, cooling tower, humidification equipments in industries.
5. The students completing this course are expected to understand theory, calculation of industrial dryer & different industrial dryers.
6. At the end of course students should understand steps, concepts, types, equipment's, and calculation of crystallization.

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

C314.1	**Describe& apply** knowledge of binary distillation to able to design equipments in industries by different methods.
C314.2	**Understand& explain** concepts, triangular coordinate system, material balance, calculation, equipments in extraction.
C314.3	**Describe& apply** knowledge & calculation of leaching in industries for controlling parameters in industrial process.
C314.4	**Discuss** the knowledge of humidification, i cooling tower with its calculation, trouble shooting with other industrial equipments.
C314.5	**Apply**knowledge of drying and dryer, its calculation in industries.
C314.6	**Apply& describe** knowledge of concepts, steps, types, calculation of crystallization in industries.

Prerequisites:	Mass transfer-I, Chemistry,Applied mathematics, Physics, Processcalculations, Thermodynamics, Fluid mechanics

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			
C314.1	2	2	3	2	-	1	1	-	-	-	-	1	3	-	3
C314.2	2	3	2	3	-	-	-	-	-	-	-	1	3	-	2
C314.3	1	3	2	2	-	1	-	-	-	-	-	1	2	-	1
C314.4	2	2	2	2	-	1	1	-	-	-	-	1	2	-	4
C314.5	2	2	3	3	-	1	-	-	-	-	-	1	3	-	2
C314.6	2	2	2	2	-	-	-	-	-	-	-	1	2	-	2,3
C314	**1.83**	**2.16**	**3**	**2.67**	**-**	**1**	**1**				**-**	**1**	**2.83**	**-**	**-**

Contents	Hours
Unit 1: Distillation: Vapour Liquid Equilibrium, Ideal Solutions, Relative volatility, Azeotropic mixtures, Methods of distillation: Flash, Differential, Steam, Vacuum, molecular, continuous, Multi-component system, Heavy & Light key component, Batch rectification, Introduction to reactive distillation. Analysis and determination of stages: Material balance, Analysis of Fractionating column by McCabe Thiele method, Lewis–Sorrel method, Ponchon- Savrit method, Lewis Matheson (Only theory), Transfer Concept in Packed Column Design, Industrial applications of Distillation	11
Unit 2:Liquid–Liquid Extraction: Liquid Equilibrium, Different coordinate systems, Single stage, cross and counter current operation and its calculation, Counter current extraction with reflux, selection of extractors, Industrial Extraction Equipments, Industrial applications of Extraction	06
Unit 3: Leaching Leaching Principles, Various Types of Leaching Operations with application, Method of Calculations, Leaching equipments, Industrial applications of Leaching	06
Unit 4: Humidification Industrial applications of Humidification, Study of Adiabatic Saturation Curve,Humidifier height calculations, definition of wet bulb ,dry bulb andequation for wet bulb depression, Percentage saturation , Percentage Humidity, Important industrial terms in humidification, Water cooling towers in detail & its design, Spray chamber, Evaporative Cooler, Industrial applications of Humidification.	05
Unit 5: Drying Theory and Mechanism of Drying, Steady and Unsteady Drying, Definition of moisture content, total time of drying, length of continuous dryer, Material and Enthalpy balance in dryer, Classification and selection of Industrial dryers, Industrial applications of Drying & new trends in industrial dryer.	05
Unit 6: Crystallization Nucleation, Crystal Growth, Methods of super saturation, Overall and Individual Growth	03

coefficient, material and enthalpy balance of crystallizer, Yield of crystallization, The Law of Crystal Growth Crystallization Equipment, Industrial applications of Crystallization.	

Text Books:

1. Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.
2. Richardson & Coulson, "Chemical Engineering", Vol.2, Pergamon Press, 1970.
3. Richardson & Coulson, "Chemical Engineering", Vol.5, Pergamon Press, 1970

Reference Books

1. McCabe and Smith, "Operation of Chemical Engineering", 5th Edition McGraw Hill, Kogakusha Ltd., 1998.
2. C.J. Geankolis,TransportProcessesandoperations,3rdEdition,Prenticehall,India 1993.
3. B.K. Datta, Principles of mass transfer & separation process.

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Distillation Summary and Numerical of Distillation (Unit 1)	1
2	Numerical of Distillation (Unit 1)	1
3	Numerical of Distillation (Unit 1)	1
4	Liquid-liquid Extraction Summary and Numerical of Extraction (Unit 2)	1
5	Numerical of Extraction (Unit 2)	1
6	Leaching Summary and Numerical of Leaching (Unit 3)	1
7	Leaching Summary and Numerical of Leaching (Unit 3)	1
8	Humidification Summary and Numerical of Humidification (Unit 4)	1
9	Numerical of Humidification (Unit 4)	1
10	Drying Summary and Numerical of Drying (Unit 5)	1
11	Crystallization Summary and Numerical of Crystallization (Unit 6)	1
12	Crystallization Summary and Numerical of Crystallization (Unit 6)	1

Minimum 10 tutorials should be conducted.

Link: https://nptel.ac.in/courses/103104046

https://www.classcentral.com/course/swayam-mass-transfer-operations-ii-12899

https://www.udemy.com/course/mass-transfer-principles-for-vapor-liquid-unit-operations/

Course Plan

Course Title : **Process Dynamics & Control (Lecture Work)**	
Course Code : 201CHL315	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 03
Evaluation Scheme : ISE + MSE Marks : 20+30=50	ESE Marks : 50 Marks

Course Description:

This course introduces dynamic processes and the engineering tasks of process operations and control. Subject covers dynamic behavior of processes, control strategies, stability of control systems, frequency response and design of various control system.

Course Objective (COs):

1. To understand the basic principles & problems involved in process control in industrial process plants.
2. To understand dynamic behavior of different order systems.
3. To understand design aspects of process control system and selection of controllers.
4. To evaluate and analyses the transfer function for various control systems and processes.
5. To acquire knowledge of stability characteristics and frequency responses.
6. Application of control systems to various operations to acquire practical knowledge through experimentation.

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

C315.1	**Remember** Laplace transforms and understands basic principles and objectives of process control.
C315.2	**Understand** basic fundamentals of first and second order process dynamics and its behavior
C315.3	**Know** about applying fundamental knowledge to design controllers and the control system.
C315.4	**Evaluate** different parameters affecting on the overall transfer function and response of process control system.

C315.5	**Understand** stability characteristics and to analyse the frequency response for design of process control systems.
C315.6	**Develop** the practical skill, team work and overall thinking to choose right career in industry or higher studies.

Prerequisite:	Process Instrumentation and Engineering Mathematics II

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			
C315.1	2	2	2	-	-	-	-	-	-	-	-	-	1	-	1
C315.2	3	3	3	3	-	-	-	-	-	-	-	-	1	-	2
C315.3	3	3	3	3	-	-	-	-	-	-	-	-	1	2	1
C315.4	3	3	3	3	-	-	-	-	-	-	-	-	1	-	3
C315.5	3	3	3	3	-	-	-	-	-	-	-	-	1	2	2
C315.6	-	-	-	-	1	1	-	1	1	1	-	1	1	-	3
C315	**2.8**	**2.8**	**2.8**	**3.0**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**2.0**	**-**

Contents	Hours
Unit 1:Laplace Transform & Importance of Process Control Introduction of Laplace transform, Applications of Laplace transform, Introduction to process dynamics, introduction of process control, History of process control, Basic principals involved in process control, Design aspects involved in process control, Software's used in process control	06
Unit 2:First and Second Order Systems First order system, Transfer Function, Time constant, Mercury in glass thermometer, Transient response of First order system, Single liquid level system, Mixing process,	06

