DEPARTMENT OF CHEMICAL ENGINEERING

Course Book

B.Tech. in Chemical Engineering

(Admission of 2015-16 onwards)

Visvesvaraya National Institute of Technology, Nagpur

January 2016

General Information about the department:

The Chemical Engineering Department at VNIT is one of the youngest and premier engineering department of VNIT Nagpur. It has dynamic and goal oriented group of highly qualified and well experienced faculty with large and modern research and development infrastructure.

Objective of the program:

The Chemical Engineering Program at Visvesvaraya National Institute of Technology produces graduates with a basic understanding of chemical engineering principles along with problem solving, teamwork and communication skills necessary to succeed in diverse careers, including chemical engineering practice and academic research. The Programme has the following educational objectives:

- To prepare students for successful practice in diverse fields of chemical engineering such as pharmaceuticals, chemicals, polymers / advanced materials, energy, biotechnology and environmental engineering and in the fields of societal expectations on time.
- To prepare students for advanced studies in Chemical Engineering and its allied fields.
- To ensure our students are recognized for excellence and leadership and selected for high-ranking industrial, academic, government and other professional positions.
- To develop students' skills and awareness to become socially, ethically and morally responsible individual in all the challenges they take over in our communities and in the field of chemical engineering.

Credit Structure of the program:

The Department offers course at undergraduate level leading to 4 year B.Tech Degree with emphasis on theory and practice of Chemical Engineering to meet the current and future requirements of the country. This is 4 year (8 semester program) , wherein student has to complete certain number of credits as indicated in Table 1. Each subject (or course) has certain number of credits. There are four types of subjects:- Departmental core (DC), Departmental elective (DE), Humanity (HM) and Open course (OC).Core courses are compulsory and some courses from electives are to be taken to complete the required credits.

Table 1. CREDIT REQUIRMENTS FOR B.TECH. CHEMICAL ENGINEERING

Category	**Credit**
1st year credits	43
DC	81
DE	36-48
HM	0-6
OC	0-6
Total	**170**

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 lectures, 1 tutorial, and 0 practical in a week. This subject will have eight credits (3X2+1X1+0X1=8). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a grade. Each grade has got certain points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. The Semester Grade Point Average (SGPA) which is the grade point average for a semester and Cumulative Grade Point Average (CGPA) which is the grade point average for all the completed semesters at any point in time. SGPA & CGPA are:

$$SGPA = \frac{\sum_{Semester}(Course\ creditsXGrade\ points)_{for\ all\ courses\ except\ audit}}{\sum_{Semester}(Course\ credits)_{for\ all\ courses\ except\ audit}}$$

$$CGPA = \frac{\sum_{All\ Semester}(Course\ creditsXGrade\ points)_{for\ all\ courses\ with\ pass\ grade\ except\ audit}}{\sum_{All\ Semester}(Course\ credits)_{for\ all\ courses\ except\ audit}}$$

Students can Audit a few subjects i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Details of faculty members of Chemical Engineering Department:

S.N.	Name	Designation	Qualification	E-mail id
1.	Agrawal Shailesh G.	Assistant Prof.	Ph.D	sgagrawal28783@gmail.com
2.	Chaurasia Ashish S.	Associate Prof.	PhD	Ashishchaurasia1@yahoo.com
3.	Dhamole Pradip B.	Assistant Prof.	Ph.D	pradipdhamole@gmail.com
4.	Gaikwad Ashwin P.	Assistant Prof.	Ph.D	ashwin2781@gmail.com
5.	Kannan Ashwin	Assistant Prof.	Ph.D	ashwink1981@gmail.com
6.	Kodape Shyam M.	Assistant Prof.	Ph.D(Submitted)	samkodape@rediffmail.com
7.	Mandavgane Sachin A.	Associate Prof.	Ph.D	mandavgane@gmail.com
8.	Methekar Ravi N.	Assistant Prof.	Ph.D	methekar.vnit@gmail.com
9.	Rathod Ajit P.	Assistant Prof.	Ph.D	ajitprathod@gmail.com
10.	Ravikumar R.C.	Assistant Prof.	Ph.D	ravikumarc2006@gmail.com
11.	Shende Diwakar Z	Assistant Prof.	Ph.D	diwakar.shende@gmail.com
12.	Sonawane Shriram S.	Assistant Prof.	Ph.D	shriramsonawane@gmail.com
13.	Tajane(Hiwarkar) Sonali P.	Assistant Prof.	Ph.D(Submitting)	sonali_hiwarkar@rediffmail.com
14.	Varma Mahesh N.	Assistant Prof.	Ph.D	maheshnvarma@gmail.com
15.	Vijayakumar R. P.	Assistant Prof.	Ph.D	jbgvijayiitb@gmail.com
16.	Wanjari Piyush P.	Assistant Prof.	Ph.D	ppwanjari@gmail.com
17.	Wasewar Kailas L.	Associate Prof.	Ph.D	k_wasewar@rediffmail.com

Scheme of Instructions for B.Tech. Chemical Engineering: For all the B.Tech. programs, first two semesters are common. The details of these courses are mention in the first year B. Tech Course Book, available at the VNIT website. In the first two semesters, all the B.Tech. Students complete 43 credits from the courses of Basic Sciences (BS), Engineering Sciences (ES), and Humanities (HU).

SCHEME OF INSTRUCTION FOR B. TECH (CHEMICAL ENGINEERING) 2015-16 ONWARD

Code	Course	L-T-P	Cr	Code	Course	L-T-P	Cr
III Semester				**IV Semester**			
Core				**Core**			
CML201	Chemical Process Calculations	3-1-0	4	CML221	Mass Transfer I	3-1-0	4
CML202	Fluid Mechanics	3-1-0	4	CML222	Heat Transfer	3-1-0	4
CML203	Mechanical Operations	3-0-0	3	CML223	Chemical Reaction Engineering I	3-1-0	4
CML204	Chemical Engg. Thermodynamics I	3-0-0	3	CML224	Chemical Engg. Mathematics	3-0-0	3
CHL263	Organic Chemistry and Synthesis	3-0-0	3	CML225	Chemical Engg. Thermodynamics II	3-0-0	3
CMP204	Technical Analysis Laboratory	0-0-2	1	CMP202	Fluid Mechanics Laboratory	0-0-2	1
CHP263	Organic Chemistry and Synthesis Lab.	0-0-2	1	CMP203	Mechanical Operations Laboratory	0-0-2	1
Elective (Any one)				**Elective (Any one)**			
MAL205	Num. Methods & Prob. Theory	3-0-0	3	MAL205	Num. Methods & Prob. Theory	3-0-0	3
CML231	Materials Science and Engineering	3-0-0	3	CML233	Environmental Engineering	3-0-0	3
CML232	Introduction to Computing Software for Chemical Engineers	3-0-0	3	CML234	Industrial Waste Treatment	3-0-0	3
	OC /HM				OC /HM		
		Total	**22**			**Total**	**23**
V Semester				**VI Semester**			
Core				**Core**			
CML301	Mass Transfer II	3-0-0	3	CML351	Chemical Technology	3-0-0	3
CML302	Chem. Process Modeling and Simulation	3-0-0	3	CML352	Transport Phenomena	3-1-0	4
CML303	Process Control and Instrumentation	3-0-0	3	CML353	Chemical Process Equipment Design	3-0-0	3
CML304	Chemical Reaction Engineering II	3-0-0	3	CML354	Energy and Environment	3-0-0	3
CMP304	Chemical Reaction Engineering Laboratory	0-0-2	1	CMP302	Chemical Process Modeling and Simulation Laboratory	0-0-2	1
CMP322	Heat Transfer Laboratory	0-0-2	1	CMP303	Process Control and Instrumentation Laboratory	0-0-2	1
				CMP321	Mass Transfer Laboratory I	0-0-2	1
Elective (Any two)				**Elective (Any two)**			
CML383	Advance Heat Transfer	3-0-0	3	CML386	Biotechnology &Biochemical Engg.	3-0-0	3
CML384	Safety and Risk Analysis	3-0-0	3	CML387	Instrumental Analytical Techniques	3-0-0	3
CML385	New and Renewable Energy Engg.	3-0-0	3	CHL366	Polymer Engineering	3-0-0	3
				CHL369	Green Chemistry and Engineering	3-0-0	3
	OC /HM				OC /HM		
		Total	**20**			**Total**	**22**
VII Semester				**VIII Semester**			
Core				**Core**			
CML403	Plant Design and Economics	3-0-0	3	CMP403	Design Lab II	0-0-2	1
CMD404	Project Phase-I	--	2	CMD405	Project Phase-II	--	4
CMP401	Mass Transfer Laboratory II	0-0-2	1				
CMP453	Design Lab I	0-0-2	1				
Elective (Any Four Theory and One Practical)				**Elective (Any Five)**			
CML422	Plant Utility	3-0-0	3	CML430	Ore and Minerals Processing	3-0-0	3
CML423	Optimization Techniques	3-0-0	3	CML431	Entrepreneurship Development	3-0-0	3
CML424	Petroleum Refinery Engineering	3-0-0	3	CML432	Computational Transport Processes	3-0-0	3
CML425	Membrane Technology	3-0-0	3	CML433	Project Planning and Management	3-0-0	3
CML426	Polymer Processing	3-0-0	3	CML434	Computational Methods in Chemical Engineering	3-0-0	3
CML427	Advanced Separation Process	3-0-0	3				
CML428	CFD for Chemical Engineers	3-0-0	3	CML435	Computer Aided Design in Chem. Engg.	3-0-0	3
CML429	Nanotechnology	3-0-0	3				
CMP427	Separation Process	0-0-2	1				
CMP433	Environmental Engineering Lab.	0-0-2	1				
	OC /HM				OC /HM		
		Total	**20**			**Total**	**20**

List of the Core Subjects

Course Code	Name of Subject	Credits
CML201	Chemical Process Calculations	4
CML202	Fluid Mechanics	4
CML203	Mechanical Operations	3
CML204	Chemical Engineering Thermodynamics I	3
CMP204	Technical analysis laboratory	1
CHL263	Organic Chemistry and Synthesis	3
CHP263	Organic Chemistry and synthesis laboratory	1
CML221	Mass Transfer I	4
CML222	Heat Transfer	4
CML223	Chemical Reaction Engineering I	4
CML224	Chemical Engineering Mathematics	3
CML225	Chemical Engineering Thermodynamics II	3
CMP202	Fluid Mechanics Laboratory	1
CMP203	Mechanical Operations Laboratory	1
CML301	Mass Transfer II	3
CML302	Chemical Process Modeling and Simulation	3
CML303	Process Control and Instrumentation	3
CML304	Chemical Reaction Engineering II	3
CMP304	Chemical Reaction Engineering laboratory	1
CMP322	Heat Transfer Laboratory	1
CML351	Chemical Technology	3
CML352	Transport Phenomena	4
CML353	Chemical Process Equipment Design	3
CML354	Energy and Environment	3
CMP302	Chemical Process Modeling and simulation laboratory	1
CMP303	Process Control and Instrumentation laboratory	1
CMP321	Mass Transfer Laboratory I	1
CML403	Plant Design and Economics	3
CMP401	Mass Transfer Laboratory II	1
CMP453	Design Laboratory I	1
CMD404	Project Phase-I	2
CMP403	Design Laboratory II	1
CMD405	Project Phase-II	4

Electives Courses

Course Code	Name of Subject	Credits
MAL205	Num. Methods & Prob. Theory	3
CML231	Materials Science and Engineering	3
CML232	Introduction to Computing software for Chemical Engineers	3
CML233	Environmental Engineering	3
CML234	Industrial Waste Treatment	3
CML383	Advance Heat Transfer	3
CML384	Safety and Risk Analysis	3
CML385	New and Renewable Energy Engineering	3
CML386	Biotechnology and Biochemical Engineering	3
CML387	Instrumental Analytical Techniques	3
CML393	Innovative Design	3
CML394	Introduction to Measuring Instruments	3
CHL336	Polymer Engineering	3
CHL369	Green Chemistry and Engineering	3
CML422	Plant Utility	3
CML423	Optimization Techniques	3
CML424	Petroleum Refinery Engineering	3
CML425	Membrane Technology	3
CML426	Polymer Processing	3
CML427	Advanced Separation Process	3
CMP427	Separation Process	1
CML428	CFD for Chemical engineers	3
CML429	Nanotechnology	3
CMP429	Nanotechnology Lab	1
CML430	Ore and Minerals Processing	3
CMP434	Industrial Waste Treatment Laboratory	1
CMP433	Environmental Engineering Lab	1
CML431	Entrepreneurship Development	3
CML432	Computational Transport Processes	3
CML433	Project Planning and Management	3
CML434	Computational methods in Chemical Engineering	3
CML435	Computer Aided Design in Chemical Engineering	3

Course Code	Name of Subject	Credits
CML388	Pulp And Paper Technology	3
CML389	Chemical Informatics	3
CML390	Technology of Paints Pigments and Powder Coating	3
CML391	Surface Coating Engineering	3
CML392	Corrosion Engineering	3
CML436	Advanced Separation Tech.	3
CML438	Piping Engineering	3
CML439	Energy Management	3
CML440	Chemical Reactor Analysis	3
CML441	Process Intensification	3
CML442	Reliability Engineering	3
CMP266	Engineering Drawing and Graphics	1
CMP267	Computer Programming and Applications	1
MAL275	Numerical and Statistical Methods	3

Syllabus

CORE SUBJETCS

List of the Core Subjects

New Course Code	Name of Subject	Credits
CML201	Chemical Process Calculations	4
CML202	Fluid Mechanics	4
CML203	Mechanical Operations	3
CML204	Chemical Engineering Thermodynamics I	3
CMP204	Technical analysis laboratory	1
CHL263	Organic Chemistry and Synthesis	3
CHP263	Organic Chemistry and synthesis laboratory	1
CML221	Mass Transfer I	4
CML222	Heat Transfer	4
CML223	Chemical Reaction Engineering I	4
CML224	Chemical Engineering Mathematics	3
CML225	Chemical Engineering Thermodynamics II	3
CMP202	Fluid Mechanics Laboratory	1
CMP203	Mechanical Operations Laboratory	1
CML301	Mass Transfer II	3
CML302	Chemical Process Modeling and Simulation	3
CML303	Process Control and Instrumentation	3
CML304	Chemical Reaction Engineering II	3
CMP304	Chemical Reaction Engineering laboratory	1
CMP322	Heat Transfer Laboratory	1

CML351	Chemical Technology	3
CML352	Transport Phenomena	4
CML353	Chemical Process Equipment Design	3
CML354	Energy and Environment	3
CMP302	Chemical Process Modeling and simulation laboratory	1
CMP303	Process Control and Instrumentation laboratory	1
CMP321	Mass Transfer Laboratory I	1
CML403	Plant Design and Economics	3
CMP401	Mass Transfer Laboratory II	1
CMP453	Design Laboratory I	1
CMD404	Project Phase-I	2
CMP403	Design Laboratory II	1
CMD405	Project Phase-II	4

Department	**: Chemical Engineering**
Course No.	**: CML 201**
Course Title	**: Chemical Process Calculations**
Course Type	**: Core**
Course Credits	**: 3**

Course Description

Fundamental concepts, gas relationship, molarity, molality, normality, partial pressure, pure component volume and the related calculations.

Humidity and saturation and their applications fundamental concepts of material balance. Material balance in various unit processes and unit operations. Material balance with chemical reactions

Energy balance related to various process equipments. Calculation of standard heat of reaction from heat of formation and heat of combustion, thermo chemistry, energy balance in various unit operations, heat of solutions, heat of neutralization etc.

Fuels and combustion calculation, proximate and ultimate analysis, adiabatic reaction temperature, air to fuel ratio, complex processes calculation

Prerequisites and Co-requisites

Students are expected to have a good understanding of material and energy balance in different chemical processes and unit operations.

Course Objectives of Chemical Process Calculations:

1) To understand the fundamental concepts and calculations of process calculation.
2) To understand the material balance in various unit processes and unit operations.
3) To understand the energy balance related to various process equipments.
4) To understand the various heats and their calculations related to chemical reactions.
5) To understand the fuels and combustion calculation, proximate and ultimate analysis.

References:

1. Narayanan K V and Lakshmikutty B, Stoichiometry and Process Calculations, Prentice Hall of India Pvt Ltd, New Delhi 2006
2. Himmelblau D.M.; Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall of India Ltd.
3. Hougen O.A. and Watson K.M.; Chemical Process Principles, Part-I (Material and Energy Balances), CBSNew Delhi

Relationship of Course Objectives to Program Outcomes

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√		
2	√	√	√				√		
3	√	√	√				√		
4	√	√	√				√		
5	√	√	√			√	√		

Course Coordinator

CML 201

Department	**: Chemical Engineering**
Course Number	**: CML 202**
Course Title	**: Fluid Mechanics**
Course Type	**: Core**
Course Credits	**: 3**

Course Description

Properties of Fluid: Pressure, density, specific weight, viscosity, dynamic and kinemetic viscosity, Newton's law of viscosity and its applications.

Fluid Statics: Pascal's Law and Hydrostatic equation, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.– Forces on plane and curved surfaces

Fluid kinetics: Description of Fluid flow, Lagrangian and Eulerian approach One dimensional flow approximation, Types of fluid Flows: Steady and unsteady, Uniform and non-uniform, control volume concept, Reynolds transport theorem, Continuity equation, Velocity and acceleration of fluid particle, stream line, streak line, path line, velocity potential function,

Fluid Dynamics: Momentum theorem and its application. Euler's equation, Bernoulli's equation for incompressible fluid flow, Engineering applications of energy equation,

Pitot – static probe, Current meters,Venturimeter, Orificemeter, Rotameter, Nozzlemeter, Notches & weirs.

Flow Through Pipes: Critical Reynold's number, velocity distribution in pipes, friction factor, Moody's chart, Laminar flow through pipe, Hagen-Poiseulli's equation, Turbulent flow through pipe, Hydraulic gradient line and Total energy line. Minor head losses in pipes. Pipe Networking Transmission of power through pipe.

Flow Over Immersed Bodies: Drag and lift, Types of drag force, Drag on sphere, Cylinder and airfoil; Circulation and Lift on a cylinder and airfoil; Magnus effect

Boundary Layer Theory: Development of Boundary layer over flat plate and pipe, boundary layer thickness

Pumps: definition and classifications - Centrifugal pump: classifications, working principles, , specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps - rotary pumps: working principles of gear and vane pumps

Course Objectives of Fluid Mechanics:

1) To understand the fundamental properties, laws and their applications related to fluids.
2) To understand the fluid kinetics and fluid dynamics.
3) To understand the fluid flow through various sections.
4) To understand the flow over immersed bodies.
5) To understand the Boundary Layer Theory.
6) To understand the various types of pumps and their working principles.

References:

1.Munson BR, Young D F and Okiishi T H , ' Fundamentals of Fluid Mechnics', 5th Edition, John Wiley & Sons

1. Gupta Santosh & Gupta Vijay, 'Fluid Mechanics and its applications', New Age International Publishers.
2. Munson BR, Young D F and Okiishi T H , ' Fundamentals of Fluid Mechnics', 5th Edition, John Wiley & Sons
3. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill International Edition, 2005

Relationship of Course Objectives to Program Outcomes

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√		√	
2	√	√				√	√	√	
3	√	√				√	√	√	
4	√	√				√		√	
5	√	√						√	

Course Coordinator

CML202

Department	**: Chemical Engineering**
Course No.	**: CML203**
Course Title	**: Mechanical Operations**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

Understand Properties and characterization of particulate soilds and mechanical separation methods such as screening, filtration, sedimentation, transportation of solids, agitation etc and associated equipments used for achieving these methods.

II. Pre-requisites: None

III. Textbooks:

1. McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering McGraw Hill, New York 2001. 6th Edition

2. Chattopadhyay O.P., Unit Operations of Chemical Engineering, Vol. 1 & 2, Khanna Publications, New Delhi, 1996.

3. Coulson J. M. and Richardson J.F; Chemical Engineering Vol. 1& 2 Publishers: Butter worth – Heinemann Ltd. 2001-2002.

4. Christie J. GeanKoplis Transport processes & Unit Operation Prentice hall International

5. Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education

6. G.G. Brown Unit Operation John Willey

7. Hiremath R.S & Kulkarni A.P.,. Mechanical Operations Vol I Everest Publication

IV. Objectives:

1) To impart the basic concepts of mechanical operations
2) To develop understanding about size analysis, size reduction and solid handling
3) Understand mechanical separation methods such as filtration, sedimentation, transportation of solids etc and associated equipments used for achieving these methods
4) The students are exposed to basic theory, calculations and machinery involved in various solid handling operations

V. Outcomes:

Upon successful completion of this course Students will be able to solve different problems involving hydro-mechanical operations and expand their knowledge in this subject. Students will increase their proficiency in

oral and written communications. Students will have gained experience in working within a team of their colleagues.

VI. Expanded Course description:

1. *Properties of particulate solid and equipment for size reduction :*

Surface area distribution of powders, size reduction and separation, crushing, grinding equipments and their characteristics, open and close circuit grinding.

2. Size Analysis:

Particle size distribution, Screen analysis, mechanical classifiers classification.

3. *Filtration and centrifugal separation:*

Principles of filtration and theory, filtration equipments and their characteristics, pressure and vacuum filters, compressible and non compressible cake and their effect on filtration rate, centrifugal separation equipments and their principles of operation as well as the characteristics, optimum filtration cycle, membrane filtration.

4. Motion of particles through fluid:

Drag coefficient, free settling and hindered settling, gravity settlers, sedimentation theory and principle of operation. Batch and continuous thickeners as well as the design procedures, sedimenting centrifuges.

5. Agitation and mixing:

Introduction to agitation and mixing of solids and liquids fundamentals, mixing and agitation equipments and their operational characteristics, power consumption in mixing and agitation, different types of agitators and their selection criteria.

6. Handling of solids:

Storage and conveying of solids, bins, hoppers, silos and their operational characteristics, Loading and unloading of solids, different types of conveyors and elevators for solid materials. Dust collectors, cyclone separators, electrostatic precipitators, bag filters, operational characteristics of these and other similar dust separators. (4-Hr)

VII. Class Schedule : Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√	√					√	√	
3	√	√					√	√	
4	√	√				√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML203

Department	**: Chemical Engineering**
Course No.	**: CML 204**
Course Title	**: Chemical Engineering Thermodynamics I**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The course present thermodynamics from a chemical engineering viewpoint. Basic definitions and a development of thermodynamic laws and its application to non flow and simple steady-flow processes are stressed in this course.

II. Pre-requisites: None

III. Objectives:

Based on the concepts taught, Student shall be able to formulate and apply the laws of thermodynamics to solve the given problem on particular thermodynamic process accurately.

IV. Outcomes:

1. Describe the basic concepts (system, surrounding, point function, path function and different types of processes etc.,)
2. Formulate the relationship between different thermodynamic parameters for different processes.
3. Apply the thermodynamic laws to the given process and solve the problem.

V. Expanded Course description:

Basic concepts and definition: Classical and Statistical thermodynamics, system, boundary, surroundings, internal energy, work, heat, equilibrium, reversible process, intensive and extensive function, ideal gas temperature scale.

First law of thermodynamics for non-flow process, flow process, State and path function, Enthalpy, Heat capacity

PVT behavior of gases: Ideal gas, definition, ideal gas law, equation of state for real gases, graphical representation of P-V-T behavior, V-T diagram, P-V diagram and P-T diagram, Thermodynamic analysis of processes. Generalized correlations for thermodynamic property of gases, reduced equation of state, two parameter and three parameter correlations

Second law of thermodynamics: Spontaneous process, qualitative difference between heat and work, heat reservoir, heat pump, heat engine, Kelvin Plank statement, Clausius statement, irreversibility, entropy, Carnot principle, postulates, thermodynamic temperature scale, third law of thermodynamics.

Thermodynamic relations: Classification of thermodynamic processes, Helmholtz and Gibbs free energy, fundamental property relations, Maxwell's relations and their applications, Clausius-clapeyron equation, modified equations for U, H and S, relationship between Cp and Cv, ratio of heat capacity, effect of pressure and volume on Cp and Cv, Gibbs Helmholtz equations.

Applications of laws of thermodynamics: Refrigeration, choice of refrigerant, Carnot cycle, vapour compression cycle, air refrigeration, Heat pumps, Liquefaction processes, free expansion, isotropic

expansion, Steam power plant, Rankine cycle, Reheat and regenerative cycles. Internal combustion engines.
Introduction to ideal mixtures.

VI. Textbooks:

1. Smith J.M., Van Ness H. C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 2005.

2. Narayan K.V., a text book of chemical engineering thermodynamics, PHI, 2001.

VII. Reference Books:

1. Rao Y.V.C., Chemical Engineering Thermo dynamics, University press (India) Ltd.
2. P.K.Nag, Engineering thermodynamics, 3rd edition, Tata McGraw-Hill Education, 2005.

3. Bett K.E., Rowlinson J.S. and Saville G. Thermodynamics for Chemical Engineers,. MIT Press America.

4. Dadge B.F., Chemical Engineering Thermodynamics, McGraw Hill Co. 1944, New York.

5. Glasstone S., Thermodynamics for Chemists, Publisher: Read Books, 2007

VIII. Class Schedule

Three 55 minutes session per week

IX. Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program outcomes								
	a	b	c	d	e	f	g	h	i
1	✓			✓					
2	✓								
3	✓	✓					✓	✓	

X. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	20
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	50

XI. Chamber Consultation Hours

To be announced in the class.

XII. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 204

Department	**: Chemical Engineering**
Course No.	**: CMP 204**
Course Title	**: Technical Analysis Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

The course covers the hands on experience on most of the basic analysis used in the process industries.

II. Pre-requisites: -

III. Objectives:

Based on the concepts taught, Student shall be able to apply the basic principles to estimate and analyse industrially important materials.

IV. Outcomes:

4. Describe the basic concepts
5. Analyze the given sample.

V. Expanded Course description:

1	**Gravimetric analysis of a phosphorus-containing fertilizer** To determine the percent phosphorous in a sample of fertilizer using Lab-Gravimetric analysis.
2	**Depression of freezing point** Study of depression of freezing point of solution.
3	**Dissolution characteristics of anatacid tablets** To determine the dissolution time of antacid tablets under different conditions To determine the effectiveness of tablet in terms of acid neutralization
4	**Determination of Saponification value of oil** To Determine the saponification value of oil/fat.
5	**Determination of Chlorine content in bleaching powder** To determination the percentage of available chlorine present in bleaching powder.

6	**Identification of plastics by simple method** To identify the given plastic samples by simple methods.
7	**Sugar analysis using Benedict's reagent** To determine (semi-quantitatively) concentration of reducing sugar in an unknown sample
8	**Synthesis of Biodiesel from Vegetable Oil** To synthesis biodiesel from vegetable oil and determine its physical properties.
9	**Estimation of silica content (analysis of ordinary portland cement** To estimate the silica content (analysis of ordinary portland cement (opc))

.

VI. Textbooks:

Puri, Sharma and Pathania, Principles of Physical chemistry, Vishal Publications, Jalandhar, 1998.

VII. Reference Books:

Books related to specific experiment as mentioned in the lab manual

VIII. Class Schedule

Three 2 hours session per week

IX. Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program outcomes								
	a	b	c	d	e	f	g	h	i
1	✓		✓	✓					
2	✓		✓			✓			

Program Outcomes for Chemical Engineering at VNIT:

a. An ability to identify, formulates, and solves engineering problems

b. An ability to design a system, component, or process to meet desired needs

c. An ability to design and conduct experiments, as well as to analyze and interpret data

d. An ability to communicate effectively

e. An understanding of professional and ethical responsibility

f. An ability to function on multidisciplinary teams

g. The broad education necessary to understand the impact of engineering solutions in a global and societal context

h. A recognition of the need for, and an ability to engage in lifelong learning

i. A knowledge of contemporary issues

X. Evaluation of students

Component	**Duration**	**Weightage**
Practical performance & Record submission	2hour per session	50
Quiz	15 min	10
End Semester Exam	30min	30
Viva	10min	10

XI. Chamber Consultation Hours

To be announced in the class.

XII. Notice

Notice will be displayed on CHE 104 Notice Board.

Course Coordinator

CMP 204

Department	**: Chemical Engineering**
Course No.	**: CHL263**
Course Title	**: Organic Chemistry & Synthesis**
Course Type	**: Core**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand the basic organic reaction like oxidation, amination, alkylation, nitration, polymerization and its application to chemical engineering

Syllabus: Oxidation: Intoduction, definition, types of oxidation, oxidising agents and their properties viz. permanganate, dichromate, sodium chlorite, chlorine dioxide, peroxides like PbO_2, MnO_2, H_2O_2 oxidation reactions, liquid and vapour phase oxidation, kinetics and thermochemistry of such reactions.

Amination by Amminolysis: General introduction including aminating agents, their properties and survey of aminating reaction, physical and chemical factors affecting these processes, catalysts used in various amination and amminolysis reactions and their brief kinetic and thermodynamic study.

Amination by reduction: General Introduction, definition, chemical reactions in iron and acid (Bechamp) other metals and acid reduction, metal and alkali reduction, sulphide reduction.

Alkylation: General Introduction, alkylating agents, Factors affecting alkylation:Catalyst, Concentration, Pressure, Temperature, Mechanism, Effect of alkylation.

Nitration: Introduction, nitrating agents, aromatic nitration, thermal properties and process equipment nitrators.**Halogenation:** Introduction, kinetics and thermodynamics of such reactions Manufacturing processes for selected industrially important organic chemicals, design and construction of equipment for halogenation, apparatus for photochlorinator.

Polymerization: Introduction to Polymerization, polymerization processes, polymerization techniques, copolymerization, manufacturing processes for various industrially important polymers.

References:

1. Jagdamba singh and LDS Yadav ; Advanced Organic Chemistry Vol I &II; Pragati Prakashan

2. Morrison and Byod , Organic Chemistry ,6th edition ;Prentice Hall,Inc

3. Groggins P. H.; Units Processes In Organic Synthesis, Tata McGraw Hills Book Co.

4. F. A. *Cotton, G.* Wilkinson.;Advanced *organic chemistry* ,Interscience publishers, 1967.

Class Schedule : Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√	√					√	√	
3	√	√					√	√	
4	√	√				√	√	√	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML263

Department	**: Chemical Engineering**
Course No.	**: CHP263**
Course Title	**: Organic Chemistry & Synthesis**
Course Type	**: Core**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to perform and understand the basic experimentation related to organic chemistry and its application to chemical engineering

Syllabus: Quantitative determination of the following functional groups: (1) Acid, (2) Phenol, (3) Nitro, (4) Amino, (5) Ester, (6) Hydroxy, (7) Aldehyde.

Organic Preparations and purification through activated charcoal treatment/ crystallization (Single/ two step)of the following; (1) Acetanilide, (2) p-Nitro-Acetanilide, (3) p- Bromo-Acetanilide, (4) Aspirin,(5) m-Dinitrobenzene, (6) Oxalic Acid.

Esterification reaction.

Sulfonation reactions.

Class Schedule

Three 2 hours session per week

Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program outcomes								
	a	b	c	d	e	f	g	h	i
1	✓		✓	✓					
2	✓		✓			✓			

Evaluation of students

Component	**Duration**	**Weightage**
Practical performance & Record submission	2hour per session	50
Quiz	15 min	10
End Semester Exam	30min	30

Viva	10min	10

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Notice Board.

Course Coordinator

CHP 263

Department	**: Chemical Engineering**
Course No.	**: CML221**
Course Title	**: Mass Transfer I**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML 221 Mass Transfer-I covers the fundamentals and basic concepts of separation and purification of mass through its transfer from one phase to the other. Further, it gives learning and understanding skills towards the problems related to separation & purification and in tern the approach to solve it by applying the concepts/principles learned in the curriculum.

II. Pre-requisites: CML201-Chemical Process Calculations

III. Textbooks:

1. Mass Transfer Operations, Treybal R.E., McGraw Hill Book Co., New York 1980, 3rd Edition
2. Chemical Engineering Vol. I, II & III, Coulson J.M. and Richardson J.F., Pergamon Press, New York 1977
3. Unit Operations of Chemical Engineering, McCabe W.L. and Smith J.C. & Harriot, McGraw Hill Book Co., New York 1980, 5th Edition
4. Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI Learning Pvt. Ltd., New Delhi, Eastern Economy Edition
5. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Book Co.

IV. Objectives:

The objective of this course is to introduce the basic principles of mass transfer and how to quantify, formulate, and solve engineering problems involving different mass transfer operations like diffusion, humidification & dehumidification, drying, crystallization and adsorption. To demonstrate that how to apply mass balances and its transfer and analyze systems

V. Outcomes:

Students will comprehend to Fick's law of diffusion, the principles of diffusion, driving force, different theories of Mass Transfer and the analogies. They will understand the through details including problem solving approach and the applications of theory learnt in industrial practices regarding the mass transfer operations like diffusion, humidification & dehumidification, drying, crystallization and adsorption.

VI. Expanded Course description:

Introduction to mass transfer operations, Diffusion in gases and liquids, steady state and unsteady state operations, diffusion mass transfer, individual and overall mass transfer coefficients concept.

Theories of mass transfer, analogies and Interphase mass transfer process; simultaneous heat and mass transfer processes.

Drying: Constant rate and falling rate periods, equilibrium moisture contents, drying equipments, rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers, dryer calculations and dryer selection criteria.

Crystallization: Theory of Crystallization, saturation, supersaturation, nucleation and crystal growth, various equipments for crystallization, their operational and design characteristics.

Adsorption: Adsorption isotherms, adsorption agents, equipments for adsorption, pressure swing adsorption technology, adsorption phenomena

Humidification and dehumidification, equipment's operational characteristics, design procedures and selection criteria along with mass transfer calculations, Types of cooling towers, cooling tower operational characteristics.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses to Program Outcomes				Program Outcomes								
Type	Credit	Course No	Course Titles	a	b	c	d	e	f	g	h	i
T	3	CML221	Mass Transfer-I									

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator
CML221

Department	**: Chemical Engineering**
Course No.	**: CML222**
Course Title	**: Heat Transfer**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML222 Heat transfer covers fundamental principles of the three basic modes of heat transmission namely conduction convection and radiation. It also covers boiling, condensation and how to identify, formulate, and solve engineering problems involving conduction, convection, radiation.

II. Pre-requisites:

Maths, Thermodynamics, Fluid Mechanics

III. Textbooks:

1. Hollman J.P.; Heat Transfer, McGraw Hill, 1993
2. Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd.,2008
3. Cengel Y.A. Heat Transfer: A Practical Approach McGraw-Hill; 2 edition ,2002
4. Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.
5. Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.
6. Dutta B.K. Heat Transfer; Principles and Applications PHI Pvt.Ltd New Delhi ,2006

IV. Objectives:

The objective of this course is to introduce the basic principles of heat transmission by conduction, convection, and radiation, how to identify, formulate, and solve engineering problems involving conduction, convection, and radiation, and how to apply energy balances and rate equations to model and analyze thermal systems.

V. Outcomes:

Students will comprehend Fourier's law of heat conduction, Newton's law of cooling, and the Stefan-Boltzmann law of radiation heating , recognize the relationship between thermo-physical properties and heat transfer, comprehend the role and importance of boundary layers and dimensional analysis to convective heat transfer, can solve one dimensional steady-state or transient heat conduction problems, can use empirical correlations to solve forced and free convection heat transfer for internal and external flows, for condensation and boiling, for heat exchangers, can predict heat transfer by radiation from ideal and actual surfaces and enclosures, can use appropriate analytical or numerical solution techniques to find temperature distributions and heat flows in thermal systems.

VI. Expanded Course description:

Basic modes of heat transfer, Fourier's law, thermal conductivity, steady state heat conduction through a plane, composite wall, cylinder, sphere, heat generation inside solids, unsteady state heat conduction, types of thermal insulation, critical thickness and optimum thickness of insulation, extended surfaces, fin performance evaluation, effectiveness of fins.

Free and forced convection inside and outside the tubes as well as over the plates, individual and overall heat transfer coefficients. Heat transfer in laminar flow and turbulent flow, dimensional analysis, dimensionless numbers in heat transfer, heat transfer correlations for natural convection.

Condensation and Boiling, Condensation over flat plate, condensation inside and outside the tubes in horizontal, vertical and inclined position, film condensation, dropwise condensing. Estimation of film coefficient of heat transfer for condensing vapours turbulence in condensing film. Heat Transfer to boiling liquids, pool boiling and forced convection boiling, boiling curve and its characteristics.