CSTR, RC Circuit, Response of first order system in series, Non interacting system, Interacting system, Linearization of non linear system, Transportation lag. Second order systems, U tube manometer, Damped vibrator, Step response for second order systems, and Impulse and Sinusoidal response for Second order Systems, Terms used to describe second order under damped system, Industrial application and case studies.	
Unit 3:Process Control System Introduction, Control system for CSTR, Block diagram, Development of block diagram, Negative versus Positive feedback control system, Servo & Regulator mechanism problem, Introduction to feedback control, Types of Feedback Controllers P, PI, PD, PID with transfer function and application, Final control element, Control valves with transfer function, Block diagram for Chemical Reactor control system, Industrial application and case studies.	06
Unit 4:Overall Transfer Function & Transient Response of Control System Overall transfer function single loop system, Overall transfer function for change in set point & load variable, Overall transfer function multiple loop system, Definition of offset, P controller for change in set point & load point, PI controller for change in set point & load point, Industrial application and case studies.	06
Unit 5:Stability of Feedback Systems Concept of Stability, definition, Stability criterion, The Characteristic Equation, Routh-Hurwitz Criterion for Stability with theorems and limitations, examples, Root-Locus Analysis, concept, plotting root locus diagram, rules for negative feedback system, examples.	06
Unit 6:Frequency Response & Design Aspects of Process Control Bode diagrams, Rules, Bode plot for a) first order system, b) second order system, c) Transportation lag, d) P, PI, PD, PID controllers, Bode stability criterion, gain & phase margin, Process & Instrumentation Diagram of Distillation column, Heat Exchanger, Reactor, Pressure vessel, Interlock system decode, Emergency shutdown,	06

Design of Control Systems, Control logic develop, DCS, PLC and SCADA systems, Software's used in Chemical industries for process control.	

Text Books:

1. Coughanowr Koppel, "Process System Analysis and Control", McGraw Hill, New York.
2. Le Blanc &Coughanowr, "Process system analysis and Control", McGraw Hill, Third edition
3. Donald K. Coughanowr, "Process system analysis and control", McGraw Hill, Second edition, New York, 1991

Reference Books:

1. Peter Harriott, "Process Control", Tata McGraw Hill, New Delhi, 1977.
2. Coulson and Richardson, "Chemical Engineering" Volume – III, Second Edition, Pergmon Press, (UK), 1985
3. Stephanopoulos G, "Chemical Process Control and introduction to theory and practice.

Course Plan

Course Title : **Chemical Reaction Engineering – I (Lecture Work)**	
Course Code : 201CHL 316	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE: 20+30=50 Marks	ESE Marks : 50 Marks

Course Description:

Chemical Reaction Engineering subject deals with homogeneous reaction system. In this syllabus we will be discussing various types of reaction, various types of reactors, performance equations, and types of reactor arrangements and effects of temperature on homogenous system.

Course Objectives:

1. Find rate law and define reaction order and activation energy for given reaction.
2. Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models.
3. Demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system and use this information to design a commercial reactor.

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

C316.1	**Define and develop** rate equations for homogeneous reactions.
C316.2	**Derive and design** equations for different types of reactors based on mole and energy balance.
C316.3	**Design** the size batch reactors, semi batch reactors, CSTRs, PFRs, for isothermal for given rate law and feed condition.
C316.4	**Relate rate** of reaction with design equation for reactor sizing.
C316.5	**Design** reactor for single and multiple reactions.
C316.6	**Understand** the effect of temperature on homogeneous reactions.

Prerequisite:	Industrial Engineering Chemistry, Process Calculation.

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			
C316.1	3	2	3	-	-	-	-	-	-	-	-	-	2	-	1
C316.2	2	2	3	2	-	-	-	-	-	-	-	-	2	-	2
C316.3	-	2	3	2	-	-	-	-	-	-	-	-	2	-	3
C316.4	-	2	3	2	-	-	-	-	-	-	-	-	2	-	2
C316.5	-	2	3	2	-	-	-	-	-	-	-	-	2	-	3
C316.6	-	2	3	2	-	-	-	-	-	-	-	-	2	-	2
C316	**-**	**2**	**3**	**2**	**-**	-	-	-	-	-	-	-	**2**	-	**-**

Contents	Hours
Unit 1:Introduction with Kinetics of Homogeneous Reactions Chemical kinetics and thermodynamics of reaction; Classification of reactions– Homogeneous and Heterogeneous reactions. Rate of reaction-broad definition for homogeneous and heterogeneous reactions. Irreversible and reversible reactions, Equilibrium, Order and molecularity of reaction. Elementary and nonelementary reactions, Stoichiometry, Fractional conversion. Rate of reaction based on all components of the reaction and their interrelation. Law of mass action, Rate Constant Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation Temperature dependency of rate Constant, Arrhenius law, Transition state theory and collision theory, Introduction to reaction mechanism. Use of software to study the kinetics of chemical reaction.	6
Unit 2:Interpretation of Batch Reactor Data Batch reactor concept, Constant volume batch reactor system; Design equation for zero, first, Second and third order irreversible and reversible reactions, graphical interpretation of these equations and their limitations, Variable volume Batch reactors .Design equation for zero, first and second order irreversible and reversible reactions, graphical	6

interpretation of their limitations, Introduction to catalytic and auto catalytic reactions, Rate equation concept for these reactions. Multiple reactions- stoichiometry and Rate equations for series and parallel reactions; Non elementary single reactions Development of rate expression; chain reactions development of rate expressions. Industrial applications of batch reactor.	
Unit 3:Ideal Flow Reactors Concept of ideality. Types of flow reactors and their differences, Space-time and space velocity. Design equation for plug flow reactor and CSTR; Design equations for first and second order reversible and irreversible constant volume and variable volume reactor. Graphical interpretation of these equations; mean holding time; Development of rate expression for mean holding time for a plug flow reactor. Industrial applications of CSTR and PFR.	6
Unit 4:Single and Multiple Reactor System Size comparison of single reactors; Optimum size determination; Staging of reactors , reactorsin series and parallel; Performance of infinite number of back mix reactors in series, Back mixand plug flow reactors of different sizes in series and their optimum way of staging ; Recyclereactors, Optimum recycleratio forauto–catalytic(recycle) reactors. Demonstration of various reactor arrangements in chemical industry with real time example.	6
Unit 5:Design of Reactor System for Single Reaction Yield and selectivity, Parallel reactions Requirements for high yield. Best operating condition for mixed & plug flow reactors, Series reactions Maximization of desired product rate in a plug flow reactor and back mixed reactor. Design of reactor using Aspen Plus simulation software.	6
Unit 6:Temperature Effects in Homogeneous Reactions Equilibrium Conversion, Optimum temperature progression, Adiabatic and non adiabatic operations, Rate, Temperature and conversion profiles for exothermic and endothermic reactions, Stable operating condition in reactors. Rector temperature control in chemical industry.	6

Text Book:

1. OctaveLevenspeil,"ChemicalReactionEngineering",2nd Edition,JohnWiley,London

Reference Books:

1. S.H. Fogler, Elements of Chemical Reaction Engineering", PHI, 4th Edition.
2. S.M. Walas, "Reaction Kinetics for Chemical Engineers" McGraw Hill, New York.
3. J. M. Smith, "Chemical Engineering Kinetics", McGraw Hill, New York.
4. J.Rajaram and J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.

Course Plan

Course Title : **Chemical Process Technology(Lecture Work)**	
Course Code : 201CHL317	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE: 20 + 30=50 Marks	ESE : 50 Marks

Course Description:

A program that prepares individuals to apply scientific principles and technical skills to the operation of chemical processing equipment in industries such as manufacturing of inorganic chemicals.