Radiation heat transfer, laws of radiation, concepts of black body, gray body, green house effect, emissive power, heat flux by radiation, view factors, radiation shield, luminous and non luminous gases, heat exchangers, heat transfer fluids.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses to Program Outcomes				Program Outcomes								
Type	Credit	Course No	Course Titles	a	b	c	d	e	f	g	h	i
P	3	CML222	Heat Transfer									

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CML222

Department	**: Chemical Engineering**
Course No.	**: CML 223**
Course Title	**: Chemical Reaction Engineering I**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

Intensive coverage of reaction kinetics, temperature pressure effects on reaction.
Various reactor types, their performances and how they affect conversion for a given reaction are stressed in this course.

II. Pre-requisites: None

III. Textbooks:

a. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 3rd edition, 1998.
b. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 4th edition, 2006.
c. Chemical Reactor Analysis, G. F. Froment and K. B. Bischoff, John Wiley & Sons, Singapore, 2nd edition, 1990.
d. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 3rd edition, 1981.

IV. Objectives:

1. Provide students with a basic understanding of reaction engineering, type of reactions, reaction kinetics.
2. Enhance their knowledge on types of reactors, working of reactors and different types of arrangements of reactors
3. Improve the student's ability in deciding type of reactor and their arrangement relating with a given conversion keeping economy in point of view

V. Outcomes:

At the end of the course, the student will understand the reaction kinetics, type and sequential arrangement of the reactors to be used, reaction mechanism and reaction path of a given chemical reaction

VI. Expanded Course description:

1. Introduction to Chemical Reaction Engineering: What is chemical reaction engineering?, Role of Chemical Reaction Engineering in Process Industry, Classification of reaction based on various terms, Reaction rate, Chemical kinetics, Variables affecting rate of reaction, Speed of reactions, Problems.
2. Kinetics of Homogeneous Reactions: Concentration dependent term and temperature dependent terms of rate equation, Single and multiple reactions, Elementary and non-elementary reactions, Molecularity and order of reaction, Rate constant, Representation of reaction rate, Kinetic models, Temperature dependency from Arrhenius' law, thermodynamics, various theories, Activation energy, Problems.

3. Interpretation of Batch Reactor Data: Constant volume batch reactor, Variable volume batch reactor, Integral method and differential method of analysis of kinetic data, other methods of analysis of kinetic data, Temperature and reaction rate, Problems.
4. Introduction To Reactor Design: Types of reactors, PFR, CSTR etc., Material & energy balances single ideal reactor, Space-time and space-velocity, Holding time, Introduction of non-ideal flow, Problems
   Ideal Reactors for a Single Reaction: Ideal Batch Reactor, Steady State Mixed Flow Reactor, Steady State Plug Flow Reactor, Problems
5. Design for Single Reactions: Size comparison of single reactors, General graphical comparison, Multiple reactor system, Recycle reactor, Autocatalytic reactions, Problems.
6. Design for Parallel Reactions: Introduction to design of parallel reactions, Qualitative and Quantitative discussion on product distribution, Contacting patterns, Reactor Size and arrangement, Selectivity, Yield, Problems.
7. Potpourri of Multiple Reactions: Reversible first order reaction, First order followed by zero order reaction, Zero order followed by first order reaction, Successive reversible reactions of different orders, reversible reactions, Irreversible series-parallel reactions, Graphical representation, Denbigh reactions and their special cases, Problems.
8. Temperature and Pressure Effects: Single and multiple reactions, Heats of reaction from thermodynamics, Equilibrium constant, Temperature, Graphical design procedure, Optimum Temperature Progression, Heat Effects, Adiabatic and non-adiabatic operations, Problems.

VII. Class Schedule

Three 55 minutes session per week

VIII. Relationship of Course Objectives to Program Outcomes:

Course objectives	Program outcomes								
	a	b	c	d	e	f	g	h	i
1	✓					✓		✓	
2	✓					✓		✓	
3	✓	✓				✓		✓	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 223

Department	**: Chemical Engineering**
Course Code	**: CML224**
Course Title	**: Chemical Engineering Mathematics**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The course covers the fundamentals of linear and non-linear algebraic equations, ordinary differential equations, discretization techniques, and optimization problems. These techniques can be applied for solving practical problems in reaction engineering, fluid flow and heat transfer.

II. Pre-requisites: None

II. Objectives:

The students are expected to clearly understand the role of fundamental tools such as linear algebraic equation, non-linear algebraic equation, ordinary differential equation and optimization in chemical engineering.

III. Outcomes:

1. Able to solve linear algebraic equations.
2. Able to solve non-linear algebraic equations.
3. Able to solve ordinary differential equations.
4. Able to formulate the problem and apply discretisation techniques.
5. Able to formulate and solve optimization problems.

IV. Expanded Course description:

Solving Linear Algebraic Equations

System of linear algebraic equations, Classification of solution approaches as direct and iterative: Gaussian elimination method, Introduction to methods for solving sparse linear systems: Thomas algorithm or tridiagonal matrix algorithm, Iterative methods: Derivation of Jacobi, Gauss-Siedel and successive over relaxation methods, System of linear equation using eigen values and eigen vector.

Solving Nonlinear Algebraic Equations

Method of successive substitutions derivative free iterative solution approaches, Secant method, regula falsi method and Wegsteine iterations, Modified Newton's method and qausi Newton method with Broyden's update, Optimization based formulations and Leverberg Marquardt method.

Solving Ordinary Differential Equations – Initial Value Problems (ODE-IVPs)

Analytical Solutions of Linear ODE-IVPs, Basic concepts in numerical solutions of ODE-IVP: step size and marching, concept of implicit and explicit methods, Taylor series based and Runge-Kutta methods: derivation and examples, Multi-step (predictor-corrector) approaches: derivations and examples, Introduction to solution methods for differential algebraic equations (DAEs), Single shooting method for solving ODE-BVPs, multiple ordinary differential equation.

Problem Discretization Using Approximation Theory

Finite difference method for solving ODE-BVPs with examples, Finite difference method for solving PDEs with examples, Orthogonal Collocations method for solving ODE-BVPs with examples, Orthogonal Collocations method for solving PDEs with examples, Model Parameter Estimation using linear least squares method, Gauss Newton Method, Curve fitting and regression.

Optimization

Basic concept of optimization and formulation, Nature of optimization problem (constraint and unconstraint), Linear programming by simplex method, Application of optimization based on simplex method.

V. Textbooks:

1. Gupta, S. K.; Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1995.
2. Pushpavanam, S,; Mathematical Methods in Chemical Engineering. Prentice Hall India, New Delhi, 2005.
3. Thomas F and Himmelblau D M; Optimization of Chemical Processes, McGraw Hill, 2001.

VI. Reference Books:

1. P. S. Ghoshdastidar, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st Edition, 1998.
2. Gourdin, A. and M Boumhrat; Applied Numerical Methods. Prentice Hall India, New Delhi, 2000.
3. Canale R P and Chapra S C, Numerical Methods for Engineers with Software and Programming Application, McGraw Hill, 2006.

VII. Class Schedule

Three hours per week.

VIII. Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program Outcomes (PO)								
	a.	**b.**	**c.**	**d.**	**e.**	**f.**	**g.**	**h.**	**i.**
1.	√								
2.	√								
3.	√								
4.	√								

Program Outcomes for Chemical Engineering at VNIT:

a. An ability to identify, formulates, and solves engineering problems
b. An ability to design a system, component, or process to meet desired needs
c. An ability to design and conduct experiments, as well as to analyze and interpret data
d. An ability to communicate effectively
e. An understanding of professional and ethical responsibility
f. An ability to function on multidisciplinary teams
g. The broad education necessary to understand the impact of engineering solutions in a global and societal context
h. A recognition of the need for, and an ability to engage in lifelong learning
i. A knowledge of contemporary issues

IX. Evaluation of students

Component	Duration	Weightage

Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	15
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML224

Department	**: Chemical Engineering**
Course No.	**: CML 225**
Course Title	**: Chemical Engineering Thermodynamics II**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The course present thermodynamics from a chemical engineering viewpoint. Thermodynamic properties, Concepts of phase and chemical equilibria and its application and basics of electrochemistry are stressed in this course.

II. Pre-requisites: CML 265 : Chemical Engineering Thermodynamics - I

III. Objectives:

Based on the concepts taught, Student shall be able to apply the concepts of thermodynamics to solve the given problem on thermodynamic process accurately.

IV. Outcomes:

6. Describe the basic concepts (Thermodynamic properties like free energy, activity, fugacity etc.,)
7. Solve the problems on phase equilibrium.
8. Apply the concepts of chemical equilibrium and solve the problem.

V. Expanded Course description:

Thermodynamic properties of pure substances: fugacity, fugacity coefficient, compressibility factor, activity.

Solution thermodynamics: Ideal and non-ideal gas mixtures and liquid solutions, partial molar properties, physical significance and determination methods, chemical potential.

Gibbs-Duhem equation: general form, various forms of Gibbs-Duhem equation, applications, limitations; Property changes of mixing, excess properties. Criteria of phase equilibrium, Duhemtheorem. Vapour liquid equilibrium, VLE equation, low pressure VLE, Phase diagrams for binary solution, T-x-y and P-x-y diagrams. Effect of pressure on VLE. Azeotropes and its types.

Activity coefficient; equations used for the determination, Margules, van Laar, Wilson equations, VLE at high pressures, bubble point, dew point calculations, Thermodynamic consistency tests for VLE data.

Chemical reaction equilibrium; criteria of equilibrium, Reaction stoichiometry, equilibrium constant, Gibbs free energy change, choice of standard state, feasibility of chemical reactions, effect of temperature on equilibrium constant, evaluation of van't Hoff constant, Effect of parameters like temperature, pressure, composition on the equilibrium conversion.

VI. Textbooks:

1. Smith J.M., Van Ness H. C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 2005.

2. Narayan K.V., a text book of chemical engineering thermodynamics, PHI, 2001.

VII. Reference Books:

1. S.Sandler, Chemical, biochemical and engineering thermodynamics, 4th edition, John Wiley, 2006.

2. Rao Y.V.C., Chemical Engineering Thermo dynamics, University press (INDIA) Ltd.

3. Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960

VIII. Class Schedule

Three 55 minutes session per week

IX. Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program outcomes								
	a	b	c	d	e	f	g	h	i
1	✓			✓					
2	✓	✓					✓		
3	✓	✓					✓		

Program Outcomes for Chemical Engineering at VNIT:

a. An ability to identify, formulates, and solves engineering problems

b. An ability to design a system, component, or process to meet desired needs

c. An ability to design and conduct experiments, as well as to analyze and interpret data

d. An ability to communicate effectively

e. An understanding of professional and ethical responsibility

f. An ability to function on multidisciplinary teams

g. The broad education necessary to understand the impact of engineering solutions in a global and societal context

h. A recognition of the need for, and an ability to engage in lifelong learning

i. A knowledge of contemporary issues

X. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	20
Session 2 Exam	1 hour	20

Class tests and Assignments	-	10
End Semester Exam	3 hours	50

XI. Chamber Consultation Hours

To be announced in the class.

XII. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 225

Department	**: Chemical Engineering**
Course No.	**: CMP202**
Course Title	**: Fluid Mechanics Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description: The course covers the Hands on experience of working by conducting experiments on most of the basic unit operations like orifice meter, venturimeter, flow through notches, friction in pipe , filtration equipment, etc.

II. Pre-requisites: none

III. Textbooks:

1. McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering McGraw Hill, New York 2001. 6th Edition
2. Chattopadhyay O.P., Unit Operations of Chemical Engineering, Vol. 1 & 2, Khanna Publications, New Delhi, 1996.
3. Coulson J. M. and Richardson J.F; Chemical Engineering Vol. 1& 2 Publishers: Butter worth – Heinemann Ltd. 2001-2002.
4. Christie J. GeanKoplis Transport processes & Unit Operation Prentice hall International
5. Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education
6. G.G. Brown Unit Operation John Willey
7. Hiremath R.S & Kulkarni A.P., Mechanical Operations Vol I Everest Publication

IV. Objectives:

1. To understand importance of various mechanical operations used in process industry.
2. To apply principles of basic sciences and chemical engineering for designing various size reduction, size separation and conveying equipments.
3. To experience of handling different unit operations

V. Outcomes:

At the end of the laboratory course students will be able to apply the principles of unit operations through experimentation and will demonstrate the ability to understand the various equipments used in chemical and allied process industry-

VI. Expanded Course description:

(Any ten practical out of list were conducted by student)

Expt. No.	***Details***
1	***Hydraulic Classifier***
	To separate different size range of solid particles
2	***Batch Sedimentation***
	To study the batch setting & based on that design of Thickener for given under-sludge concentration
3	***Stokes law***
	To study C_D vs Nre nature of steel ball in different fluids
4	***Sieve Analyser***
	To determine the average diameter of a different size solid particle mixture
5	***Jaw Crusher***
	To verify laws of crushing.
6	***Ball Mill***
	To verify laws of crushing.
7	***Cyclone Separator***
	To study the separation of solid fine dust particle from air.
8	***Centrifuge***
	To study the separation of sludge by using centrifugal force
9	***Magnetic Separator***
	To find out the efficiency of magnetic separator
10	***Rotary Vaccum Drum Filter***
	To study the working of continuous Rotary Vaccum Drum Filter
11	***Orifice Meter***
	To determine discharge coefficient C_d
12	***Venturi Meter***
	To determine discharge coefficient C_d
13	***Pitot Tube***

	To determine discharge coefficient C_d & determine point velocity.

VII. Class Schedule : Three 2 hour session per week

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√	√	
2	√	√				√	√	√	
3	√					√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Practical performance	2hour per session	50
Record submission	15 min	10
Sliptest –I & II	30min	30
End Semester Exam	10min	10
viva		

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CMP202

Department	**: Chemical Engineering**
Course No.	**: CMP203**
Course Title	**: Mechanical Operation lab** **Course Type : Core**
Course Credits	**: 1**

I. Course description:

The course covers the hands on experience of working by conducting experiments on most of the basic unit operations like hydraulic classifier, sedimentation , ball mill, jaw crusher , cyclone separator , filtration equipment , sieve analysis etc.

II. Pre-requisites: Mechanical Operation CML 203

III. Textbooks:

1. McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering McGraw Hill, New York 2001. 6th Edition

2. Chattopadhyay O.P., Unit Operations of Chemical Engineering, Vol. 1 & 2, Khanna Publications, New Delhi, 1996.

3. Coulson J. M. and Richardson J.F; Chemical Engineering Vol. 1& 2 Publishers: Butter worth – Heinemann Ltd. 2001-2002.

4. Christie J. GeanKoplis Transpor processes & Unit Operation Prentice hall nternational

5. Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education

6. G.G. Brown Unit Operation John Willey

7. Hiremath R.S & Kulkarni A.P.,. Mechanical Operations Vol I Everest Publication

IV. Objectives: To understand importance of various mechanical operations used in process industry. To apply principles of basic sciences and chemical engineering for designing various size reduction, size separation and conveying equipments

V. Outcomes: At the end of the laboratory course students will be able

1. To apply the principles of unit operations through experimentation and

2. To demonstrate the ability to understand the various equipments used in chemical and allied process industry-

VI. Expanded Course description:

1	**Hydraulic Classifier** To separate different size range of solid particles.
2	**Batch Sedimentation** To study the batch setting & design of Thickener for given under-sludge concentration.

3	**Stokes law** To study C_D vs N_Re graph of steel ball in different fluids
4	**Sieve Analyser** To determine the average diameter of a different size solid particle mixture
5	**Jaw Crusher** To verify laws of crushing.
6	**Ball Mill** To verify laws of crushing.
7	**Cyclone Separator** To study the separation of fine solid dust particle from air.
8	**Centrifuge** To study the separation of sludge by applying centrifugal force.
9	**Magnetic Separator** To find out the efficiency of magnetic separator.
10	**Rotary Vaccum Drum Filter** To study the working of continuous Rotary Vaccum Drum Filter.
11	**Leaf Filter** To find out the rate of Filtration & resistance offered by cake & filter media.

Course Out come	Programme outcomes

12	**Vibrating Screen** To find out the Effectiveness of Triple deck Vibrating Screen
13	**Sampling methods** To study different sampling method to determine the average diameter of particle.
14	**Plate & Frame Filter Press** To study batch filtration in Plate & Frame Filter Press.

(Any ten practical out of above were conducted by student)

VII. Class Schedule Three 2 hour session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

	a	b	c	d	e	f	g	h	i
1	√		√			√			
2	√		√			√			

IX. Evaluation of students

Component	**Duration**	**Weightage**
Practical performance & Record submission	2hour per session	50
Sliptest –I	15 min	10
End Semester Exam	30min	30
viva	10min	10

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CMP203

Department	**: Chemical Engineering**
Course No.	**: CML301**
Course Title	**: Mass Transfer II**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML 301 Mass Transfer-II covers the fundamentals and basic concepts of separation and purification of mass through its transfer from one phase to the other. Further, it

gives learning and understanding skills towards the problems related to separation & purification and in tern the approach to solve it by applying the concepts/principles learned in the curriculum.

II. Pre-requisites: CML201-Chemical Process Calculations

III. Textbooks:

1. Mass Transfer Operations, Treybal R.E., McGraw Hill Book Co., New York 1980, 3rd Edition
2. Chemical Engineering Vol. I, II & III, Coulson J.M. and Richardson J.F., Pergamon Press, New York 1977
3. Unit Operations of Chemical Engineering, McCabe W.L. and Smith J.C. & Harriot, McGraw Hill Book Co., New York 1980, 5th Edition
4. Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI Learning Pvt. Ltd., New Delhi, Eastern Economy Edition
5. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Book Co.

IV. Objectives:

To provide students the basic learning and understanding skills towards the problems related to separation & purification and in turn the approach to solve it by applying the concepts/principles learned in the curriculum and to increase the student's ability to apply the principles for the design of Mass Transfer Equipments and their application in process industries.

V. Outcomes:

At the end of the course, the student will understand the Mass Transfer-II principles. The students will be able to the basic principles of Mass Transfer and to apply it for the design of Mass Transfer equipments needed in process industries.

VI. Expanded Course description:

Distillation: Vapour – liquid equilibria, Raoult's law, X-Y and H-X-Y diagrams, differential distillation and equilibrium distillation, steam distillation, azeotropic distillation, extractive distillation.

Fractionation, binary distillation, plate and packed columns for distillation, analytical and graphical methods for estimation of number of stages required in distillation column, minimum reflux ratio, optimum reflux ratio, number of stages at optimum reflux, murphree plate efficiency and overall plate efficiency, effect of feed conditions on number of plates for separation.

Concept of HETP, HTU, NTU in distillation, plate and packed columns, packings for packed columns, pressure drop in plate and packed columns, bubble cap, sieve tray, valve tray plate columns.

Absorption Equilibrium relationships, two film theory, penetration theory, surface renewal rate theory, concept of driving force and mass transfer coefficient, plate column and packed columns for absorption, selection of solvent for absorption and absorbers design procedures.

Liquid – Liquid Extraction fundamentals, selection of solvent for extraction, estimation of mass transfer coefficients, triangular diagram representation, equipments for liquid – liquid extraction, plate and packed columns, spray columns, rotary disc contactors, design procedures and equipment selection criteria. Single stage, multistage operations etc.

Solid – Liquid Extraction fundamentals, Solvent selection, equilibrium relationship, triangular diagram representation, single stage, multistage concurrent and counter current operation, equipments for solid – liquid extraction, their design procedure and selection criteria.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses to Program Outcomes				Program Outcomes								
Type	Credit	Course No	Course Titles	a	b	c	d	e	f	g	h	i
T	6	CML361	Mass Transfer-II									

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator
CML301

Department	**: Chemical Engineering**
Course No.	**: CML 302**
Course Title	**: Chemical Process Modeling and Simulation**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML 302 Chemical Process Modelling and Simulation covers fundamental Laws, principles and uses as well as formulation of mathematical model. It also covers various mathematical models related to chemical engineering systems. The subject covers practical knowledge of simulation examples of core chemical engineering systems formulated by FORTRAN

II. Pre-requisites:

Maths, Thermodynamics, Heat Transfer, Mass Transfer, CRE, Fluid Mechanics

III. Textbooks

1. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering ,Tata-McGraw-Hill, New Delhi, 2002.
2. Jensen V.G., Jeffrey's G.V., Mathematical Methods in Chemical Engineering", 2nd Ed. Academic Press, London, 1978.
3. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill,New York, 1989.
4. A. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication
5. Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd., 2008

IV. Objectives:

1) To understand knowledge of fundamental principles and basic laws of modeling
2) To understand the approach for mass/heat transfer & CRE
3) To apply the knowledge of differential equations
4) To understand the approach for modeling
5) Formulation of mathematical model for various chemical Engg. system

V. Outcomes:

Students are able to model every Chemical Engg. System given to them. Moreover they could make program of the model equation to get output results, and analyzed the performance of the system

VI. Expanded Course description:

INTRODUCTION TO PROCESS MODELING AND SIMULATION

MATHEMATICAL MODELING OF CHEMICAL ENGINEERING SYSTEM Principle of formulations, Mathematical consistency of model, Continuity equations, Componentcontinuity equations, Energy equations, Equations of motion, Transport equations, Equilibrium, Chemical Kinetics with examples.

MODELING OF CHEMICAL KINETICS AND REACTOR DESIGN

Modeling for different reaction scheme

Introduction to Reactor Design Fundamentals

for Ideal Systems

Introduction

A General Approach

Ideal Isothermal Reactors

Numerical Methods for Reactor Systems Design

Reversible Series Reactions

The Semibatch Reactor

Continuous Flow Stirred Tank Reactor (CFSTR)

Multi-Stage Continuous Flow Stirred Tank Reactor

Equal Size CFSTR In Series

APPLICATIONS IN CHEMICAL ENGINEERING SYSTEMS

Series of isothermal, constant_holdup CSTR'S,CSTR'S with variable Holdups, two heated tanks,Gas-Phase pressurized CSTS,NONISOTHERMAL CSTS, single component vaporizer,Multicomponent flash Drum,Batch Reactor, Reactor with mass Transfer, idial binary distillation column, multicomponent Nonidial distillation column, batch distillation with holdup

TREATMENT OF EXPERIMENTAL RESULTS

Solve above developed modeling equations using polymath/matlab/c++

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√		

2	√					√	√		
3	√					√	√		
4	√					√	√		
5	√					√	√		

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator

CML 302

Department	**: Chemical Engineering**
Course No.	**: CML303**
Course Title	**: Process Control and Instrumentation**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject "Process Control and Instrumentation" provides introduction to process control and in depth discussion on process modelling. The methods of analysis used in the control area are so different from the previous experiences of students that the materials comes to be regarded as a sequence of special mathematics techniques, rather than the integrated design approach to a class of real and practically significant industrial problems.

II. Pre-requisites: Mathematics

III. Textbooks:

1. "Process system Analysis & Control", Donald R. Coughanowr and Kappel, Mc Graw Hill Book Company.
2. T. Marlin, "Process Control", McGraw Hill, 1995.
3. W.L.Luyben, "Process Modelling Simulation and Control for Chemical Engineers", McGraw Hill, 1990.
4. G.Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice-Hall, New Jersey, 1984.
5. R.P.Vyas, "An Introduction to Process dynamics & control, Central publication, Nagpur, 2001

IV. Objectives:

1. To obtain theoretical and empirical mathematical models of different processes**.**
2. To introduce some of the basic principles and problems involved in process control.
3. To introduce analytical tools and design methodologies to tackle process control problems.
4. To design simple and effective control systems.

V. Outcomes:

1. Students will able to analyze the dynamic behavior of processes and develop good understanding of their behavior in different situations.
2. Students will able to design different types of controllers and tuning techniques.
3. Students will able to apply control schemes in chemical process Industries.
4. Student will exposed to various schemes like Multi input and multi output, complex control system, and application of control valves.

VI. Expanded Course description:

Importance, aims and objectives of process control, introduction to system dynamics, concept of dynamic response, first order, second order interacting and non interacting systems, concepts of transfer function, time constant, process gain, overshoot, decay ratio, dead time.

Introduction to set point, disturbance, closed loop and open loop control, feedback and feed forward configurations, dynamics of feedback control system.

Types of controllers, P, PI and PID controllers, controller gain, stability analysis, Routh stability criteria.

Design of controllers using open loop response, Zigeler – Nichols controller settings, Bode and Nyquist stability criteria.

Control valve and choice of controller settings. Basic design of pneumatic controllers, electric / electronic controllers, discontinuous control modes – two position, classical and modern control actions.

Process instruments used for measurement of pressure, temperature, liquid level, flow rate and compositions, pressure gauge, strain gauge, McLeod gauge, vacuum measurement, transducers, transmitters, digital signal processing.

Introduction to set point, error, accuracy, sensitivity, Application of control systems to chemical process equipments such as chemical reactors, heat exchangers, distillation columns, boilers etc.

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√		√	
2	√							√	
3	√					√		√	
4	√					√		√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	55

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML303

Department	**: Chemical Engineering**
Course No.	**: CML304**
Course Title	**: Chemical Reaction Engineering II**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML 304 Chemical Reaction Engineering – II covers the application of CML 223 Chemical Reaction Engineering – I in understanding Flow Pattern and Non-ideal behavior; heterogeneous catalytic, fluid – fluid, fluid – particles reactions and reactors.

II. Pre-requisites:

CML 223 Chemical Reaction Engineering – I

III. Textbooks:

1. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 1998 3rd Edition
2. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 2006, 4th Edition
3. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 1981, 3rd Edition

IV. Objectives:

1. Provide students with a basic understanding of Flow Pattern, Non-ideal behavior; heterogeneous catalytic systems, fluid – fluid systems, fluid – particles systems.
2. Provide the kinetics and design concepts for these systems.
3. Increase the student's ability to apply these principles for the design of reactors and application in process industries.

V. Outcomes:

At the end of the course, the student will understand the Chemical Reaction Engineering - II principles. The students will be able to apply these principles for the design of reactors and application in process industries.

VI. Expanded Course description:

Unit I (4 hrs)

Overview of Chemical Reaction Engineering: Summary of Chemical Reaction Engineering-I, Choosing the right kind of reactor, Problems.

Unit II (8 hrs)

Flow Pattern, Contacting, and Non-Ideal Flow: Non ideal flow in reactors, RTD of fluid in reactors, Age distribution, F curve, C curve and E curve, Compartment model, Dispersion model, Tank in Series model, Problems.

Unit III (8 hrs)

Introduction to Heterogeneous Reactions: Examples of heterogeneous reactions, contacting pattern and flow modeling, Problems.
Solid Catalysed Reactions: Introduction and Spectrum of kinetic regimes, Surface kinetics and rate equation, pore diffusion, porous catalyst, Heat effects, Performance Equation, Experimental methods and rate equation, Controlling Resistance, Product distribution in multiple reactions, Problems.
Unit IV (4 hrs)
Introduction to Catalyst and Catalytic Reactors: Typical Catalysts, Catalyst Characterizations, Catalyst Deactivation and Regeneration, Packed bed reactor, Fixed Bed, Fluid Bed, Trickle bed, Slurry Reactors etc., Problems.
Unit V (6 hrs)
Kinetics and Design of Fluid- Fluid Reactions: The rate equation, Kinetic regimes for mass transfer and reaction, Fast reaction, Intermediate reaction, Slow Reactions, Factors to select the contactor, Straight mass transfer, Various cases of mass transfer with chemical reaction, reaction kinetics, Problems.
Unit VI (6 hrs)
Kinetics and Design of Fluid- Particle Reactions: Various models for fluid-solid reactions, Shrinking core model, Rate of reaction, Reaction/Mass transfer Control, Rate controlling steps, plug flow and mixed flow of solids, Problems.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√		√					√	
2	√	√	√			√		√	
3	√	√	√			√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator
CML

Department	**: Chemical Engineering**
Course No.	**: CMP 304**
Course Title	**: Chemical Reaction Engineering Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

This course mainly deals with the understanding the basic fundamental principles of chemical reaction engineering by performing different experiments

II. Pre-requisites:

Chemical reaction engineering I, Chemical Reaction Engineering II

III. Textbooks:

1) Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 1998 3rd Edition
2) Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 2006, 4th Edition
3) Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 1981, 3rd Edition

IV. Objectives:

1) To understand the basic principle of chemical reaction engineering

V. Outcomes:

1) Students will understand the basic of chemical engineering and its practical application.

VI. Expanded Course description:

1) Three CSTRS Connected in Series

Aim: Study the kinetics of reaction for all the combination for given three CSTR in series

2) PFR & CSTR in Series

Aim: Study the kinetics of reaction for all the combination for given PFR and CSTR in series

3) Isothermal Continuously Stirred Tank Reactor

Aim: To Study the performance of isothermal continuous stirred tank reactor for the reaction ethyl acetate and NaOH

4) Isothermal Plug Flow Reactor

Aim: To Study the performance of isothermal continuous stirred tank reactor for the reaction ethyl acetate and NaOH

5) R.T.D. Studies in Plug Flow Reactor

Aim: To plot the F-Curve and C- Curve for given Plug Flow Reactor

6) Semi Bath Reactor

Aim: To determine overall order of Reactions for bimolecular reactions

7) R.T.D. Studies in Series & Parallel CSTR
Aim: To plot the F-Curve and C- Curve for given Plug Flow Reactor

8) Adiabatic Batch Reactor
Aim: To study the kinetics of reaction adiabatically

9) Isothermal Batch Receiver
Aim: To find the Arrhenius constant

10) R.T.D. Studies in Packed Bed Reactor
Aim: To plot the F-Curve and C- Curve for given packed bed reactor

11) Condensation Polymerization Reactor
Aim: To study the polymerization reaction in given condensation polymerization reactor

12) Fluidized Bed Reactor
Aim: To study the performance of fluidized bed reactor.

VII. Total Experiments to be conducted : Any eight out of above list

VIII. Lab Schedule: Two hours per week.

IX. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1			√			√	√		

X. Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	40
Assignments and Objective Test	-	30
Final Submission and viva	--	30

XI. Chamber Consultation Hours
To be announced in the class.

XII. Notice
Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CMP 304

Department	**: Chemical Engineering**
Course No.	**: CMP 322**
Course Title	**: Heat Transfer Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

Lab experiments on various equipments related to heat transfer.

II. Pre-requisites:

CML 222 Heat Transfer

III. Textbooks:

1. Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I, Butterworth Heinemann, New Delhi.
2. Kern D.Q, Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.

IV. Objectives:

1. To give the in-hand experience of lab scale experiments on various equipments such as heat transfer through forced convection, pin fin, lagged pipe, emissivity apparatus, stefan's boltzmann apparatus, shell and tube heat exchanger, double pipe heat exchanger, open pan evaporator, single effect evaporator, heat transfer in agitated vessel system
2. To observe and note down the steady state temperatures of all equipments.
3. To determine the heat transfer rate, heat transfer coefficient, and overall heat transfer coefficient for various equipments such as shell and tube heat exchanger, double pipe heat exchanger etc.

V. Outcomes:

Students will gain practical knowledge of experimental methods. it is expected that students will be able to plan an appropriate approach to experiment work, adapt original plans in the light of preliminary findings, demonstrate safe working in the choice of method and apparatus, handle apparatus and substances correctly and safely, make measurements to an appropriate degree of accuracy and precision, collect information to arrive at a final conclusion, appraise critically the experimental work, including identification of, and accounting for, anomalous results and experimental error, and suggest related improvements to methods, to write up an appropriate concise report

VI. Expanded Course description:

1. To find surface heat transfer coefficient for a pipe flowing heat by forced Convection of air flowing through it for different air flow rate and heat flow rate
2. To study the temperature distribution along the length of a pin fin under free and forced convection heat transfer
3. To determine heat flow rates through the lagged pipe for known value of thermal conductivity of lagged material and To plot the temperature distribution across the lagged material.
4. To determine the emissivity of grey surface.
5. To find out Stefan's Boltzmann constant.
6. To determine cold water side and hot water side heat transfer coefficient, LMTD and overall heat transfer coefficient for parallel and counter flow.
7. To calculate rate of heat transfer, LMTD and overall heat transfer coefficient for parallel and counter flow.
8. To determine the evaporation coefficient and overall heat transfer coefficient of the open pan.
9. To determine the overall heat transfer coefficient of the evaporator.

10. To determine the heat transfer coefficient in agitated vessel system.

VII. Total Experiments to be conducted : Eight

VIII. Class Schedule

Two hours per week.

IX. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√			√			
2	√	√	√			√	√	√	
3	√	√	√		√	√	√	√	

X. Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	40
Assignments and Objective Test	-	30
Final Submission and viva	--	30

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator

CMP322

Department	**: Chemical Engineering**
Course No.	**: CML351**
Course Title	**: Chemical Technology**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The core subject CML 351 Chemical Technology covers fundamental knowledge of all Unit operation and Unit Process required for synthesis of production process. It covers production process of various industries like Industrial gases, Industrial carbon, Marine Chemicals, Nuclear Industries, Chlor – alkali industries, Electrolytic and Electrochemical Industries, Fertilizers, Glass - Chemistry

Overall this course is highly useful for the students of Chemical Engg for industrial point of view production processes.

II. Pre-requisites: NIL

III. Textbooks

C. L. Dryden, Outlines of Chemical Technology, Edited and Revised by M.Gopala Rao and S. Marshall, 3rd Ed., Affiliated East West, New Delhi, 1997.

T. G. Austin and S. Shreve, Chemical Process Industries, 5th Ed., McGraw Hill, New Delhi, 1984.

P. H. Groggins, Unit Processes in Organic Synthesis, 5th Ed., McGraw Hill, 1984.

IV. Objectives:

1) To understand knowledge of unit operation and processes
2) To understand the knowledge of flow/ separation pattern of material
3) To understand the design of unit operations
4) To understand the approach for mass/heat transfer & CRE
5) To understand the approach for modeling
6) To study the overall synthesis of various chemical product of importance

V. Outcomes:

Students can synthesis production process of required product.

VI. Expanded Course description:

Introduction and overview of Chemical Process Technology. Preparation of process flow diagrams, Instrumentation diagrams and Process symbols.
Petrochemical Industries: production of petrochemical feedstocks, olefins and aromatics, intermediates from olefins and aromatics.
Inorganic Chemical Industries: chlor---alkali industries, manufacture of acids, ammonia, and fertilizers.
Industrial gases: CO, CO_2, H_2, O_2, N_2, SO_2, C_2H_2, Helium and Nitrogen oxide. Industrial acids: 25% & 65% oleums, Liq. Sulphur Trioxide, Liq. Sulphur dioxide manufacture. Sulphuric acid, Nitric acid, Hydrochloric acid and Phosphoric acid. Miscellaneous Chemicals industries: Alum [ferric & Non-ferric], sugar, carbon-disulphide.
Fertilizers: Ammonia, Nitrogenous fertilizers, Phosphatic fertilizers, Potassic fertilizers, Compound and Complex fertilizers, miscellaneous fertilizers.
Fermentation: manufacture of sugar, starch, and its derivatives, manufacture of industrial alcohols.
Pulp, Paper, and Rayon industries. Edible oils: extraction and refining, fat splitting, soaps and detergents.

VII. Class Schedule: Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√			√
2	√					√			
3	√								
4	√					√			√
5	√					√			
6	√					√	√		√

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours
To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator

CML 351

Department	**: Chemical Engineering**
Course No.	**: CML 352**
Course Title	**: Transport Phenomena**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

This course mainly deals with application of knowledge gain by students in fluid mechanics, heat transfer and mass transfer. This subject also covers the topic which shows the similarity between fluid mechanics, heat transfer and mass transfer

II. Pre-requisites: Fluid mechanics, Heat Transfer and Mass Transfer

III. Textbooks:

1) R.B. Bird, W. Stewart and E.N Lightfoot, Transport Phenomena, John Wiley & Sons, 2nd Edition, 2006
2) C.O. Bennet and J.E. Myres, Momentum, Heat & Mass Transfer, McGraw Hills, 3rd Edition, 1994
3) R. Brodkey and H. C. Hershey, Transport Phenomena – A Unified Approach, volume 1, McGraw Hill Book Co., 2nd Edition, 1988
4) C.J. Geankoplis, Transport Processes and Separation Process Principles, Prentics Hall India Ltd., 4th edition, 2003
5) G.S. Laddha and T.E. Degaleesan, Transport Phenomena in Liquid Extraction, Tata McGraw Hill Book Co., 1st edition, 1978

IV. Objectives:

1) To understand the theoretical similarities between heat, mass and momentum transfer
2) To understand the shell balance approach for momentum transfer
3) To understand the shell balance approach for heat transfer
4) To understand the shell balance approach for mass transfer
5) Application for differential equation for shell balance modeling

V. Outcomes:

1) Student will understand the analogical correlation between heat, mass and momentum transfer. Using this information they can solve the problem in any area (e.g. momentum transfer) using corresponding logical data in other area (like head and mass transfer).
2) Velocity profile equation derived for given case can be used to estimate various important properties in momentum transfer.
3) Temperature profile equation derived for given case can be used to estimate various important properties in heat transfer.
4) Concentration profile equation derived for given case can be used to estimate various important properties in mass transfer.
5) Student can develop model equations for important properties in the area of momentum, heat and mass transfer.