Course Objectives:

1. To learn chemical processes for industrial gases, fuel gases.
2. To learn manufacturing processes for ceramic and glass industries.
3. To learn manufacturing processes of chlor alkali & electrolytic industries.
4. To learn synthesis process Hydrochloric acid & sulfur based inorganic chemicals
5. To learn manufacturing of various processes in Potassium & Phosphate industries
6. To learn manufacturing processes of nitrogen industry.

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

C317.1	**Explain** manufacturing of various fuel gases and industrial gases
C317.2	**Describe** various types of glasses& manufacturing processes of glasses & ceramics
C317.3	**Discuss** manufacturing process of various Chlor-Alkali and Electrolytic based inorganic chemicals
C317.4	**Investigate**various synthesis process Hydrochloric acid & sulfur based inorganic chemicals
C317.5	**Estimate** manufacturing processes of various Potassium & Phosphate based inorganic chemicals
C317.6	**Elaborate** the manufacturing processes of nitrogen industries

Prerequisite	Industrial Engineering chemistry, Mechanical Operation

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			
C317.1	2	-	2	2	-	-	2	-	-	-	-	-	2	-	2
C317.2	2	-	2	-	-	-	2	-	-	-	-	-	2	-	2
C317.3	2	-	2	2	-	-	2	-	-	-	-	-	2	-	2
C317.4	2	-	2	2	-	-	2	-	-	-	-	-	2	-	2
C317.5	2	-	2	2	-	-	2	-	-	-	-	-	2	-	2
C317.6	2	-	2	2	-	-	2	-	-	-	-	-	2	-	2
C317	**2**	**-**	**2**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Contents	Hours
Unit 1:Fuels, Fuel Gases and Industrial Gases Introduction to Chemical Manufacturing and Processing sector. Study of the role of Chemical Engineers and Technologists in the development of the nation. Study of the manufacture: water gas, producer gas, natural gas, LPG, hydrogen, oxygen, nitrogen, carbon dioxide and acetylene. Concept, types and applications of fuel cells and their advance methods in chemical industries.	08
Unit 2:Ceramic & Glass Industries Basic raw materials, Chemical Conversions, White wares, Structural clay products, Manufacture of refractory, Glass raw materials, Manufacture, types and applications of glass	06
Unit 3:Chlor-Alkali and Electrolytic Industries Manufacture of sodium chloride, sodium sulphate and by-products. Manufacture of Soda	06

ash, caustic soda, chlorine, bleaching powder, sodium bicarbonate, aluminium, Sodium, chlorates and per chlorates, recent technologies in process industries	
Unit 4:Hydrochloric Acid and Sulphur Industries Manufacture of hydrochloric acid, aluminium sulphate and alums. Manufacture of elemental sulphur and sulphuric acid, modern tools and techniques.	06
Unit 5:Phosphate and Potassium Industries Study of elemental phosphorous, raw materials and processes for phosphoric acid, Manufacture of ammonium phosphate, baking powder. Manufacture of potassium, potassium chloride, potassium sulphate and potassium nitrate, new synthesis processes of phosphate and potassium products	06
Unit 6:Nitrogen Industries Manufacture of synthetic ammonia, nitric acid, ammonium nitrate, and urea and their engineering problems.	04

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.

Course Plan

Course Title : **Mass Transfer-II (Laboratory Work)**	
Course Code : 201CHP320	**Semester : VI**
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 mass transfer operations including separation of gas- liquid, gas-solid, liquid-liquid and solid-liquid phases.

Course Objectives:

To teach the students different separation techniques, at the end of the study students will come to know the design of a distillation column, as well as design of an adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction.

1. To study the different separation techniques in process industries.
2. At the end of the study, students will come to know the design of a distillation column.
3. To study the calculations involved in liquid-liquid extraction and solid liquid extraction.
4. At the end of the study, students will come to know the design of industrial dryer & cooling tower.

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

C320.1	**Know** different separation techniques in process industries.
C320.2	**Design** & do the calculation of distillation column.
C320.3	**Design**& do the calculations involved in liquid-liquid extraction and leaching.
C320.4	**Design**& do the calculation of industrial dryer & cooling tower.

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			
C320.1	2	2	-	2	-	1	1	-	-	-	-	-	2	-	3
C320.2	2	2	1	2	-	-	-	-	-	-	-	-	2	-	3
C320.3	2	2	1	2	-	-	-	-	-	-	-	-	2	-	3
C320.4	2	-	1	-	-	-	-	-	-	-	-	-	2	-	2
C320	**2**	**2**	**1**	**2**	**-**	1	1	-	-	-	-	-	**2**	**-**	**-**

Expt. No.	Name of Experiment	Type	Hours
1	Simple Distillation: To verify Rayleigh's equation for simple distillation.	O	2
2	Binodal curve: To plot bimodal curve by using system distilled water, chloroform & acetone.	O	2
3	Cross current leaching: To study principle of leaching by studying result obtained by leaching a mixture of Oxalic acid & sand with distilled water by cross current leaching	O	2
4	Counter current leaching: To study principle of leaching by studying result obtained by leaching a mixture of Oxalic acid & sand with distilled water by counter current leaching	O	2
5	Liquid- liquid extraction: To calculate percentage recovery of acetic acid from mixture of acetic acid and water with benzene as extracting solvent by single stage and multistage cross current extraction.	O	2
6	Tray Dryer-I: To study drying characteristics and to study characteristic curve for saw dust and moisture content.	O	2
7	Tray Dryer-II: To study drying characteristics and to study characteristic rate of drying curve for saw dust and moisture content.	O	2
8	Steam Distillation: To determine thermal, vaporization efficiency in steam distillation operation..	O	2
9	Oil Extraction: To determine percentage of recovery of oil by leaching operation.	O	2
10	Crystallization: To find yield of batch crystallization	O	2

11	Cooling Tower: To determine volumetric mass transfer coefficient for air water system in cooling tower	O	2
12	Reactive Distillation: To study the principle, construction, working of reactive distillation.	S	2

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

TextBooks:

1. Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.
2. Richardson & Coulson, "Chemical Engineering",Vol.2, Pergamon Press,1970
3. Richardson & Coulson, "Chemical Engineering",Vol.4, PergamonPress,1970

Reference Books

1. Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, "Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd.,1975.
2. McCabe and Smith, "Operation of Chemical Engineering", 5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3. C.J. Geankolis, Transport Processes and operations, 3rd Edition, Prentice hall, India, 1993.
4. B.K. Datta, Principles of mass transfer & separation process
5. K. D. Patil, Mass Transfer Operation Vol.I & II.

Course Plan

Course Title : **Process Control (Laboratory Work)**	
Course Code : 201CHP321	**Semester : VI**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks : 25	ESE (POE) Marks : 25

Course Description:

To the basic principle and calculation techniques used in the chemical industries and to acquaint them with the fundamentals of the material and energy balances as applied to chemical engineering process

Course Objectives:

1. The objective of this course is to expose students to the various methods of process control engineering.
2. To know the basic principles & importance of process control in industrial process plants.

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

C321.1	**Understood** the control engineering problems.
C321.2	**Explain** the basic principles & importance of process control in industrial process plants.

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			
C321.1	2	3	2	1	-	-	-	-	-	-	-	-	1	1	2
C321.2	3	2	2	2	-	-	-	-	-	-	-	-	1	1	2
C321	**2.5**	**2.5**	**2**	**1.5**	-	-	-	-	-	-	-	-	**1**	**1**	**-**

Expt. No.	Name of Experiment	Type	Hours
1	Time Constant of Thermometer	O	2
2	Time Constant of U tube Manometer	O	2
3	Liquid Level Control System	O	2
4	Two Tank Interacting System	O	2
5	Two Tank non-interacting System	O	2
6	Study of Control Valve Characteristics	O	2
7	Control of Flow System	O	2
8	Control of level System	O	2
9	Control of Pressure System	O	2
10	Control of temperature System	O	2
11	PID control of Shell and tube heat exchanger	O	2

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

Text Books:

1. Coughanowr Koppel, “Process System Analysis and Control”, McGraw Hill, New York.
2. Le Blanc &Coughanowr, “Process system analysis and Control”, McGraw Hill, Third edition
3. Donald K. Coughanowr, “Process system analysis and control”, McGraw Hill, Second edition, New York, 1991

Reference Books:

1. Peter Harriott, “Process Control”, Tata McGraw Hill, New Delhi, 1977.
2. Coulson and Richardson, “Chemical Engineering” Volume – III, Second Edition, Pergmon Press, (UK), 1985
3. Stephanopoulos G, “Chemical Process Control and introduction to theory and practice.