VI. Expanded Course description:

Definition of transport properties, their measurement and estimation, velocity distribution in laminar and turbulent flow, shell momentum balances, flow of non-Newtonian fluids, development of boundary layer, flow over flat plates, and velocity profiles.

Similarity between heat, momentum and mass transport and mass transport and various analogies. Application of heat, momentum and mass transport concepts to various to various disciplines of engineering and technology.

One-dimensional equation of motion and continuity, Euler and Navier–stokes equation, dimensional analysis of equation change.

Shell balance approach for developing equations for momentum, heat and mass transport, Temperature distribution in solids and fluids in laminar flow, development of thermal boundary layer.

Concentration distribution in solids and in fluids in laminar flow, equations of change for multi component systems.

VII. Class Schedule : 3 Classes a week each of 55 minutes

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	**Programme outcomes**								
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**
1	√					√		√	
2	√	√				√	√	√	
3	√	√				√	√	√	
4	√	√				√		√	
5	√	√						√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	20
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announce in the class

XI. Notice

To be announce in the class

Course Coordinator

CML352

Department	**: Chemical Engineering**
Course No.	**: CML353**
Course Title	**: Chemical Process Equipment Design**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The course covers the methods and procedure adopted in designing process equipment. The emphasis here is on specifying the function, operation and size of the equipment and also on the choice of the material of construction and strength considerations.

II. Pre-requisites: Physical Chemistry & General Metallurgy, Mechanical Operations

III. Textbooks:

1. Process equipment dsign-vessel design by Lloyd E. Brownell and Edwin Young, John Wiley, NewYork 1963.

2. Chemical Engineering Volume 6 – Design by J.M. Coulson, J.F. Richardson and R. K. Sinnott, Pergamon press International Edition 1989.

3. Introduction to chemical equipment design – Mechanical Aspects by B.C. Bhattacharyya, CBS Publications.

4. Process Equipment Design by M.V. Joshi and V.V. Mahajani Macmillan India

5. Pressure Vessel Hand book by Eugene F. Megyesy, Pressure vessel company USA.

6. Design of machine elements by V.B. Bhandari, McGraw Hill.

7. Appropriate ISI Specifications and codes for unfired pressure vessels, viz IS: 2825, IS: 803, IS: 804,IS: 1182, IS: 4853, IS: 3658, IS: 3703, IS: 3664, IS: 4260, IS: 4072, IS4503.

IV. Objectives:

1. Provide students with basic understanding equipment design.
2. To teach students the design of pressure vessel.
3. To teach students the design of storage vessel.
4. To teach students to apply the design concepts in practical industrial design problem.

V. Outcomes:

After completion of this course the students will be able to do design of industrial pressure vessel and storage vessel.

VI. Expanded Course description:

Unit-1

Importance of chemical process equipment design, design procedure for pressure vessels subjected to internal pressure, and combined loading, closures for pressure vessels, Code and standards for pressure vessels (IS:2825:1969), materials of construction, selection of corrosion allowance and weld joint efficiency.

Unit-2

Design of pressure vessels subjected to high pressure, monoblock construction, shrink fit construction, external pressure, optimum proportions of pressure vessels, optimum sizing of vessels.

Unit-3

Design of supports, flanges, nozzles for vessels, Design of jackets (as per IS 2825), coils for pressure vessels.

Unit-4

Mechanical design of storage tanks for volatile and non-volatile liquids, roof and bottom design, optimum proportions of storage tank, storage tanks for solids and its design procedure, Design of cylindrical storage vessel as per IS:803 and rectangular tanks as per IS:804.

Unit-5

Codes and standards for heat exchangers; Baffles; Tie-rods; Tube joining methods; Design of shell and tube heat exchangers as per IS : 4503 and TEMA standards; design of single effect evaporator

Unit-6

Design of distillation column, absorption column, and reactors

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	**Program Outcomes (PO)**								
	a.	**b.**	**c.**	**d.**	**e.**	**f.**	**g.**	**h.**	**i.**
1.	√	√	√						
2.		√	√						
3.		√	√						
4.		√	√			√	√	√	√

IX. Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	55

X. **Chamber Consultation Hours**
To be announced in the class.

XI. **Notice**
Notice will be displayed on Chemical Engineering Notice Board.
Course Coordinator

CML353

Department	**: Chemical Engineering**
Course No.	**: CML 354**
Course Title	**: Energy and Environment**
Course Type	**: Core**
Course Credits	**: 3**

Course Description: This course mainly focuses on conventional and non-conventional energy sources such as coal, petroleum, natural gas, nuclear energy, bioenergy, hydropower, geothermal energy, solar energy and wind energy. It is also designed to establish a connection between all the energy sources and their environmental influences. Several novel concepts for treating the environmental problems are also addressed in this course.

Pre-requisites: None

Textbooks:

1. G.N.Rai, "Non conventional energy sources," Khanna Publishers, New Delhi.
2. Samir Sarkar, "Fuels and Combustion", 2nd Edn, Orient Longman Publication, 1988.
3. J. G. Speight, Fuel Science & Technology Handbook, Dekker, 1990.
4. V.Balzani and N.Armaroli, Energy sustainable world, Wiley-VCH, 2011
5. G.Boyle, Renewable Energy, Oxford University Press, 2004.

Objectives:

1. To be able to analyze and interpret the current methods of energy production from various conventional and non-conventional sources.
2. To be able to understand the modification in the current technology that can be made for efficient and high energy production.
3. To be able to identify the environmental issues related to each energy source.
4. To be able to understand the modification in the current technology that can resolve the environmental issues significantly.

Outcome:

Upon successful completion of the course, the students will be able to well interpret the various aspects involved in conventional and non-conventional energy sources. They will be able to identify the environmental issues relevant with the current techniques. They will also understand the modification that will be needed to solve the environmental concerns and to optimize the energy production.

Syllabus: Conventional and non-conventional energy sources; Coal, oil and gas, solar energy; wind energy; Geothermal energy; Hydropower; Bioenergy; Nuclear energy. Energy survey in India. Current and future energy requirements in India and across the world and associated environmental problems.

Coal: Coal and Coal derived fuels; Characteristics, production methods and uses. Coal combustion technology, waste heat recovery.
Oil and Gases: Fuels from oil and gases: Characteristics, production methods and uses. Technology for combustion of fuels derived from oil and gas.
Solar Energy: Solar energy utilization, Thermal application and photovoltaic applications; Wind, geothermal and hydro energy utilization.
Bio Energy: Biomass conversion for fuels; production methods based on thermochemical and bioconversion. Characteristics and uses; Design of digestors.
Nuclear Energy: Nuclear Energy; Nuclear fission fuels processing, Nuclear reactions and nuclear reactors, Nuclear Engineering.
Environmental aspect related to coal, oil, fuel gases, bio-energy, Nuclear energy.

Class Schedule
Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	**Program Outcomes (PO)**								
	a.	**b.**	**c.**	**d.**	**e.**	**f.**	**g.**	**h.**	**i.**
1.			√	√					√
2.	√	√	√	√		√	√		
3.			√	√	√				√
4.	√	√	√	√		√	√	√	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	20
End Semester Exam	3 hours	50

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 354

Department	**: Chemical Engineering**
Course No.	**: CMP 302**
Course Title	**: Chemical Process Modelling and Simulation Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

Course description:
Lab experiments on various chemical engineering process
Pre-requisites:
Theory course of Process Modeling and Simulation

Textbooks:

1. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering ,Tata-McGraw-Hill, New Delhi, 2002.
2. Jensen V.G., Jeffrey's G.V., Mathematical Methods in Chemical Engineering", 2nd Ed. Academic Press, London, 1978.
3. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill,New York, 1989.
4. A. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication
5. Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd., 2008

Objectives:

1) To understand knowledge of fundamental principles and basic laws of modeling
2) To understand the approach for mass/heat transfer & CRE
3) To apply the knowledge of differential equations
4) To understand the approach for modeling
5) Formulation of mathematical model for various chemical Engg. system

Outcomes:
Out put data are created for each program and graphs are plotted to analyze the system

Expanded Course description:

1. The following experiments have to be conducted using any one software Polymath/C / C++/ Fortran Depending on availability on machine (Any six out of 14 listed below).

1. Gravity Flow tank.
2. Three CSTR's in series – open loop.
3. Three CSTR's in series – closed loop.
4. Non-isothermal CSTR.
1. Complex reaction scheme (Batch Reactor)
2. Second order complex batch reactor

3. Series parallel reaction scheme
4. Semi-batch reactor model
5. Complex reaction model
6. Parallel second order reaction scheme
7. Reversible and irreversible 1st order reactions
8. 2nd order series reactions
9. Complex set of series parallel reactions

Total Experiments to be conducted : **Nine**

Class Schedule
Two hours per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√		√			√			
2	√		√			√			
3	√		√			√			
4	√		√			√			
5	√		√			√			

Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	40
Assignments and Objective Test	-	30
Final Submission and viva	--	30

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CMP 302

Department	**: Chemical Engineering**
Course No.	**: CMP 303**
Course Title	**: Process Control and Instrumentation Laboratory**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

The core subject "Process Control and Instrumentation laboratory" provides knowledge on practical performance of different control instruments through experimentation.

II. Pre-requisites: Mathematics

III. Objectives:

1. To make students aware of working of Different process control instruments through hands on training.
2. To make students to correlate theory and practical process control through principles, fundamental concepts and by experimentation.

IV. Outcomes:

1 Students will be able to apply the knowledge of control theory for understanding the various processes, carried out in the Chemical process industry.

2 Students demonstrate their ability of understanding the process control and its application by virtue of experimentation.

3 Students will be able to learn due care and precautions in handling measuring instruments.

V. Expanded Course description:

S.N.	List Of Experiments
1.	Interacting System
2.	Non-Interacting System
3.	Flapper Nozzle Trainer
4.	Response Of U-Tube Manometer
5.	Control Valve Characteristics
6.	Water Temperature Control System Trainer

7.	Level Measurement By Air Purge Method
8.	Determination of Time Constant of Thermometer And Thermocouple
9.	Study of Temperature Measurement Using Sensor RTD
10.	Study of Multi Process (Cascade) Control System

VI. Textbooks/Reference books:

6. T. Marlin, "Process Control", McGraw Hill, 1995.
7. W.L.Luyben, "Process Modelling Simulation and Control for Chemical Engineers", McGraw Hill, 1990.
8. G.Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice-Hall, New Jersey, 1984.

VII. Class Schedule

Two hours per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	**Program Outcomes**								
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**
1					√	√		√	
2								√	

IX. Chamber Consultation Hours

To be announced in the class.

I. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator:

CMP 303

Department	**: Chemical Engineering**
Course No.	**: CMP321**
Course Title	**: Mass Transfer Laboratory I**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

Lab experiments on various equipments / instruments related to Mass Transfer Operations.

II. Pre-requisites:

None

III. Textbooks:

1. Mass Transfer Operations, Treybal R.E., McGraw Hill Book Co., New York 1980, 3rd Edition
2. Chemical Engineering Vol. I, II & III, Coulson J.M. and Richardson J.F., Pergamon Press, New York 1977
3. Unit Operations of Chemical Engineering, McCabe W.L. and Smith J.C. & Harriot, McGraw Hill Book Co., New York 1980, 5th Edition
4. Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI Learning Pvt. Ltd., New Delhi, Eastern Economy Edition
5. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Book Co.

IV. Objectives:

1. To give the hand-in-hand experience of lab scale experiments on various equipments based on the theoretical understanding and its application learned in Theory Course.
2. To understand the scaling approach of understanding from Experimental to Industry applications.
3. To develop the students ability regarding analytical and data interpretation skills.
4. To develop the discipline, sincerity, perfection and dedication towards works/assignment/aim among students.
5. To make students ready to work in industrial environment providing the lab training.

V. Outcomes:

Students will gain practical knowledge of experimental methods. It is expected that students will be able to plan an appropriate approach to experiment work, adapt original plans in the light of preliminary findings, demonstrate safe working in the choice of method and apparatus, handle apparatus and substances correctly and safely, make measurements to an appropriate degree of accuracy and precision, collect information to arrive at a final conclusion, appraise critically the experimental work, including identification of, and accounting for, anomalous results and experimental error, and suggest related improvements to methods, to write up an appropriate concise report.

VI. Expanded Course description:

List of Experiments:

1. To determine the Mass Transfer coefficient for Absorption of CO_2 in NaOH solution in packed Column.
2. Study of adsorption of acetic acid on activated charcoal [To verify adsorption isotherms].
3. To determine the number of Heat Transfer Units (HTU) & height equivalent to Theoretical plate (HETP) of Packed distillation column.
4. To study the drying characteristics curve under constant drying condition in rotary vacuum or tray dryer.
5. Diffusion (Liquid – Liquid) –To calculate the diffusion coefficient of vapour in still Air.

6. To study the characteristics of Boiling point diagram.
7. To study the characteristics Cooling Tower experiment.
8. Experiments on Differential Distillation.
9. To determine rate of distillation by Steam Distillation.
10. Performance evaluation of fluid bed dryer.
11. Study of factors affecting rate of Evaporation :-
    i) Effect of Surface Area.
    ii) Effect of Temperature.
12. Solid liquid extraction
13. Liquid – Liquid Extraction– To determine Overall efficiency for a three stage counter-current and cross current system.
14. Diffusion (Liquid–Air):- To find the diffusion coefficient of vapour instill air.
15. Experiments on Fractional Crystallization.
16. Spray Column Dryer:- To study the Design and operating Principles of Spray Dryer.
17. Plate Column Distillation :- to study the Performance of a rectification column.
18. Determination of Rate of drying, Free moisture content and bound moisture content.

Total Experiments to be conducted / designed: 8-10

VII. Class Schedule

Two hours per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√	√		√		√	
2	√	√	√	√		√	√	√	
3	√	√				√	√	√	
4	√	√			√	√	√	√	√
5	√	√			√			√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Class tests, Quizes and Assignments	-	20
Final Submission and viva	--	20

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator:

CMP 321

Department	**: Chemical Engineering**
Course No.	**: CML403**
Course Title	**: Plant Design and Economics**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

The course covers two aspects:

a) Basic economic analysis of a chemical plant and various profitability criteria

b) Safety and operability issues in a chemical plant and their incorporation in plant design

The students will be required to complete a design dissertation as a part of evaluation.

II. Pre-requisites: Heat Transfer, Advance Heat Transfer, Chemical Reaction Engineering –I and II, Mass Transfer I and II, Fluid mechanics, Process Control

III. Textbooks:

R Turton, R Balie, W B Whiting, J Shaeiwitz, D Bhattacharya Prentice Hall (4th Edition) Analysis, Synthesis, and Design of Chemical Processes 2013

Douglas J McGraw-Hill Sciences (1st Edition) Conceptual Design of Chemical Processes

Study material developed by Kevin Dunn and Dr. Thomas Marlin http://learnche.mcmaster.ca/4N4/Main_Page

at McMaster University, Canada

Reference books:

J.M. Coulson, JF Richardson, RK Sinnott Butterworth Heinman, Chemical Engineering Volume 6, Revised Second Edition, Butterworth-Heinemann, 1996

M Peters, K Timmerhaus, R West McGraw Hill (5th Edition) Plant Design and Economics for Chemical Engineers, 2011

IV. Objectives:

Objective of this subject is to expose students to basic concepts in engineering economics, plant design, safety features and its application to chemical engineering.

V. Outcomes:

After the course students will be able:

1) to read complex P&ID diagrams and develop a chemical process from scratch
2) to perform a complete economic analysis of a proposed chemical plant
3) to appreciate the importance of safety and incorporate safety features in design and convey
4) to appreciate that the chemical plants are not always run at design conditions and will experience faults
5) to write and present a design dissertation

VI. Expanded Course description:

- Block flow diagram, process flow diagram, piping and instrumentation diagram (P&ID)
- Conceptual design and synthesis of a process flow diagram, development of PFD from generic BFD
- Plant layout, location and site selection
- Estimation of capital costs, purchased equipment costs, total capital cost of a plant, bare module cost-base and non-base conditions, estimation of manufacturing costs, cost of labor, utility cost, raw material costs,
- Investment and the time value of money, different types of interest, cash flow diagrams, inflation, Annuities, depreciation, taxation, profitability analysis, criteria for profitability for large projects, net present value, rate of return, evaluation of equipment alternatives, evaluation of risks, sensitivity and uncertainty analysis.
- Safety design: Major chemical industry disasters, safety hierarchy, basic process control safety, Alarms, SIS (safety interlock system), HAZOP, safety valves
- Operability issues and troubleshooting in a chemical plant
- Introduction to computer aided flow sheeting

VII. Class Schedule : Three classes a week each of 55 min

VIII. Relationship of Course Outcome to Program Outcomes:

Course Outcome	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1		√							
2	√	√					√		
3	√	√					√		
4	√	√							
5	√	√		√					

IX. Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Design Dissertation	-	20
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 403

Department	**: Chemical Engineering**
Course No.	**: CMP401**
Course Title	**: Mass Transfer Laboratory II**
Course Type	**: Core**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to understand and perform the experiments related to the basic mass transfer and its application to chemical engineering

Syllabus:

1. Study of Membrane Bioreactor
2. Study of Pervaporation (1)
3. Study of Pervaporation (2)
4. Study of fermentor : Ethanol production
5. Study of fermentor: Carboxylic acid production
6. Study of Reactive Extraction (1)
7. Study of Reactive Extraction (2)
8. Study of Supercritical Extraction (Design)
9. Study of Multi-component Distillation (Design)
10. Study of hybrid separation (Design)
11. Study of Membrane Filtration (Design)

REFERENCES

1. Seader J. D., Henley E. J., Separation Process Principles, Wiley, 2001, 2nd Edition
2. Richardson J. F., Harker J. H., Chemical Engineering Vol. 2, Elsevier, 2002, 5th Edition.
3. Mukhopadhyay M., Natural Extract using Supercritical CO_2, CRC Press, 2000, 1st Edition.
4. Nath K., Membrane Separation Processes, Prentice Hall of India, 2008, 1st Edition.
5. Sivasankar B., Bio-separations: Principles and Techniques, Prentice Hall of India, 2005, 1st Edition.
6. International Research Papers

Class Schedule

Two hours per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√	√		√		√	

2	√	√	√	√		√	√	√	
3	√	√				√	√	√	
4	√	√			√	√	√	√	√
5	√	√			√			√	

Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Class tests, Quizes and Assignments	-	20
Final Submission and viva	--	20

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator:

CMP 401

Department	**: Chemical Engineering**
Course No.	**: CMP453**
Course Title	**: Design laboratory I**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description: The course covers symbols used in Drawing, Design and Drawing of various chemical equipments and accessories like storage tank, Jacketed vessel, reaction vessel, coils, gasket, pressure vessel, supports, Agitator, etc. Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which 1/3rd should be drawn using computer software like AutoCAD.