Course Plan

Course Title : **Chemical Reaction Engineering – I (Laboratory Work)**	
Course Code : 201CHP322	**Semester : VI**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE : 25 Marks	ESE (POE) : 25 Marks

Course Description:

This subject deals with practical understanding of hoe to calculate rate constant, order of reaction, reaction rate, analysis of kinetic data by using various models and effect of various parameters on homogenous reaction.

Course Objective:

1. Demonstrate the ability to quantitatively predict the performance of common chemicalreactorsusing simplified engineeringmodels.
2. Demonstrate the ability to regress the experimental data from which they determine thekinetic model of a multi-reaction system and use this information to design a commercialreactor.

Course Outcomes (COs):

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

C322.1	**Find** rate constant and order of reaction from analysis of experimental data.
C322.2	**Find** rate constant and order of reaction from analysis of experimental data for different types of reactor.
C322.3	**Use** various software's to determine kinetic parameters for data of various types of reactor.

Prerequisite	Industrial Engineering Chemistry, Process Calculation.

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			
C322.1	-	2	3	2	-	-	-	-	-	-	-	-	2	-	2
C322.2	-	2	3	3	-	-	-	-	-	-	-	-	2	-	2
C322.3	-	2	3	3	2	-	-	-	-	-	-	-	2	-	3
C322	**-**	**2**	**3**	**2.67**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Expt. No.	Name of Experiment	Type	Hours
1	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in batch reactor-I (where M=1).	O	2
2	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in batch reactor-II (where M=2).	O	2
3	Verification of Arrhenius law.	O	2
4	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in straight tube reactor.	O	2
5	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in bend tube reactor	O	2
6	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in helical coil reactor.	O	2
7	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in spiral coil reactor.	O	2
8	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in packed bed reactor.	O	2
9	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in mixed flow reactor.	O	2

10	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in mixed flow reactors in series.	O	2
11	To calculate rate of reaction of autocatalytic reaction in recycle reactor.	O	2

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

Note: Experimental calculations & graphs by using software's like Polymath, Excel etc.

Text Book:

1. Octave Levenspeil, "Chemical Reaction Engineering", 2nd Edition, John Wiley, London.

Reference Books:

1. S.H. Fogler,"Elements of Chemical Reaction Engineering", PHI, 4th Edition.
2. S.M. Walas, "Reaction Kinetics for Chemical Engineers" McGraw Hill, New York.
3. J.M. Smith, "Chemical Engineering Kinetics", McGraw Hill, New York.
4. J. Rajaramand J.C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.

Course Plan

Course Title : **Applications of MATLAB in Chemical Engineering (Tutorial)**	
Course Code : 201CHMC323	**Semester : VI**
Teaching Scheme : L-T-P : 0-1-0	Credits : 1
Evaluation Scheme : ESE: 50 Marks	

Course Description:

The course includes Mathematical Programming for chemical engineering Application

Course Objectives:

1. To study the fundamental/basic MATLAB
2. To develop mathematical model for Numerical Method
3. To study Application of MATLAB in various Chemical Engineering operation

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

C323.1	Develop program on Numerical Method
C323.2	Develop program on unit operation, unit process in chemical engineering Heat Transfer, Mass Transfer, & Chemical Reaction Engineering

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			
C323.1	3	2	2	2	-	-	-	-	-	-	-	-	2	1	3
C323.2	-	-	2	2	2	-	-	-	-	-	-	2	2	2	3
C323	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1.5**	**-**

List of Tutorials

Tut. No.	Name of Tutorials	Hours
1	Program of co-current Heat Exchanger with MATLAB	1
2	Program of Counter current Heat Exchanger with MATLAB	1
3	Program of Shell and Tube Heat Exchange With MATLAB	1

4	Program of Binary Batch Distillation with MATLAB	1
5	Program of Continuous Distillation with MATLAB	1
6	Program of Multi Solute liquid- liquid Extraction	1
7	Program of Continuous Liquid –Liquid Extraction with MATLAB	1
8	Programming of batch reactor with MATLAB	1
9	Program of Semi batch reactor with MATLAB	1
10	Program of CSTR with MATLAB	1
11	Program of PFR with MATLAB	1
12	Program of Absorption with MATLAB	1
13	Program of Numerical Method with MATLAB	1

- Minimum 12 tutorial should be conducted

Text Books:

1. Numerical Methods for Engineers, S.K. Gupta, New Age International,
2. Getting Started With MATLAB: A Quick Introduction for Scientists And Engineers, Rudra Pratap, Oxford University Press,

Reference Books:

1. Process Optimization in Chemical Engineering by Edger Himmelblau
2. Applied Mathematics and Modeling for Chemical Engineers, R. G. Rice, D. D. Do, John Wiley & Sons, 1995.

D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

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'A' Grade

Department of Chemical Engineering

Program Structure

Open Elective-I

To be implemented from

A.Y. **2022-23**

Open Elective:

Open elective courses are offered to gain the knowledge of multidisciplinary areas. Students must choose one open elective course from the list of courses offered by other departments (excluding open elective courses offered by their department). Following is the list of open elective courses. The detailed syllabus is available on to the college website under academic tab.

Sr. No.	Department	Course Code	Open Elective-I Course
1	Chemical	201CHL318	Industrial Safety and Act
		201CHL319	Energy Conservation and Audit
2	Mechanical	201MEL313	Human Resource Management
		201MEL314	Electric Vehicle
3	Civil	201CEL330	Disaster Management
		201CEL331	Green Building
4	Architecture	201ARL318	Residential Gardening
		201ARL319	Role of Art & Technology in Interior Design
5	Electronics and Telecommunication	201ETL318	Sensor Technology
		201ETL319	Electronic Instrumentation
6	Computer Science & Engineering	201CSL319	E- Commerce & Digital Marketing
		201CSL320	Python Programming
7	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	201AIML320	Applications of AI ML
		201AIML321	Augmented Reality and Virtual Reality
8	Computer Science & Engineering (Data Science)	201DSL319	Basics of Data Science
		201DSL320	Basics of Database

Course Plan

Course Title : Industrial Safety & Act	
Course Code : 201CHL318	**Semester : VI**
Teaching Scheme : L-T-P : 3-1-0	Credits : 4
Evaluation Scheme : ISE + MSE: 20+30=50 Marks	ESE: 50 Marks

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:

1. Understand the importance of industrial safety.
2. Understand industrial accidents, hygiene, hazards and risk analysis.
3. Understand and apply industrial safety acts
4. Apply the preventive techniques to avoid the accidents in the industry.