II. Pre-requisites: none

III. Textbooks:

1. Joshi M.V., Mahajan V.V. Process Equipment Design MacMillan India Ltd

2. Khurmi R.S ,Gupta J.M., , A text book of machine design S.Chand &Company Ltd, New Delhi

3. Dawande S.D. Process Design of Equipments volume 1&2 Central Techno Publication, Nagpur

IV. Objectives:

1. To learn how to use and draw basic Standard equipment symbols and Standard instrumentation symbols used in chemical process industry.
2. To study how to design and draw Heads and closures, Keys and couplings, Supports for vessels- like Bracket Support, Leg Support, Skirt Support and packed absorption tower.
3. To learn how draw, Riveted joints, Welded joints and other types of joints

V. Outcomes:

At the end of course students exhibit how to use and draw basic standard equipment symbols and standard instrumentation symbols used in chemical process industry and in a competitive manner how to design and draw Heads and closures, Keys and couplings, Supports for vessels- like Bracket Support, Leg Support, Skirt Support and packed absorption tower and also demonstrate the use of drawing Pipe fittings, Riveted joints, Welded joints and Pressure relief devices.

VI. Expanded Course description:

Sheet- No	**Title of Sheets**
1.	Basic Instrument symbols
2.	Type of joints

3.	Types of Heads and Storage vessel
4.	Types of Supports
5.	Types of Jackets and Coils
6.	Types of Flanges and its joints
7.	Gaskets and Flange Assembly
8.	Complete Assembly of Pressure vessel with Jacket
9.	Reaction vessel with Coils

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√	√	
2	√	√				√		√	
3	√	√				√	√		

10	One complete Process Flow sheet

VII. Class Schedule

Three 2 hour session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

IX. Evaluation of students

Component	**Duration**	**Weightage**
Marks on drawing sheet (Total no. of sheets = 10)	2- hour per week	50
Assignment on each sheet (Detail description of the diagram and related theory).	-	20
Slip test -1 (after completing five sheets)	15min	10
Slip test -2 (after completing rest five sheets)	15min	10

Viva and end sem exam	10min	10

X. Chamber Consultation Hours
To be announced in the class.

XI. Notice
Notice will be displayed on Chemical Engineering Notice Board.
Course Coordinator

CMP453

Department	**: Chemical Engineering**
Course No.	**: CMD404**
Course Title	**: Project Phase I**
Course Type	**: Core**
Course Credits	**: 2**

Objective: Objective of this subject is to expose students to apply the all skills to solve given problem

Syllabus: Student will select topic in consultation with project advisor and work on this topic

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1		√				√			
2		√				√			
3		√							
4		√				√			
5		√				√			

Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Assignments and Objective Test	-	25
Final Submission and viva	--	15

Chamber Consultation Hours
To be announced in the class.

XII. Notice
Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CMP 403

Department	**: Chemical Engineering**
Course No.	**: CMP 403**
Course Title	**: Design Laboratory II**
Course Type	**: Core**
Course Credits	**: 1**

I. Course description:

Drawing sheets on chemical equipments and flow sheets such as heat exchanger, distillation column, jacketed vessel, agitated vertical column, evaporator, fermentor, reactor cyclone separator, autoclave, dryer, pump, flow sheets.

Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which 1/3rd should be drawn using computer software like AutoCAD.

II. Pre-requisites:

CML 353 Chemical Process Equipment Design

III. Textbooks:

1. Joshi M.V., Mahajan V.V, Process Equipment Design, Macmillan India Ltd
2. Khurmi R.S ,Gupta J.M. A Text Book Of Machine Design, S.Chand &Company Ltd, New Delhi
3. Dawande S.D. Process Design of Equipments, Central Tecno Publication, Nagpur.

IV. Objectives:

1) To understand knowledge of unit operation and processes
2) To understand the knowledge of flow/ separation pattern of material
3) To understand the design details of unit operations for towards systematic drawing
4) To understand the approach for scaling for drawing
5) To study the overall synthesis of various chemical product of importance

V. Outcomes:

At the end of the sheets, the student will understand the basic concepts and operations of various chemical equipments and flow sheets related to chemical engineering design and drawing.

VI. Expanded Course description:

Design and drawing of chemical equipments like, Heat exchanger, distillation column, evaporator, cyclone seperator, autoclave, Dryer, Pump, etc.

Preparation of working drawing part list & assembly drawings of plant layouts and piping drawing, device drawing.

Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which 1/3rd should be drawn using computer software like AutoCAD.

VII. Total Sheets to be drawn : Ten

VIII. Class Schedule

Two hours per week.

IX. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1		√				√			
2		√				√			
3		√							
4		√				√			
5		√				√			

X. Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Assignments and Objective Test	-	25
Final Submission and viva	--	15

XI. Chamber Consultation Hours

To be announced in the class.

XII. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CMP 403

Department	**: Chemical Engineering**
Course No.	**: CMP405**
Course Title	**: Project Phase I**
Course Type	**: Core**
Course Credits	**: 4**

Objective: Objective of this subject is to expose students to apply the all skills to solve given problem

Syllabus: Student will select topic in consultation with project advisor and work on this topic

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1		√				√			
2		√				√			
3		√							
4		√				√			
5		√				√			

Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Assignments and Objective Test	-	25
Final Submission and viva	--	15

Chamber Consultation Hours
To be announced in the class.

XII. Notice
Notice will be displayed on Notice Board near to Chamber.
Course Coordinator
CMP 405

Electives

Electives Courses

New Course Code	Name of Subject	Credits
MAL205	Num. Methods & Prob. Theory	3
CML231	Materials Science and Engineering	3
CML232	Introduction to Computing software for Chemical Engineers	3
CML233	Environmental Engineering	3
CML234	Industrial Waste Treatment	3
CML383	Advance Heat Transfer	3
CML384	Safety and Risk Analysis	3
CML385	New and Renewable Energy Engineering	3
CML386	Biotechnology and Biochemical Engineering	3
CML387	Instrumental Analytical Techniques	3
CML393	Innovative Design	3
CML394	Introduction to Measuring Instruments	3
CHL336	Polymer Engineering	3
CHL369	Green Chemistry and Engineering	3
CML422	Plant Utility	3
CML423	Optimization Techniques	3
CML424	Petroleum Refinery Engineering	3
CML425	Membrane Technology	3
CML426	Polymer Processing	3
CML427	Advanced Separation Process	3
CMP427	Separation Process	1
CML428	CFD for Chemical engineers	3
CML429	Nanotechnology	3

CMP429	Nanocomposite Technology Lab	1
CML430	Ore and Minerals Processing	3
CMP433	Environmental Engineering Lab	1
CMP434	Industrial Waste Treatment Laboratory	1
CML431	Entrepreneurship Development	3
CML432	Computational Transport Processes	3
CML433	Project Planning and Management	3
CML434	Computational methods in Chemical Engineering	3
CML435	Computer Aided Design in Chemical Engineering	3

Department	**: Chemical Engineering**
Course No.	**: MAL205**
Course Title	**: Numerical Methods & Probability Theory**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand the basic numerical analysis, probability study and its application to chemical engineering

Syllabus: The objective of this subject is to expose student to understand the basic importance of numerical methods to tackle the problems which cannot be solved analytically. It also focuses the probability theory and its applications in science and engineering.

Numerical Analysis: Solutions of algebraic and transcendental equations by Iteration method, method of false position,

Newton-Raphson method and their convergence. Solutions of system of linear equations by Gauss elimination method, Gauss Seidal method, LU decomposition method. Newton- Raphson method for system of nonlinear equations. Eigen values and eigen vectors : Power and Jacobi methods. Numerical solution of ordinary differential equations: Taylor's series method, Euler's modified method, Runge-Kutta method, Adam's Bashforth and Adam's Moulton, Milne's predictor corrector method. Boundary value problems: Shooting method, finite difference methods.

Probability theory:

Random variables, discrete and continuous random variable, probability density function; probability distribution function for discrete and continuous random variable joint distributions. Definition of mathematical expectation, functions of random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis. Binomial, Geometric distribution, Poisson distribution, Relation between Binomial and Poisson's distribution, Normal distribution, Relation between Binomial and Normal distribution. Random processes, continuous and discrete, determinism, stationarity, ergodicity etc. correlation functions, autocorrelation and cross-correlation, properties and applications of correlation functions.

Text Books:

1. Jain, Iyengar and Jain : Numerical Methods for Engineers and Scientists, Wiley Eastern,1995

2. V.K. Rohatgi and A.K.M. Ehsanes Sateh: An Introduction to Probabability and Statistics, John Wiley & Sons.

Reference Books

1. S. D. **Cante** and **C**. **de Boor**, Elementary Numerical Analysis, an algorithmic approach, McGraw-Hill, 2000.

2. Gerald and Wheatley : Applied Numerical Analysis, Addison-Wesley, 1999.

3. Spiegel, M.R.; Theory and problems of Probability and statistics; McGraw-Hill Book Company; 1980.

4. K.S. Trivedi: Probability Statistics with Reliability, Queuing and Computer Science applications, Prentice Hall of India

Pvt. Ltd, 2000.

Class Schedule

Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course objectives	Program outcomes								
	a	b	c	d	e	f	g	h	i
1						✓		✓	
2						✓		✓	
3						✓		✓	
4						✓		✓	
5					✓	✓	✓	✓	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

MAL205

Department	**: Chemical Engineering**
Course No.	**: CML231**
Course Title	**: Materials Science and Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The course covers the fundamentals of different kinds of materials used in chemical industries, their physical and chemical interactions under various service conditions, testing and maintenance.

II. Pre-requisites: None

III. Textbooks:

1. Introduction to material science, James F. Shacketford, McMillan publishing company, New York ISBN 1990.
2. Properties of Engg. Materials, Jestrazebaski D.Z., Toppers. Co. Ltd. 3rd edition.

IV. Objectives:

1. To provide basic knowledge and application of different type of materials.
2. To study short-term and long-term mechanical behavior of materials.
3. To understand the science behind the failure of materials.
4. To provide knowledge on different heat treatment techniques.
5. To understand the types of corrosion and methods to prevent it.

V. Outcomes:

Students shall have a solid knowledge basis in physical and chemical properties of different types of materials.

They shall understand the development of science and technology of materials in chemical industry from time to time.

VI. Expanded Course description:

Introduction : Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hook's law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy

Basic principles in their selection for fabrication and erection of chemical plant: Testing of materials, destructive and non-destructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes. Special diffusion process : Aluminizing, Electroplating-hard chrome & nickel plating - Hard dip coating, Cladding - Physical and chemical vapour deposition - Metal spraying , Plastics and rubber coating ,Conversion coating , Coating of tools ,TiC, TiN,

Alumina and diamond coating of tools ,Selection of coating of tools , Selection of coating for wear and corrosion resistance.

Metals and their alloys: Iron–carbon diagram, Ferrous and nonferrous alloys, Fe-C diagram, mild steel, special steels, stainless steels, brasses, aluminium alloys and titanium alloys, high and low temperature material, insulation, refractories. Selection of the steel, Heat treatment of steel, Proper design for proper heat treatment , Critical temperature and heating - Annealing- Spheroidzing- normalizing , hardening -Isothermal transformations , TTT diagram - tempering - austempering - martempering and ausforming. Heat treatment of corrosion - resistance steels. Hardenability and its testing, hard material alloys, Types of structure and their specific volume. Effect of temperature on mechanical properties various methods of improving the strength for service conditions. Effect of alloying elements on properties of steel. Alloys of copper, aluminium, magnesium, nickel and zinc, compositions and their uses.

Corrosion and its control: Different types of corrosion: chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments. Corrosion factors, inhibition, prevention, control and testing, Corrosion behaviour of metals and alloys. Forming processes and corrosion. Fracture in Ductile and Brittle materials, creep, mechanisms of creep and methods to reduce creeping in materials, creep rate and relations. Fatigue-mechanism- methods to improve fatigue resistance in materials. Composite materials, types, stress-strain relations in composite materials, applications.

Polymers, natural & synthetic: Selection of polymeric materials for equipment linings, fiber reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering. Elastomers and plastomers, molecular structure and properties of polymers.

Ceramic and glasses: Crystalline and non-crystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica, and borosilicate, Ceramic

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course objectives	Program outcomes								
	a	b	c	d	e	f	g	h	i
1						✓		✓	
2						✓		✓	
3						✓		✓	
4						✓		✓	
5					✓	✓	✓	✓	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10

End Semester Exam	3 hours	60

X. Chamber Consultation Hours
To be announced in the class.

XI. Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML231

Department : Chemical Engineering

Course No. : CML232

Course Title : Introduction to Computing software for Chemical Engineers Course Type : Elective

Course Credits : 3

Objective: Objective of this subject is to expose students to understand basic application for commonly used software package and its application to chemical engineering

Syllabus:

Introduction to Softwares- Documentation; Development Environment; Desktop Tools, Other development environment tools.

Manipulating Matrices-Matrices and Magic squares, Expressions, Working with Matrices, More about Matrices and Arrays, Controlling commnad window input and output; Graphics-Basic plotting, Editing plots, Mesh and surface plots, Printing and Handling the Graphics.

Programming with MATLAB-Flow control, Other data structures, Scripts and Functions.

Examples of Chemical engineering solved problems using MATLAB-Equations of state, Vapour liquid equilibrium, Chemical reaction equilibria, Reaction-kinetic system, Transport processes, etc.

Text Boks

1. Rudra Pratap, Getting Started with MATLAB7: A Quick Introduction for Scientists and Engineers, Oxford University Press, Newdelhi, India
2. Andrew Knight, Basics of MATLAB and Beyond, Chapman & Hall/CRC press LLC., 2000
3. W. Fred Ramirez, Computational Methods in Process Simulation, Elsevier Science & Technology Books

Class Schedule

Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course objectives	Program outcomes								
	a	b	c	d	e	f	g	h	i
1						✓		✓	
2						✓		✓	
3						✓		✓	
4						✓		✓	
5					✓	✓	✓	✓	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15

Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML232

Department	**: Chemical Engineering**
Course No.	**: CML233**
Course Title	**: Environmental engineering**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The aim of this course is to make students aware about the environmental problems, methods to treat the wastes and also develop analytical ability to identify and solve the environmental problems mainly related with chemical industry.

Pre-requisites: None

II. Textbooks:

1. Mahajan S.P. Pollution Control in Process Industries, Tata McGraw Hill Book Co.
2. Pandey G.N. and Camey G.C.; Environmental Engineering, Tata – McGraw Hill Book Co., New Delhi (1989)
3. David L; Weber W.J. Environmental Engineering Handbook, Physico – Chemical Processes for Water Quality Control,Lewis Publishers.
4. Sincero A., Environmental Engineering, A Design Approach. , Prentice – Hall of India, New Delhi (1996)

III. Objective:

To study the interrelationship between living organism and environment, natural resources, pollution control and waste management.

IV. Outcomes:

1. Understand key current environmental problems.
2. Be able to analyse an industrial activity and identify the environmental problems.
3. Be able to plan strategies to control, reduce and monitor pollution.
4. Be able to select the most appropriate technique to purify and/or control the emission of pollutants.
5. Be conversant with basic environmental legislation.

V. Expanded Course description:

1. Man and environment, biogeochemical cycles, Biosphere and ecosystem, Forest Nutrient cycles and the parameters responsible for the disturbance of these cycles.

2. Mobile and stationary sources of air pollutants, air pollution, behaviour of pollutants and atmospheric chemical reactions, air pollution control processes, atmospheric dispersion of pollutants, models for dispersion, limitations of models, effective stack height concept, gas sampling and analysis.

3. CO, CO_2, H_2S, SO_x, NO_x emissions and their control, desulphurization. Sources of water and pollutants, classification and characterization of solid, liquid and gaseous waste, measurement of levels of pollution such as DO, BOD, COD, TOC,ThOD, soluble and suspended volatile solids, Water quality and discharge

standards.Unit operations such as screening, coagulation, flocculation, filtration, clarification, solvent extraction.

4. Chemical treatment of waste material, oxidation, chlorination, Ozonation, incineration etc. Biological Treatment,biochemical kinetics, microbial kinetics, microbial growth.

5. Aerobic and anaerobic waste treatment, activated sludge process, aerated lagoons, anaerobic digesters, Biogas & trickling filters & its utilization. Solid Waste & its disposal pyrolysis (Incineration, Composing and filling etc.).

6. Measuring environmental impacts, life cycle analysis, legislation controlling discharges, optimal degree of abatement, and policies for regulation of environmental impacts.

VI. Class Schedule
Three 55 minutes session per week.

VII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses Outcomes to Program Outcomes								
a	b	c	d	e	f	g	h	i
X				X		X	X	X
X				X		X	X	X
X	X		X	X		X	X	X
X	X	X	X	X		X	X	X
				X		X	X	X

VIII. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	20
Session 2 Exam	1 hour	20
Project		20
End Semester Exam	3 hours	40

IX. Chamber Consultation Hours
To be announced in the class.

X. Notices
Notice will be displayed on Chemical Engineering Notice Board.
Course Coordinator

CML233

Department	**: Chemical Engineering**
Course No.	**: CML234**
Course Title	**: Industrial Waste Treatment**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

Our objective is to discuss engineering aspects of industrial Pollution Control Technologies. The emphasis in this course will be the control of gaseous ,liquid and solid pollutants.