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

C318.1	**Understand** the concept and importance of industrial safety
C318.2	**Identify** the hazard in industry and control it.
C318.3	**Understand** the importance of industrial hygiene and effectively implement.
C318.4	**Prevent** accidents in the industry by understanding the previous incidents with help of various case studies.
C318.5	**Identify** the hazardous chemical in industry and able to handle hazardous chemical safely.
C318.6	**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) 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			
C318.1	-	-	-	-	-	2	-	2	-	-	-	-	2	-	2
C318.2	-	3	-	3	-	2	-	-	-	-	-	-	3	-	2
C318.3	-	-	-	-	-	3	-	3	-	-	-	-	2	-	2
C318.4	-	2	-	2	-	2	-	2	-	-	-	-	3	-	3
C318.5	-	3	-	3	-	2	-	-	-	-	-	-	3	-	2
C318.6	-	-	-	-	-	2	-	2	-	-	-	-	2	-	2
C318	**-**	**2.67**	**-**	**2.67**	**-**	**2.167**	**-**	**2.25**	**-**	**-**	**-**	**-**	**2.5**	**-**	**-**

Contents	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), steps for hazard identification, 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-	6

the-event approach), Deductive technique, Inductive technique.	
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 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).	6
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	6

(Prevention and Control) Act, 1974, Boiler Vessels Act, Child Labor and Women Employee Act., EPA 1986.	

Text Books:

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

Reference Books:

1. Industrial Safety and Environment, A. K. Gupta, Laxmi Publications, New Delhi
2. Techniques of Safety Management (ISBN: 978-18-8-558139-6), Dan Petersen, McGraw-Hill Book Co. Ltd., New York, N.Y. USA,
3. Hazardous Chemical Data Book ISBN:081-551072-1), G. Weiss, Noyes Data Corporation, Park Ridge, New Jersey, N.Y. (USA)

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Need for safety, Accident sequence (Unit 1)	1
2	Process of accident, Causes of accidents (Unit 1)	1
3	Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents (Unit 1)	1
4	Fire triangle (Unit 2)	1
5	Hazard Identification and Risk Assessment (HIRA), steps for hazard Identification (Unit 2)	1
6	Definition of Industrial Hygiene (Unit 3)	1
7	Introduction to chemical hazards, dangerous properties of Chemical, MSDS(Material Safety Data Sheets) (Unit 3)	1
8	Purpose of PSM, its elements and Risk-Based Process Safety Management (RBPSM) (Unit 4)	1

9	Major Industrial Disasters (Case Studies) Bhopal disaster (1984), Chernobyl Disaster, Fukushima Daiichi Disaster etc. (Unit 4)	1
10	Safety Precautions for transporting hazardous/ toxic/ flammable/explosive/ radioactive substances by all modes (Unit 5)	1
11	Safety legislation: Acts and rules (Unit 6)	1
12	Legislative measures in industry (Unit 6)	1

Minimum **10** tutorials should be conducted.

Links: Industrial Safety & Act:
https://onlinecourses.nptel.ac.in/noc22_ch44/preview
https://onlinecourses.nptel.ac.in/noc22_mg97/preview
https://www.udemy.com/course/industrial-safety/

Course Plan

Course Title : Energy conservation & Audit	
Course Code : 201CHL319	**Semester : VI**
Teaching Scheme : L-T-P : 3-1-0	Credits : 4
Evaluation Scheme : ISE + MSE : 20 + 30=50 Marks	ESE: 50 Marks

Course Description:

Energy conservation and audit course provides the detail information of energy conservation and audit. 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 Indian energy scenario and importance of energy.
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 learn the basics of energy audit.
5. To learn the implementation of energy audit.
6. To study energy conservation act 2001.

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

C319.1	**Explain** energy scenario in India and importance of energy in production and employment
C319.2	**Describe** how to forecast industrial energy supply, demand, price & availability? and what is role of energy conservation in industry?
C319.3	**Implement** the energy conservation policy.
C319.4	**Understand** the basic concepts of energy audit and energy management.
C319.5	**Discuss** energy audit instruments, Procedures and Techniques.
C319.6	**Discuss** 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			
C319.1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C319.2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2
C319.3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	3
C319.4	2	-	-	-	-	-	-	-	-	-	-	-	2	-	2
C319.5	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
C319.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2
C319	**2**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Contents	Hours
Unit 1:Indian energy scenario Definition of energy 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. Importance of energy in production and employment	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.	05
Unit 3:Energy management and policy Comprehensive energy conservation planning (CECP), Motivation for	07

Comprehensive energy planning, Definition of energy conservation, Principles of energy conservations, Procedure for Comprehensive energy conservation planning, Significance of CECP, Tasks required for CECP and application of CECP.	
Unit 4:Basics of energy audit Definition and objectives of energy management, Energy audit definition, Need for energy audit, Scope of energy audit, Responsibility of energy management, Types of energy audit and approach.	04
Unit 5:Energy audit and management Understanding energy cost, Benchmarking, energy performance, Matching energy usage to requirement, Maximizing system efficiencies, Optimizing input energy requirements, Fuel & energy substitution, Instruments & metering for energy audit, Targeting and monitoring energy consumption, General questionnaire, Case study of energy audit, Bureau of energy efficiency regulations, 2008.	10
Unit 6:Energy conservation act 2001	04

Text Books:

1. S. Devid Hu. Hand book of Energy Conservation, VAN Nostrand Reinhold Company, New York.
2. Rao, Diwalkar P. L., Energy Conservation Hand book, Utility Publication, Hydrabad.
3. The Bulletin on Energy Efficiency and Management by IRADA, MITCON,MEDHAetc.
4. Handbook of Energy Audit, Sonal Desai, Mcgraw Hill Education Private Ltd.

Reference Books:

1. A Practical Guide to Energy Conservation, PCRA Publication, 2010.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Industrial Energy Management and Utilization -L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
4. Amit Tagi, Hand book Energy Audit, Tata McGraw Hill publication, 2000.

List of Tutorials

Tutorial No.	Name of Tutorial	Hours
1	Growth and demand of energy in India (Unit 1)	1
2	Energy availability in India (Unit 1)	1
3	What are the barriers in energy conservation (Unit 1)	1
4	List and explain in detail new energy technologies(Unit 2)	1
5	Numerical on CECP (Unit 3)	1
6	Application of CECP(Unit 3)	1
7	Scope of energy audit(Unit 4)	1
8	Responsibility of energy management(Unit 4)	1
9	Instruments &metering for energy audit(Unit 5)	1
10	General questionnaire for energy audit (Unit 5)	1
11	Case study of energy audit(Unit 5)	1
12	Energy conservation act 2001(Unit 6)	1

Minimum **10 tutorials** should be conducted.

Links:

Energy Conservation

https://youtu.be/WTgGO3izbqQ
https://youtu.be/nPY-vOP1nRc
https://youtu.be/QFQGXei47c0
https://youtu.be/EYYHfMCw-FI
https://youtu.be/mCRDf7QxjDk

Energy Audit

http://www.elion.co.in/ energy audit

National Certification Examination for Energy Managers and Energy Auditors

http://www.beeindia.gov.in
www.aipnpc.org

D.Y.PATIL
COLLEGEofENGINEERING&TECHNOLOGY
DepartmentofChemical Engineering

D. Y. Patil College of Engineering and Technology

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Accredited by NAAC with 'A' Grade

Department of Chemical Engineering

Program Structure

Food & Nutrition Technology (Minor)

(To be implemented from academic year **2022-23**)

D.Y.PATIL
COLLEGEofENGINEERING&TECHNOLOGY
DepartmentofChemical Engineering

Minor Degree details

With a view to enhance the employability skills and impart knowledge in emerging areas which are usually not being covered in Undergraduate Degree credit framework, AICTE has come up with the concept of 'Minor Degree' in emerging areas.

Minor specialization in EMERGING AREAS in Under Graduate Degree Courses is allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a degree with minors in specialized area. These credits are in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline. Knowledge of these emerging areas will help students in capturing the plethora of employment opportunities available in these domains. With the help of industry-academia experts, the institute has framed the curriculum of Minor Degrees. Following are the minor degrees offered by the various departments:

Sr. No.	Department	Minor Degree Offered
1	Architecture	Sustainable Energy Practices
2	Chemical Engineering	Food and Nutrition Technology
3	Civil Engineering	Environmental Sustainability
4	Mechanical Engineering	Robotics and Industry 4.0
5	Electronics & Tele communication Engineering	Internet of Things (IoT)
6	Computer Science & Engineering	Cyber Security
7	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	Artificial Intelligence & Machine Learning
8	Computer Science & Engineering (Data Science)	Data Science

Interested students studying in semester III can choose only one minor degree track offered by other department (excluding minors offered by their core undergraduate course). The final list of allocation will be displayed, following the eligibility criteria mentioned in the academic rules and regulations, before beginning of semester IV.

- The minor degree will be run only when the minimum students count is 30 for respective track.
- Students once enrolled for any minor degree are not permitted to change the track. However, a student can withdraw at any semester.
- The fee for minor degree is to be paid in addition to the college fees. There will not be any fee concession/relaxation for any category student. The fee will not be refunded when withdrawn from the minor degree.
- Minor degree courses will begin from semester IV onwards as per the structure of the respective tracks.

B. Tech. Chemical Engineering Minor Degree Structure													
Sr.No	**Course Code**	**Course Type**	**Name of the Course**	**Sem**	**Teaching Scheme Per Week**			**Credits**	**Total Marks**	**Evaluation scheme**			
1	201CHMIL 221	PCC	Principles of Food Preservation	IV	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
2	201CHMIP 222	PCC-LC	Principles of Food Preservation Laboratory	IV	-	-	2	1	25	ISE	25	10	10
3	201CHMIL 312	PCC	Human Nutrition	V	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
4	201CHMIP 313	PCC-LC	Human Nutrition Laboratory	V	-	-	2	1	25	ISE	25	10	10
5	201CHMIL 324	PCC	Food Process Engineering	VI	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
6	201CHMIL 325	PCC	Food Packaging	VI	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
7	201CHMIP 326	PCC-LC	Food Process Engineering Laboratory	VI	-	-	2	1	50	ISE ESE (PEO)	25 25	10 10	10 10
8	201CHMIL 413	PCC	Food Quality & Safety Management	VII	3	-	-	3	100	ISE MSE ESE	20 30 50	20 20	40
					15	**-**	**06**	**18**	**600**	**Total Credits:18**			
				Total	**21**					**Total Contact Hrs.:05/Week**			

CourseCode	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	MandatoryCourse
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation,
MSE: Mid semester Examination,
ESE: End Semester Examination

Note:
ESE will be conducted for 100 marks and converted to 50 marks

D.Y.PATIL
COLLEGE of ENGINEERING & TECHNOLOGY
Department of Chemical Engineering

Course Title : **Principles of Food Preservation** (Lecture work)	
Course Code :201CHMIL221	**Semester : IV**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE Marks : 50 Marks

Course Objectives (COs):

1. Applying basic food science knowledge and understanding of biochemical changes that occur during various processing and conservation techniques.
2. Introduce students to different food processing techniques.
3. Educate students on the technical mechanism for preserving food.
4. Introduce students to food preservation methods to avoid waste.
5. Introduce students to different non thermal ways of food processing.
6. Introduce students to different modern ways of processing and conserving food.

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

C221.1	**Understand** the need for food processing
C221.2	**Grasp** the various food processing techniques
C221.3	**Understand** the different preservation technique
C221.4	**Understand** the principles of food spoilage and the ways to prevent.
C221.5	**Describe** the principles involved in non-thermal food processing.
C221.6	**Describe** the principles involved in the various modern ways of food processing.

Prerequisite	Basic sciences

Contents	Hours
Principles of Food preservation Scope and Importance of food processing, National and International perspectives, Objectives and techniques of food preservation.	06
Food preservation by low temperature Cold Preservation: Freezing and Refrigeration- Air freezing, Indirect contact freezing, Immersion freezing, Dehydro-freezing, Cryo-freezing, Changes in foods during refrigeration and frozen storage	06
Food preservation by heating	06

Blanching, pasteurization, sterilization, UHT processing, extrusion cooking of food, Moist and Dry heat methods, Dehydration, Concentration, Canning	
Preservation by drying Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products;	06
Food preservation by Non-thermal method Chemical preservation, fermentation methods for food preservation, irradiation, membrane technology.	06
Recent methods for food preservation Pulsed electric field processing, high pressure processing, processing by using ultrasound, dielectric, ohmic and infrared heating etc.	06

Text Books:

1. "Food processing technology: principles and practice", Fellows, P. and Ellis H. (1990). Wood Head Publishing Ltd.
2. "Food preservation and processing", Manoranjan Kalia and SangitaSood. (2019). Kalyani Publishers. New Delhi.
3. "Chemical changes in food during processing". Richardson, T. and Finley, J.W. (2003).Macmillon Publishers, Canada.

Reference Books:

1. Jelen, P. (1985). Introduction to Food Processing. Prentice Hall, Reston Virginia, USA.
2. Heldman, D.R. and Singh R. P. (2016). Introduction to Food Engineering.5th Edition. Elsevier India
3. William C. Frazier and Dennis C. Westoff (2017)., Food Microbiology 5th Edition, McGraw Hill Education.
4. Singh, Anju. (2017). Handbook of Food Preservation. Agrotech Press

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Course Title : **Principles of Food Preservation Laboratory** (Practical work)	
Course Code : 201CHMIP222	**Semester : IV**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks: 25 Marks	

Course Objectives (COs):

1. To imparts knowledge and expertise on preservation and food processing methods.
2. To familiarize themselves with good manufacturing practices and standard operating procedures used in laboratory activities.
3. To preserve food through drying, through freezing with the help of sugar, salt and acids.
4. To assist with the quality assessment of conservation products.

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

C222.1	**Apply** knowledge and expertise on preservation and food processing methods
C222.2	**Explain** themselves with good manufacturing practices and standard operating procedures used in laboratory activities.
C222.3	**Describe** preservation of food through drying, through freezing with the help of sugar, salt and acids.
C222.4	**Assist** with the quality assessment of conservation products.

Prerequisite	Basic sciences

List of Experiments			
Expt. No.	**Name of Experiment**	**Type**	**Hours**
1.	Introduction to food processing equipment's	S	02
2.	To study effect of blanching on quality of foods	S	02
3.	To check the adequacy of Blanching treatment	O	02
4.	Preservation of food by the process of freezing	O	02
5.	Drying of food using Tray dryer/other dryer	O	02
6.	Preparation of product by using sugar as preservative	O	02
7.	Preparation of product by using salt as preservative	O	02
8.	Preservation of product by using chemical preservatives	O	02
9.	Preservation of food by canning	O	02

10.	Extrusion cooking of food	O	02
11.	Food Fermentation	O	02
12.	Market Survey	S	02

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

Text Books/ Reference Books:

1. "Food processing technology: principles and practice" Fellows, P. J. (2009). Elsevier.
2. "Introduction to food engineering" Singh, R. P., and Heldman, D. R. (2001). Gulf Professional Publishing.
3. "The technology of food preservation" Desrosier, N. W., and James N. Desrosier. (1977). 4th Ed. AVI Publishing Company, Inc.

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Course Title : **Human Nutrition** (Lecture work)	
Course Code : 201CHMIL312	**Semester : V**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE Marks : 50 Marks

Course Objectives (COs):

1. To understand the physiological and metabolic functions of human digestive system.
2. To understand an overview of the major macro and micronutrients relevant to human health
3. To formulate dietary recommendations.
4. To understand proper diet planning, nutritional facts for balanced nutrition and healthy diets.
5. To understand the role of diet in causing and preventing various diseases
6. To get a basic foundation in human nutrition in preparation for any of the health professions.