II. Pre-requisites: None

III. Textbooks:

1. Industrial Waste Treatment,Nemerow N.L,Butterworth-Heinemann,1st
2. Pollution Control in Process Industries,S. P. Mahajan,Tata McGraw Hill ,1st
3. Industrial Waste Treatment Handbook,Frank Woodard,Butterworth-Heinemann, 1st
4. Environmntal pollution control engineering,C.S.Rao,New Age International, 2nd
5. Industrial Pollution Prevention Handbook, Freeman H. M.,McGraw Hill,1st

IV. Objectives:

1. To understand the effect of air, water and solid pollutant on public health and on environment.
2. To study the different methods of sampling.
3. To describe the different control strategies to protect the ecosystem from adverse effect of pollutants.
4. To identify waste management practices and technologies adapted by different industries.

V. Outcomes:

1. Student will gain the knowledge of adverse effect of different pollutants on public health and on ecosystem.
2. Students will learn the different methods of collection and measurement of air pollutant.
3. Students will learn different methods to control the different pollutants.
4. Students will gain the knowledge of conventional methods as well as new methods to control the pollution.

VI. Expanded Course description:

Nature and characteristics of industrial wastes; Sources and types of wastes: solid, liquid, and gaseous wastes; Pre-treatment of Industrial wastes, unit operations and unit processes. Sampling Techniques.

Methods for Treating industrial waste gases or air discharges- physical method, chemical method, combined method, biological method.

Solid and Hazardous wastes: definitions, concepts. Incineration, recycling, composting, landfill, On-Site Monitoring and Analysis of Industrial Pollutants.

Waste water treatment-physical, chemical and biological method.

Recent trends in Industrial waste treatment. Application of Biotechnology for Industrial Waste Treatment.

Case Studies:- Example (Treatment of Pharmaceutical Wastes, Treatment Refinery Wastes, Treatment of Textile Wastes, Treatment of Pulp and Paper Mill Wastes, Treatment of Dairy Processing Wastewaters, Treatment of Pesticide Industry Wastes, Food Waste Treatment, Treatment of Rubber Industry Wastes, Treatment of Tannery Industry Wastes and Radioactive waste etc.).

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√			√		√	
2	√	√		√					√
3	√	√						√	
4	√	√				√		√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	55

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML234

Department	**: Chemical Engineering**
Course No.	**: CML383**
Course Title	**: Advance Heat Transfer**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The core subject CML 383 Advance Heat transfer covers the fundamental theory for the analysis of heat transfer processes occurring in heat exchangers, evaporators, jacketed vessels, boilers, furnaces and reactors, reboilers, agitated vessels with and without coils, packed and fluidized beds.

II. Pre-requisites:

Maths, Thermodynamics, Fluid Mechanics

III. Textbooks:

1. Hollman J.P.; Heat Transfer, McGraw Hill, 1993
2. Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd.,2008
3. Cengel Y.A. Heat Transfer: A Practical Approach McGraw-Hill; 2 edition ,2002
4. Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.
5. Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.
6. Dutta B.K. Heat Transfer; Principles and Applications PHI Pvt.Ltd New Delhi ,2006

IV. Objectives:

1. To understand the fundamental theory of heat transfer processes occurring in heat exchangers, evaporators, jacketed vessels, boilers, furnaces and reactors, reboilers, agitated vessels with and without coils, packed and fluidized beds.
2. How to identify, formulate, and solve engineering problems involving heat transfer equipments.
3. How to apply energy balances and rate equations to model and analyze thermal systems.

V. Outcomes:

Students will gain fundamentals, design approach and its application for various heat exchangers, evaporators, jacketed vessels, boilers, furnaces and reactors, reboilers, agitated vessels with and without coils, packed and fluidized beds. Students will have knowledge of different types of heat exchangers, evaporators and their suitability for particular applications, Students can estimate heat exchanger performance given size and inlet conditions and design the geometry required to deliver a desire heat transfer rate.

VI. Expanded Course description:

Classification of heat exchangers, recuperative, regenerative and direct contact type, double pipe heat exchangers, co-current counter, current flow arrangement, overall heat transfer coefficient.

Fixed tube sheet, floated head and U–tube shell and tube heat exchangers, their design procedures, number of passes in heat exchangers, fouling of heat exchangers, baffles in heat exchangers, selection of heating and cooling media for heat exchangers, Troubleshooting of shell and tube heat exchangers, thermal stresses and vibrations in shell and tube heat exchangers.

Plate heat exchangers, design procedure, advantages over shell and tube heat exchangers, spiral plate heat exchangers, helical coil heat exchangers.

Heat Regenerators, fixed and fluidized bed, Evaporators types and their operational characteristics. Single stage and multistage evaporation system, Steam economy, boiling point rise of solution and its effect on evaporation system, rising film and falling film evaporators.

Effectiveness of heat exchanges, NTU method. Heat Transfer in jacketed vessels, boilers, furnaces and reactors, reboilers, heat transfer in agitated vessels with and without coils, Heat transfer in packed and fluidized beds.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√			
2	√	√				√	√	√	
3	√	√				√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CML383

Department	**: Chemical Engineering**
Course No.	**: CML384**
Course Title	**: Safety and Risk Analysis**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

A brief review of the existing standards of safety in chemical process industries and the analysis of event. Hazard identification, different analytical techniques of analysis of hazards regarding Fire and Explosion and Chemical hazards in process industries. This course will terminate with much understanding of the different aspects of safety and hazards and their analytical valuation for prevention and standards for future.

II. Pre-requisites:

None

III. Textbooks:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl and Joseph F. Louvar, Prentice Hall International Series, 2nd Edition
2. Safe and Efficient Plant Operation and Maintenance, Greene R., McGraw Hill Book Co., New York.
3. Safety Management and Practices for Hazardous Units, Dekkar Marcel, McGraw Hill Book Co., New York, 1995
4. Safety and Good House Keeping, Saxena, National Productivity Council, New Delhi (1976), 3rd Edition.
5. Safety in Process Plant Design, Wells G.L., George Godwin Ltd., (1980).

IV. Objectives:

1. To give knowledge of process plant safety, hazardous chemicals, fire and explosion hazards and different methods of hazard identification and its analysis in qualitative and quantitative scales.
2. The students will introduce to personnel safety and case study problems.
3. To develop the social, ethical and environmental responsibility among the students.
4. To develop the safety concepts among the students with detailed understanding of technical knowledge.
5. To develop the responsibility and ability for precautions and remedial actions for any untoward event.

V. Outcomes:

At the end of the course, the student Students will gain knowledge of safety standards to be maintained at process industries and handling of problems related to safety, different methods of hazard identification and their analysis.

VI. Expanded Course description:

Introduction to process plant safety, handling of hazardous chemicals, Lower flammability limit (LFL), UFL, LEL, UEL, TLV, electrostatic hazards, Hazard code and explosive limit, TWA, Ceiling level, Safety in handling of gases, liquids and solids

Flammable liquid hazards, fire and explosion index, fire ball hazards, oil spillage hazards, Bleveuvce, pool fires, jet fires, radiation hazards.

Explosion, emergency and disasters in chemical process plants, onsite and offsite emergency plan, Fire detectors, smoke detectors.

Safely audit of chemical process plants, HAZOP studies, fault tree and event tree analysis.

Resources for combating fires, dry chemical powders, fire fighting foam, fixed and portable fire extinguishers, FMEA.

Risk analysis of chemical processes, risk management, risk identification, personnel training, risk to environment.

OSHA standards, importance of plant layout in safety, importance of site selection, personnel safety, role of human error in losses. Case studies of fires, explosions, disasters in chemical process plants.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√	√			√	√	
2	√	√	√	√	√	√	√	√	√
3					√	√	√		√
4	√	√	√					√	
5	√	√	√	√	√	√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assignments	-	10

End Semester Exam	3 hours	60

X. Chamber Consultation Hours :
To be announced in the class.

XI. Notice
Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator

CML384

Department	**: Chemical Engineering**
Course No.	**: CML385**
Course Title	**: New and Renewable Energy Engg.**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The core subject CML 222 Heat transfer covers concept of various forms of renewable energy, to outline division aspects and utilization of renewable energy sources for both domestics and industrial applications, to analyze the environmental and cost economics of using renewable energy sources compared to fossil fuels.

II. Pre-requisites:

Thermodynamics, Heat Transfer

III. Textbooks:

1. Rai G.D, Solar Energy Utilization , Khanna Publishers, Delhi.
2. Rai G.D, Non-Conventional Energy Sources, Khanna Publishers, Delhi.
3. Twiddle J., Weir T., Renewable Energy Resources, Cambridge University Press, 1986.
4. Veziroglu, N., Alternative Energy Sources, Volume 5 & 6, McGraw-Hill, 1978

IV. Objectives:

1. To understand concept of various forms of renewable energy.
2. To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
3. To analyze the environmental and cost economics of using renewable energy sources compared to fossil fuels.

V. Outcomes:

At the end of the course the student will have knowledge about various renewable energy sources, be able to choose the appropriate renewable energy as an alternate for conventional power in any application.

VI. Expanded Course description:

Introduction : Energy scene of supply and demand in India and the world, Energy consumption in various sectors, potential of non-conventional energy resources, energy needs and energy supply, sources, contribution of non-conventional energy.

Solar Energy: Solar radiation and its measurement, characteristics and estimation, limitations in the applications of Solar Energy, Collectors: flat plate and concentrating types, their comparative study; design and material selection, efficiency, selective paints and surfaces. Solar water heater, applications

of Solar Energy for heating, drying, water desalination, solar concentrators, photovoltaic power generation using silicon cells. Thermal storages, Solar ponds, solar pumps, Solar power, Solar cookers etc. Direct conversion of solar energy to electricity and its various uses, materials, limitations and costs.

Bio- Fuels: Photosynthesis and generation of bio-gas, digesters and their design, selection of material; feed to digester, pyrolytic gasification, production of hydrogen, algae production and their uses.

Wind Energy: Principle of energy from wind, availability, site selection, different types of wind turbines, design criteria and material selection, economics.

Geo-Thermal Energy: Geo-technical wells and other resources dry rock and hot aquifer analysis, harnessing geothermal energy resources

Tidal Energy: Its meaning, causes of tides and their energy potential, enhancement of tides, limitations, different methods of using tidal power. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.

Ocean Thermal Energy: Principle of utilization and its limitations, description of few systems.

Other Non-conventional Energy Sources, fluidized bed combustion, heat from waste and other sources.

Energy Conservation: Principles of energy conservation. Familiarization with the different energy conservation appliances and practices, improved cooking stoves, benefits of improved cooking stoves over the traditional cooking stoves. Scope of energy conservation in the domestic, commercial and agricultural sector.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√			
2	√	√			√	√	√	√	
3	√	√				√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CML 385

Department	**: Chemical Engineering**
Course No.	**: CML386**
Course Title	**: Biotechnology & Biochemical Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

A consideration of the engineering and scientific basis for using cells or their components in engineered systems. Central topics addressed include kinetics and reactor design for enzyme and cellular systems; fundamentals, techniques, and bioseparations. Additional lectures will provide an introduction to metabolic modeling as well as special topics. The course is designed to be accessible to students with engineering backgrounds.

II. Pre-requisites: Mass Transfer, Chemical Reaction Engineering

III. Textbooks:

1. Biochemical Engineering fundamentals By Bailey ollis
2. Bioprocess Engineering:-Basic concept by Shuler & Kargi (PHI)
3. Biochemical Engineering:-principles & concepts by Syed Tanveer Ahmed Inamdar(PHI)
4. Introduction to Biochemical Engineering by D.G.Rao

IV. Objectives:

1. To introduce the essential concepts of bioprocessing to traditional chemical engineers.
2. To make the student aware about advances in Biotechnology.
3. The Program encourages students to work in the field of biotechnology.

V. Outcomes:

Student will gain an ability to apply knowledge of mathematics, bioscience, and engineering. Students will learn to apply the principles of biology, engineering science, along with problem solving skills and critical thinking to a broad spectrum of problems in biotechnology.

VI. Expanded Course description:

Types of micro organisms, structure and function of microbial cells, batch and continuous culture, microbial growth kinetics, enzymes from cells, their function and immobilized kinetics, kinetics of microbial growth.

Enzyme technology and kinetics, enzyme catalysis, enzyme applications in industries and medicines, metabolism and bioenergetics, photosynthesis, synthesis and regulation of bimolecular, fundamentals of microgenetics, role of DNA and RNA.

Reactions catalyzed by enzymes, types of reactors such as CFSTR, Plug flow.

Introduction to Bioreactor design, scale up of bioreactions and bioreactors, volumetric mass transfer rate of oxygen from air bubbles, respiratory model for mycellial pallet, mechanical mixing, aeration, power consumption, heat transfer in bio reactor.

Sterilization techniques, media and air sterilization, death rate of micro organisms.

Introduction to fermentor design, design of fermentors with modified organisms.

Bioreactor modeling and simulation. Design for bioproducts, applications in biochemical and biomedical engineering.

Downstream processing in biochemical industries: such as separation processes for bulk chemicals unit operations such as Ultra filtration, Aqueous two phase extraction.

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1							√		√
2							√		√
3							√		√

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	55

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML386

Department	**: Chemical Engineering**
Course No.	**: CML 387**
Course Title	**: Instrumental Analytical Techniques**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

This course mainly deals with basics and application of various analytical equipments like, gas chromatography, liquid chromatography, gas chromatography mass spectroscopy, liquid chromatography mass spectroscopy, UV visible Spectrophotometer and infra red spectrophotometer etc.

II. Pre-requisites: Basic courses in Fluid mechanics, Heat Transfer and Mass Transfer

III. Textbooks:

1) Harris, D.C., *Quantitative Chemical Analysis,* 7th Edition, W.H.Freeman and company, New York 2006.
2) Bruno, T.J, and Svoronos, P. D. N., *Handbook of Basic Tables for Chemical Analysis*, 2nd Edition, CRC Press, New York 2003.
3) McNair, H. M. and Miller, J. M., *Basic Gas Chromatography*, 1st Edition, John Willy and Sons, Inc, Singapore, 1998.
4) Palvia D. L., Lampman G. M., Kriz G. S. and Vyvyan J. R., *Introduction to Spectroscopy,* 4th Edition, Brooks/Cole, Belmont USA, 2009.
5) Snyder L. R, and Krikland J. J., *Introduction to Modern Liquid Chromatography*, 2nd Edition, A Wiley Inetrscience Publication, New York, 1979.

IV. Objectives:

1) To understand the fundamental analytical chemistry for instrumentation
2) To understand the basic processes used in Instrumental Analytical Techniques
3) To understand the basic working principle of some important analytical instruments like GC, GCMS, LC, LCMS, FTIT, UV-Vis etc

V. Outcomes:

Student will understand basic fundamental and operating principle for different analytical instruments like GC, GCMS, LC, LCMS, FTIT, UV-Vis etc.

VI. Expanded Course description:

An introduction to analytical chemistry: choice of analytical methodology, sampling, sample preparation, chemical analysis, tools for quantitative chemical analysis, quality assurance.

Extraction methods such as liquid-liquid extraction, solid phase extraction, super-critical fluid extraction and accelerated solvent extraction. Cleanup and fractionation methods.

Introduction to Chromatography, high-pressure liquid chromatography (HPLC), gas chromatography (GC) and other chromatographic methods. Detector types with focus on mass spectrometry and hyphenated techniques such as GC-MS and LC-MS.

Introduction to spectroscopic methods (UV-VIS, IR, X-ray, atomic absorption spectroscopy (AAS) and inductive coupled plasma mass spectrometry).

Introduction to data processing, errors in chemical analyses, statistical analyses (including chemometrics) and data presentation. Method development, evaluation, validation and QA/QC measures. Uncertainty analysis.

VII. Class Schedule : Three class a week, each of 55 minutes

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1		√	√						
2		√	√						√
3		√	√						√

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	20
End Semester Exam	3 hours	50

X. Chamber Consultation Hours
To be announce in the class

XI. Notice
To be announce in the class

Course Coordinator

CML387

Department	**: Chemical Engineering**
Course No.	**: CML 393**
Course Title	**: Innovative Design**
Course Type	**: Elective/ Open Course**
Course Credits	**: 3**

Course description

The course focuses on innovative engineering design in a team-based, cross-disciplinary setting. "Innovative Design" implies both identifying and solving real – world problems for real people. The course engages students with a real problem, which has no given solution in an industrial / social context, develop social and collaborative skills, introduce new product development methods in a project environment.

The course emphasizes the use of Project Based Learning where students participate in active and experiential learning through real product development situations. It will start with an open-ended situation of identifying a problem to solve and eventually end with a possible solution that may be implemented.

Objectives

- To contribute to the understanding of human creativity
- To orient students outward, toward the rest of society and to create a broader outlook to face the challenges of the real world effectively
- To augment engineering education by adding the design component in thinking and doing
- To impart product and system building knowledge and skills
- To tackle real life problem by cross-functional and multi-disciplinary team approach

Outcomes

1. Students will be able to identify and define a problem
2. Learn to frame the design challenge properly
3. Ideate and iterate solutions
4. Develop skills and attitudes such as experimentation, design thinking, teamwork, communication, societal context and business context
5. Learn to participate more fully in society

Course Outline

The course Includes following topics

1. **Orientation**
    - *Designing attitude in day-to-day life*
    - *Design thinking*
    - *Social responsibility for product design*
    - *Case Studies of successful designs*
    - *Movie/Documentary Screening*
    - *Project 1 Submission & Presentation*
2. **Problem Mapping**
    - *Knowing problems*
    - *Searching problems*
    - *Project 2 Submission & Presentation*
3. **Ideation Stage**
    - *Defining the Problem Statement*
    - *Available solution*
    - *Prioritizing Solutions*
    - *PAS of shortlisted solutions and their feasibility study*
    - *Proposed Solutions*
    - *Project 3 Submission & Presentation*

Detail course description

1. Orientation

Designing attitude in day-to-day life:

Everybody design/innovate/ jugaad on almost daily basis, examples of everyday research, survey, observations, experimentation and problem solving

Design thinking:

Design thinking including socio-ecological design/empathetic design,

Case Studies of successful designs

Case studies of grass root innovators, UG students of solving real life problems.

Movie/Documentary Screening

Movie on design thinking, design challenges, solutions, IPR etc.

2. Problem Mapping

Knowing problems:

What is the problem? How do people deal with it now? Key pain points?