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

C312.1	**Understand** the physiological and metabolic functions of nutrients.
C312.2	**Familiarize** nutritional assessment, RDA and Dietary Recommendations and guidelines.
C312.3	**Understand** the importance of energy and water balance
C312.4	**Understand** malnutrition, their causes and treatment
C312.5	**Understand** the principals involved in the diet, exchange lists, food labels and nutritional facts for balanced nutrition and healthy diets.
C312.6	**Describe**undesirable Constituents and toxic substances and their disorders.

Prerequisite	Basic sciences

Contents	Hours
Nutrition Scope, concepts and importance of nutrition, human digestive system	06
Nutritional aspects Nutritional aspects of carbohydrate, protein, lipids, water, vitamin and minerals, food, fad and faddism.	06
Energy and water balance Energy and water balance, Water intake and losses, energy requirement, and physiological energy value, bomb colorimeter	06

Malnutrition Types of malnutrition, multi-factorial causes, epidemiology of under nutrition and over nutrition, nutrition infection and immunity, nutrition education	06
Balance diet Balance diet, types of balance diet, diets for specific purposes.	06
Undesirable Constituents and toxic substances Undesirable Constituents and toxic substances and their disorders, hormones	06

Text Books:

1. "Nutrition and Dietetics" Joshi, Shubhangini A., (1992). Tata Mc Grow- Hill publishing Company Ltd., New Delhi.
2. "Fundamentals of Human Nutrition".Geissler.(2009). Elsevier Science.
3. "Advance Nutrition and Human Metabolism" Gropper, S. S. (2013). Cenage Learning.
4. "Advanced Text Book on Food and Nutrition"Swaminathan, M. (2006). (Volume I and II) The Bangalore Printing and Publishing Co. Ltd., Bangalore.

Reference Books:

1. Stewart Truswell. (2003) .ABC of Nutrition .4th edition. BMJ Publishing Group.
2. Carolyn D. Berdanier, Elaine B. Feldman and Johanna Dwyer. (2008). Handbook of Nutrition and Food. 2nd Ed. CRC Press, Boca Raton, FL, USA.
3. Swaminathan, N. (1987). Food Science and experimental foods. Ganesh Publications, Madras.5th Edition, vol 2, 2002.
4. Paul Singh R, and Dennis R.Heldman "Introduction to Food Engineering" 4th Edition. Academic Press – Elsevier India Private Ltd. New Delhi, 2008.

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Course Title : **Human Nutrition Laboratory** (Practical work)	
Course Code : 201CHMIP313	**Semester : V**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks: 25 Marks	

Course Objectives (COs):

1. To understand the physiological and metabolic functions of nutrients.
2. To determine the major macro and micronutrients relevant to human health
3. To understand methods of nutritional assessment, RDA and guidelines.
4. Explain how dietary recommendations are formulated.

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

C313.1	**Understand** the methods used for nutritional assessment.
C313.2	**Familiarize** nutritional assessment, RDA and Dietary Recommendations and guidelines.
C313.3	**Describe** the different nutritional assessment methods
C313.4	**Understand** the food composition and energy balance requires in diet planning.

Prerequisite	Basic sciences

List of Experiments

Expt. No.	Name of Experiment	Type	Hours
1.	Calculation of BMR and body surface area	S	02
2.	Calculation of energy value of food	S	02
3.	Preparation of balance diet	O	02
4.	Anthropometric measurements	O	02
5.	Biochemical analysis of blood	O	02
6.	Biochemical analysis of urine	O	02
7.	Computation of energy requirement on the basis of physical activity ACU units	O	02
8.	Role of various national and international agencies in field of human nutrition	O	02
9.	Nutritional labelling of food products	O	02

10.	Nutritional survey	S	02
11.	Determination of energy value of food by bomb calorimeter	S	02
12.	Diet for specific health condition	S	02

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

Text Books/ Reference Books:

1. "Advanced Text Book on Food and Nutrition" Swaminathan, M. (2006). (Volume I and II). The Bangalore Printing and Publishing Co. Ltd, Bangalore.
2. "ABC of Nutrition" Stewart, Truswell. (2003) (4th edition). BMJ Publishing Group. ISBN 0727916645.
3. "Handbook of Nutrition and Food" Carolyn D. Berdanier, Elaine B. Feldman and Johanna Dwyer. (2008). 2nd Ed. CRC Press, Boca Raton, FL, USA.

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Course Title : **Food Process Engineering** (Lecture work)	
Course Code : 201CHMIL324	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE: 20+30=50 Marks	ESE Marks : 50 Marks

Course Objectives (COs):

1. Define the course and indicate the importance of the same to the students.
2. Introduce students to different machines/equipment used in food processing
3. Make the student to become acquainted with the principles of handling and processing food and agricultural products.
4. Emphasis on to the principles of operation of equipment used in the processing industry and the response of biological materials to these operations.
5. Apply engineering principle and concepts to handle store and process of various food products.
6. Design food processing and operating equipment for production of various food products.

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

C324.1	**Explain** the machines/equipment used for the different unit operations in food processing carry out some of the basic unit operations in food processing
C324.2	**Understand** of specific processing technologies used for various food products
C324.3	**Develop** an ability to identify, formulate, and solve engineering problems
C324.4	A comprehensive **understanding** of the aspects required to be controlled during food processing.
C324.5	Problem **evaluation** and problem solving skills regarding food processing operations that can affect the quality of foods
C324.6	**Developed** self-learning and practical proficiency and team work in food processing techniques to specific commodities and industrial plant unit operations.

Prerequisite	Principles of Food Preservation, Food Chemistry

Contents	Hours
Filtration and Centrifugation Filtration : Theory of filtration, industrial filters, applications to food industries Centrifugation: Theory of centrifugation, equipment, applications to food industries	05
Evaporation	

Principles of evaporation, types and selection of evaporators, mass and energy balance. Design of single and multiple effect evaporators, applications in food industries.	05
Drying & psychometric chart The psychometric chart: construction and use of psychometric chart for food unit operations. Drying: Principles of drying, drying rate kinetics, Dehydration systems, and dehydration system design by mass and energy balance, drying time prediction.	07
Refrigeration and Freezing Refrigeration: Refrigeration system and its components. Selection of a refrigerant. Cold– storage plants Freezing: Food Freezing systems, Frozen food properties, Calculation of freezing time by Plank's equation and other modified methods	07
Extrusion processes of Food Basics principle of extrusion, Extrusion systems : cold and hot extrusion; single screw and twin screw extruder design, extrusion cooking, application of extrusion	06
Crystallization Theory and principles of Crystallization, nucleation, crystal growth, crystallization equipment, applications of crystallization in food processing.	06

Text Books:

1. "Food Process Engineering and Technology" Berk, Zeki Academic Press, 2009.
2. "Introduction to Food Process Engineering". Smith, P.G. Springer, 2004.
3. "Fundamentals of Food Process Engineering".Toledo, Romeo T. 3rd Edition, Springer, 2007.

Reference Books:

1. Ibarz A. & Barbosa-Canovas G. V., "Unit operation in food engineering". CRC PRESS, 2013.
2. Bark Z. "Food Process engineering and technology". Academic Press. 1st Edition, 2009.
3. Smith P.G., "Introduction to food processing engineering". Springer, 2nd education, 2011.
4. Fellows P.J. "Food processing Technology-Principles and Practices". Wood head Publishing Limited,

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Course Title : **Food Packaging** (Lecture work)	
Course Code : 201CHMIL325	**Semester : VI**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE : 20+30=50 Marks	ESE Marks : 50 Marks

Course Objectives (COs):

1. To impart comprehensive overview of the scientific and technical aspects of food packaging.
2. To instill knowledge on packaging machinery, systems, testing and regulations of packaging.
3. To gain knowledge on the different types of materials and media used for packaging foods
4. To gain knowledge on hazards and toxicity associated with packaging materials and laws, regulations and the monitoring agencies involved food safety, labeling of foods.
5. To gain knowledge on methods of packaging, shelf life and food factors affecting packaging.
6. To select the correct food packaging materials for different food products.

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

C325.1	**Understand** the various properties of food packaging materials.
C325.2	**Confirm** packaging laws and regulations meeting standards.
C325.3	**Describe** the properties of food packages, conversion technologies, processing and packaging technologies and user requirements including safety, convenience and environmental issues
C325.4	**Select** suitable packaging material for specific foods.
C325.5	**Describe** the technology involved in the production, shaping and printing of various packaging materials and package
C325.6	**Utilize** the correct packaging materials use for different food products manufacture in Food Industry.

Prerequisite	The students should have knowledge of Food Preservation, Food Engineering-I &II, Food Chemistry and Food Microbiology

Contents	Hours
Introduction to Food Packaging Package requirements, package functions, Hazards acting on package during transportation, Storage and atmospheric package, labeling laws Mechanical and functional tests on Package :Various mechanical and functional	06

testes perform in laboratories on package boxes and package materials	
Package Materials Classification packages, paper as package material its manufacture, types, advantages corrugated and paper board boxes etc. Glass as package material, Manufacture, Advantages, disadvantages. Metal as package material-manufacture, Advantages, disadvantages, Aluminum as package material, Its advantages and disadvantages, plastic as package material classification of polymers, properties of each plastics, uses of each plastics, chemistry of each plastic such as polyethylene, Polypropylene, polystyrene, polycarbonate, PVC, PVDC, Cellulose acetate, Nylon etc.	08
Lamination and Coating on paper and films Lamination, need of lamination, types, properties, advantages and disadvantages of each type. Types of coatings. Need of coating, methods of coatings.	06
Aseptic packaging Need, Advantaged, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging, Machineries used in Packing foods	06
Packaging of Specific Foods Packaging of specific foods with its properties like bread, biscuits, coffee, milk powder, egg powder, carbonated beverages, Snack foods etc.	05
Novel Food Packaging Packaging of Space food, Retort able pouches, Controlled and Modified atmosphere Packaging, Active packaging, Edible Packages etc.	05

Text Books:

1. “Food Packaging Technology”, 2003, Coles. Richard et al, Blackwell Publishing, Oxford Department of Technology, B.Tech (Food Technology) Program- Syllabus w.e.f. 2018 – 19
2. “Food Packaging Principles and Practice” Second Edn., 2005, G.L. Robertson
3. “Food Packaging Science and Technology”, Dong Sun Lee, 2008

Reference Books:

1. Saroka, W 2002, Fundamentals of Packaging Technology, 3rd edition, Institute of Packaging Professionals, Herndon, Virginia.
2. Twede, D 2005, Cartons, Crates and Corrugated Board: Handbook of Pap*er and Wood Packaging Technology*, DEStech Publications.

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Department of Chemical Engineering

Course Title : **Food Process Engineering Laboratory** (Practical work)	
Course Code : 221CHMIP326	**Semester : VI**
Teaching Scheme : L-T-P : 0-0-2	Credits : 1
Evaluation Scheme : ISE Marks: 25 Marks	ESE (POE) : 25 Marks

Course Objectives (COs):

1. To food unit operation applied in food process industries
2. To different machines/equipment used in food processing
3. To become acquainted with the principles of handling and processing food and agricultural products.
4. To inculcate the practical proficiency in a food process engineering laboratory.

Course Outcomes (COs):

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

C326.1	Better **understanding** of food unit operation applied in food process industries
C326.2	**Explain and apply** the machines/equipment used for the different unit operations in food processing
C326.3	**Explain** practical proficiency in a food processing units
C326.4	**Identify, formulates,** and solves engineering problems.

Prerequisite	Principles of Food Preservation, Food Chemistry, Food Process Engineering I

List of Experiments

Expt. No.	Name of Experiment	Type	Hours
1.	Experiment on Filtration	O	02
2.	Experiment on Centrifugation	O	02
3.	Study of evaporator	S	02
4.	Determination of air properties using psychometric chart	S	02
5.	Study of dryers	S	02
6.	Osmotic Dehydration of Foods.	O	02
7.	Study of Freezing of foods by different methods	S	02
8.	Study of refrigeration of foods	S	02
9.	Determination of freezing time of a food material,	S	02
10.	Study of Extrusion process in food	S	02

11.	Study of crystalliser	S	02

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

Text Books/ Reference Books:

1. "Introduction to food processing engineering". Smith P.G., Springer, 2nd education, 2011.
2. "Food processing Technology-Principles and Practices". Fellows P.J. Woodhead Publishing Limited, 2ND Edition, 2000.
3. "Chemical Engineering". Coulson J.M & Richardsons J.F., Butterworth Heinemann, 5th Edition, vol 2, 2002.

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Department of Chemical Engineering

Course Title : **Food Quality and Safety Management** (Lecture work)	
Course Code : 201CHMIL413	**Semester : VII**
Teaching Scheme : L-T-P : 3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE:20+30=50 Marks	ESE Marks : 50 Marks

Course Objectives (COs):

1. The basic knowledge of food quality and Safety aspects
2. To quality assessment of different food products
3. To various regulatory aspects for food business operators
4. The sensory assessment for different food products
5. Understand various standards in food products and industries.
6. To apply the knowledge of sensory assessment methods in food industries.

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

C413.1	**Understand** the food quality aspects and need of food safety.
C413.2	**Apply and analyses** the quality assessment for perishable food products.
C413.3	**Apply and analyses** the quality assessment for nonperishable food products.
C413.4	**Understand** the various regulatory aspects for food business operators
C413.5	**Understand** the various voluntary standards for food processing industries.
C413.6	**Understand, apply and analyses** the sensory assessment for different food products.

Prerequisite	The students should have the knowledge of Food Quality & Safety Management

Contents	Hours
Introduction to food quality & Food safety management Food quality, its role in industry, Factors affecting quality control, Quality Attributes-Classification: Quality attributes, dominant attributes, hidden attributes	06
Methods of quality assessment of Perishable food material Sampling and specification of raw materials and finished products, Methods of quality assessment of food materials fruits, vegetables, dairy products, meat, poultry, egg and processed food products etc.	06
Methods of quality assessment of Non Perishable food material Methods of quality assessment of food materials Cereals, Bakery and confectionery,	06

Spices and plantation of Crop	
Regulatory system in food processing Food laws and standards: FSSAI, Concept of Codex Alimentations/ /USFDA Food Safety Modernization Act (FSMA)/, BIS standards, BRC standards , International Food Standard (IFS)	06
Voluntary standards Food Safety management system: ISO 22000, HACCP, PRP and OPRP: GMP, GLP. GAP, GHP, GDP, Global Food Safety Initiative (GFSI) and Global-Gap.	06
Sensory Evaluation Introduction -Panel Screening, Selection of Panel members, Requirements for conducting Sensory Evaluation and serving, Procedures, Methods of Sensory Evaluation, Instrumental analysis in quality control	06

Text Books:

1. Amerine, M.A. Pangborn, R.M., and Rosseler, E.B. 1965.
2. “Principles of Sensory Evaluation of Food”. Academic Press, New York. 2. Birk, G.G., Herman, J.G. and Parker, K.J. Ed. -1977.
3. “Sensory Properties of Foods”. Applied Science, London. 3. Charalambous, G. and Inglett, G. 1981.

Reference Books:

1. “The Quality of Foods and Beverages”. (2 vol.set). Academic Press, New York. 4. Furia, T.E. Ed. 1980.
2. “Regulatory Status of Direct Food Additives”. CRC Press, Florida. 5. Krammer, A. and Twigg, B.A. 1970. “
3. Quality Control for the Food Industry”. 3rd Edition. AVI, Westport. 6. Pattee, H.E. Ed. 1985.
4. “Evaluation of Quality of Fruits and Vegetables”. AVI, Westport.