Understanding user context (social, family, community, ecological, cultural, institutional, technological, political-economic etc.,)

Searching problems

- To do Prior Art Review/Search, Literature/patent/market review, and peer review
- Using NIF database
- List all the problems in hand
- Short list of problems to be taken up
- Shortlist vital challenges

Defining the problem statement

3. Ideation Stage

Available solution

Seeking solutions from existing designs, embedded thumb rules in people's practices, nature's patterns and strategies; constellation of technological, institutional, cultural and ecological endowments in which local practice is embedded

- Mapping of all possible solutions to the problem begin with optimal, wishful thinking, Sub-optimise the ideal solution on the basis of constraints of cost, environment, ease of operation, affordability, maintenance, and other dimensions

Prioritizing Solutions

- short-listing ideas, prioritization and assigning weights
- Preparing Problem Positioning and Analysis Report (PPAR)
- What, Why, How, for whom and Novelty (comparison with existing solutions)
- What are the gender, ecological/circularity (cradle to cradle) sustainability, ergonomic, socio-cultural issues that might affect, or be affected by the proposed solution

PAS of shortlisted solutions and their feasibility study

Form, Feature and functions: analysis of selected solutions (Defining Boundary conditions), making a bill of materials, flow chart of implementation plan; chances and risks

Proposed Solutions

- Paper design of the proposed solution
- Review of the design by functional experts from Technical, Design, Social Sciences, Finance and Fabrication disciplines to give feedback to each team on their shortlisted ideas

Textbooks

1) Ulrich, Karl T. and Steven D. Eppinger, Product Design and Development, 5th edition (2012),Irwin/McGraw-Hill
2) Sir Peter Medawar, *.Advice to Young Scientist,* Alfred P. Sloan Foundation Series, Edition 1st
3) Santiago Ramón Cajal **,** *Advice to Young Investigator,* The MIT Press, Edition 1st

Websites

1) National Innovation Foundation www.nif.org.in
2) Knowledge bank, http://summerschool.sristi.org/

Class schedule

Three 55 minutes session per week**.**

Relationship of Course Outcomes to Program Outcomes:

Course Outcome	Program Outcomes (PO)								
	a.	**b.**	**c.**	**d.**	**e.**	**f.**	**g.**	**h.**	**i.**
1.		√		√		√	√		√
2.		√		√		√	√		√
3.			√	√		√			
4.				√	√	√	√	√	√
5				√		√	√		

Evaluation scheme

Class participation (Individual)	15%
Project 1 (Report on prior art/ nif data base/ literature/ survey/ field visit + Presentation (Individual)	25%
Project 2 (Report on problem mapping and defining problem + Presentation) (Group)	25%
Project 3 (Listing of possible solutions, proposed solution and paper design + Presentation) (Group)	25%
Insight Paper (Individual)	10%

Teaching Modes

Lectures, videos, case studies, small group discussions and exercises. Students are expected to read the assigned chapters and papers before class and to participate actively in class discussions. The sessions are conducted interactively and thus may not follow strictly the presentations slides issued.

Prerequisite:

2nd and 3rd year students of Chemical, Mechanical, Civil, & Metallurgy students

Justification of course

Kakodkar committee has recommended Design Spine in its report (Annexure V) an elementary course is developed based on the recommendations of the Kakodkar committee.

The course was developed by referring “Innovation Enterprise I ” offered in National University of Singapore. The proposed module is reviewed by Professor Prahlad Vedakkepat who teaches this course in NUS.

Course Coordinator

CML393

Department :	**: Chemical Engineering**
Course Number :	**:ML394**
Course Title :	**: Itroduction to Measuring Instrument**
Course Type:	**: Core**
Course Credits :	**: 3**

Objectives

The objective of this course is to familiarize the students with basic working principal and construction of various measuring instrument used in Process industry.

Outcomes

Upon completion of this course, students will acquire knowledge about to:

1. Know the operation of various measuring instruments.
2. Use, calibrate and maintenance of different types of instrumentation systems.
3. Understanding of the construction, material used and principle of operation of various types of measuring instruments.

Expanded course description

1.Introduction to Instrumentation: Role of instruments in industrial processes; Block representation of measurement systems; Need for calibration and standards; Instrument parameters: sensitivity, accuracy, resolution, span, range; Static errors: zero error, proportionality error, hysteresis and maximum non-linearity error, role of transducer.

2.Pressure Measurement: Definition and units; Relationship between absolute, atmospheric and gauge pressures; Relationship between height of a column of liquid and pressure; Use of manometers for pressure measurement; Principle of operation and installation of the following pressure gauges: diaphragm gauges, bellows gauges, Bourdon gauges, strain gauges; Gauge calibration using manometers, dead-weight testers, portable field calibrators and comparators; Pressure transmitters: standard pneumatic and electrical signals.

3.Level Measurement: Factors influencing level measurement; Direct level measuring systems: the dip stick, the sight glass, floats; Pressure operated systems: purged dip pipe, diaphragm box, differential pressure transmitter, manometer; Suitability of specific devices for different liquid conditions; Relationship between level and content (volume and mass) for spherical and cylindrical tanks.

4.Flow Measurement: Volume and mass flow rate; Turbulent flow, streamlined flow and Reynolds number; The Continuity Equation, Bernoulli's Equation and application to differential pressure devices; Differential pressure primary elements: orifice plate, Venturi tube, Dall tube, flow nozzle and pitot-static tube; Installation procedures; Positive displacement flow meters: reciprocating piston, rotating impeller, semi-rotary type; Variable area flow meters; Flow integration and linearization; Calibration of liquid flow

meters: volumetric tank, gravimetric tank, pipe prover, reference meter, standing start and finish, flying start and finish.

5.Temperature Measurement: Thermal expansion thermometers: liquid in glass, bimetallic, liquid in metal, vapour pressure, and constant volume gas; Metal resistance thermometers an thermistors : theory, types, industrial installation and applications; Thermocouples: Seebeck effect, base metal and rare metal thermocouples, their metal combinations, operating ranges and uses; Law of Intermediate Metals and Law of Intermediate Temperatures; Practical application of these laws in the use of thermocouples; Installation techniques; Thermowells; Thermometer calibration procedures.

6. Control valve: Pressure drop across the valve, valve noise, flow characteristics of linear & equal percentage control valves on load changes. Control valve selection, Seat leakage & calibration.

Textbooks

1. Measurement and Instrumentation Principles, Alan S. Morris, Butterworth-Heinemann, (2001), ISBN: 0750650818

2. Temperature Measurement, L. Michalski, John Wiley & Sons, (2001), ISBN: 0471867799

3. Industrial Flow Measurement, 3rd Edition, David W. Spitzer, ISA (2000) ISBN: 1556178719

4. Measurement and Control Basics,3rd Edition, T. A. Hughes, ISA (2002) ISBN: 155617764X

Reference Book

1. Instrument Engineers' Handbook 4th Edition – Process Measurement and Analysis, Volume 1,B.G. Liptak, ISA, (2003), ISBN: 0849310830.

2. Industrial Instrumentation and Control, W. Buchanan, Butterworth- Heinemann, (1999),ISBN: 0340719222.

Class schedule

Three 55 minutes session per week**.**

Relationship of Course Outcomes to Program Outcomes:

Course Outcome	Program Outcomes (PO)								
	a.	**b.**	**c.**	**d.**	**e.**	**f.**	**g.**	**h.**	**i.**
1.	√	√				√		√	
2.	√	√				√		√	
3.	√	√				√		√	
4.	√	√				√		√	
5.	√	√				√		√	
6.	√	√				√		√	
7.	√	√				√		√	

Evaluation of Students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Design Project		25
Video making		05
End Semester Exam	3 hours	40

Notice : Notice will be displayed on Chemical Engineering Notice Board

Course Coordinator

CML394

Department	**: Chemical Engineering**
Course No.	**: CHL336**
Course Title	**: Polymer Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic polymeric material, its properties and its application to chemical engineering

Syllabus: Introduction to Polymeric Materials : Structure of polymers - Linear, branched, cross linked, classification of polymers.

Polymerisation Types and Techniques: Distinctive features of addition and condensation polymerisation, Mechanisms of addition polymerisation, radical, Ionic, Co-ordination, Copolymerisation. Block & graft copolymers. Chemistry of thermoplastic and thermosetting polymers, Solid State polymerisation. Advanced polymerization techniques using Ziegler-Natta catalysts, metallocenes etc. Bulk, solution, suspension and emulsion polymerization technique. Polymer Processing: Analysis of polymer processing. rheology of polymers, flow in tubes, calendaring, extrusion, injection modeling, fiber spinning, and coating.

Polymer Structure – Property - Relationships: Effect of chemical composition on various properties of Polymer, Mechanical properties: Stress-strain in polymers, elasticity, tensile strength;Transition Properties : Glass transition (Tg), melt transition (Tm);Electrical Properties : Dielectric constant, power factor, dissipation factor; Optical Properties: Chemical Properties : Cohesive energy, solubility parameter, Polymer toxicity; Physical properties of polymers and adhesives. Phenolic, Epoxy and Polyurethane structural adhesives.

Engineering and Speciality Polymers: Polyolefins; Polyamide; Biopolymer : Insulating Polymers; Polymer blend and alloys; Inorganic polymers; Conducting polymers.

Polymer Composite: Fundamentals of polymer composites, Different type of Polymer Composites, Different reinforcement and matrices, fiber and polymer matrix properties, interfacial adhesion, and manufacturing.

References

1. BillMeyer F. W., Textbook of polymer science,3rd edition, John Wiley & Sons

2. Gowarikar V.R. and Viswanathan N.V., Jayadav Sreedhar ,Polymer Science, Wiley Eastern Limited.

3. Askeland W.D.,The Science & Engg. of Materials, Academic Press.

4. Bueche F., Physical properties of polymers, Wiley, New york, 1962.

5. Clegg D.W., Structure & Properties of Polymers, Elseveir Publication,2005.

6. Fried J. R., Polymer Science & Technology, 3rd edition, Interscience, New York.

7. Ku C.C.& Liepins R., Electrical Properties of Polymers Hanser Publications, Munich,1987.

8. Seanor, D.A., Electrical properties of polymers, Acadamic press, Newyork, 1982.

Class Schedule : Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√	√	
2	√	√				√		√	
3	√	√				√	√		
4	√					√	√		

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CHL336

Department	**: Chemical Engineering**
Course No.	**: CHL369**
Course Title	**: Green Chemistry and Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic advancement in technology with less environmental damage and its application to chemical engineering

Syllabus: Introduction to environmental issues- Air, Water, Land, Biodiversity, Solid waste, Air quality issues – NO_x, HCs and VOCs. Ground level ozone, Pb, particulates, SO_x, NO_x and acid deposition; Water Quality issues Ecology; Waste flows – sources, trends, preventive environmental management, (PEM). Global environmental and energy issues, Global warming, Ozone depletion.

Environmental Laws and Regulations – Indian rules and regulations; Indian scenario vis-à-vis global

scenario paradigm shift from end – of – pipe to front - end pollution prevention and waste minimization.

Green Chemistry - Green Chemistry principles and methodologies – alternative feedstocks, green solvents, synthesis pathways, inherently safer chemistry; Environmental ethics – roles and responsibilities of chemical engineers for chemical process safety and environmental protection, Industrial ecology.
Evaluation and Improvement of Environmental Performance of Chemical Processes - Evaluation of environmental fate, estimation of ecosystem risks, classification of environmental risks. Evaluation of exposures–workplace characterization, exposure pathways, monitoring worker exposure, Designing safer chemicals; Design for environment (DFE), Life cycle assessment.

Evaluation of environmental performance during process synthesis –Environmental performance tools – Economic criteria, environmental criteria, Threshold limit values (TLVs), permissible exposure limits (PELs), and Recommended exposure limits (REL s), Toxicity weighting; evaluating alternative synthetic pathways; Environmental release assessment. Release quantification methods and modeled release assessments. Integrated with Hazard and Operability (HAZOP) analysis.

Green Engineering: Principles of green engineering, pollution prevention for chemical reactors; pollution prevention in storage tanks and fugitive emission; pollution prevention assessment. Assessment of environmental performance, Concepts of sustainability and sustainable processes.

Flowsheet Analysis for Pollution Prevention and evaluation of Environmental performance of a flow sheet: Process and energy integration; optimizing strategies for segregation, mixing and recycling of streams; Evaluation of environmental performance of a flow sheet – Fugacity capacity, intermedia transport, reaction loss processes, Metrics for environmental risk evaluation of process design with respect to environment.

References

1. Ahluwalia V.K. and Kidwai M. New Trends in Green Chemistry, Anamaya Publishers, New Delhi
2. Anastas P.T. and Williamson T.C. Green Chemistry, Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1998)
3. David T. Allen & David R Shonnard, Green Engineering: Environmentally Conscious Design of Chemical Process, Prentice Hall PTR.
4. Lancaster M (Mike), Green Chemistry: An Introductory Text, Royal Society of Chemistry, 2002.

Class Schedule : Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√	√	
2	√	√				√		√	
3	√	√				√	√		
4	√					√	√		

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CHL369

Department	**: Chemical Engineering**
Course No.	**: CML422**
Course Title	**: Plant Utility**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The course covers the major utilities required for process plants such as water and its treatment, properties of steam and boiler performance, different refrigerants and refrigeration cycle , air compressor and psychometric properties. It also involves the basic calculations for evaluating the performance of steam generation, refrigeration, compressor and cooling tower.

II. Pre-requisites: none

III. Textbooks:

1. Chattopadhya Boiler operations Tata McGraw Hill, New Delhi

2. Yadav R. Thermodynamics & Heat Engines Central Publishing House

3. Lyle O. Efficient Use of Steam Prentice Hall 1963

4. Mahesh Rathore Thermal Engineering McGraw Hill,

IV. Objectives:

1. State the principles involved during water treatment, generation of steam and its uses, refrigeration cycles.
2. Describe the different equipments used to run the process plant with different utilities.
3. Acquire the knowledge for selection of different utilities.
4. Understand basic calculation involved in steam generation, psychometric operation and refrigeration

V. Outcomes:

At the end of the course student will be able to describe the different utilities used to run the process plant. Acquire the knowledge for selection of different utilities. Understand basic calculation involved in steam generation, psychometric operation, cooling tower and refrigeration.

VI. Expanded Course description:

1. *Importance of utilities :*

Sources of water, hard and soft water , Requisites of industrial water and its uses, Methods of water treatment, Chemical softening, Demineralization, Resins used for water softening, Reverse osmosis and membrane

separation, Effects of impure boiler feed water & its treatments., Scale & sludge formation, Corrosion, Priming & foaming, Caustic embrittlement.

2. Refrigeration:

Refrigeration cycles 04, Different methods of refrigeration used in industry, Vapour compression, Vapour absorption: Lithium bromide (eco-Friendly)‘ Different refrigerants‘ Monochlorodifluoro methane (R-22)‘ Chlorofluorocarbons (CFC-Free) ‘ Secondary refrigerants: Brines’ Simple calculation of C.O.P. Refrigerating effects.

3. *Steam and steam generation:*

Properties of steam, Problems based on enthalpy calculation for wet, steam, dry saturated steam, superheated steam,, Types of steam generator / boilers: water tube & fire tube, Solid fuel fired boiler. , waste gas fired boiler., Waste heat boiler., Fluidized bed boiler., Scaling, trouble shooting, preparing boiler for inspection, Steam traps, boiler mountings and accessories , Boiler Act.

4. *Psychrometry:*

Properties of Air-water vapors. Use of humidity chart , Equipment used for humidification, dehumidification ,Evaporative cooling, spray ponds, cooling towers .

5. Air:

Use of Compressed air, process air and instrument air, Process of getting instrument air.

6. Non steam heating system:

Thermic fluid heater, Down therm heater , Temperature range , Principle, construction & working.(3-Hr)

VII. Class Schedule : Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√	√	√	
2	√	√				√		√	
3	√	√				√	√		
4	√					√	√		

IX. Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML422

Department	**: Chemical Engineering**
Course No.	**: CML 423**
Course Title	**: Optimization Technique**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

This course mainly deals with basics of different optimization techniques and its application for various engineering purpose.

II. Pre-requisites: Numerical methods, Basic Math's

III. Textbooks:

1) Edgar, T.F., D.M. Himmelblau, and L.S. Lasdon, Optimization of Chemical Processes, 2nd Edition, McGraw-Hill International Edition, Singapore, 2001.
2) Rao, S.S., Engineering Optimization Theory and Practice, 4th Edition, A Wiley Inetrscience Publication, Canada, 2009.
3) Reklaitis, G.V., A. Ravindran, and K.M. Ragsdell, Engineering Optimization: Methods and Applications, 2nd Edition, John Wiley, New York, 2006.
4) Fletcher R., Practical method of optimization, 2nd Edition, John Wiley, New York, 2000.
5) Chong E.K.P. and Zal S. H., An Introduction to optimization, 2nd Edition, John Wiley, New York, 2001.
6) Nocedal J. and Wright S.J. Numerical Optimization, 2nd Edition, Springer,2000.
7) G. Mitsuo and C. Runwei, Genetic Algorithms and Engineering Optimization, John Wiley, New York, 2000.

IV. Objectives:

1) To understand the basics of optimization techniques, and problem formulation for optimization
2) To understand the single variable and multivariable optimization techniques and their application
3) To understand the linear programming application for optimization
4) To understand the advance optimization technique like genetic algorithm

V. Outcomes:

1) Student will understand necessary and sufficient condition for optimization and will be able to formulate the optimization problem.
2) Student will be able to solve different optimization problem and their application to the case studies like heat exchanger, evaporator etc

VI. Expanded Course description:

Nature and organization of optimization problems: what optimization is all about, Why optimize, scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization. Classification of models, how to build a model, fitting functions to empirical data, the method of least squares, factorial experimental designs, fitting a model to data subject to constraints.

Basic concepts of optimization: Continuity of functions, unimodal versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function, interpretation of the objective function in terms of its quadratic approximation.

Optimization of unconstrained functions: one-dimensional search:

Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni-dimensional search, region elimination methods, polynomial approximation methods, how the one- dimensional search is applied in a multi-dimensional problem, evaluation of uni-dimensional search methods.

Unconstrained multivariable optimization:

Direct methods, random search, grid search, uni-variate search, simplex method, conjugate search directions, Powell's method, indirect methods- first order, gradient method, conjugate method, indirect method- second order: Newton's method forcing the Hessain matrix to be positive definite, movement in the search direction, termination, summary of Newton's method, relation between conjugate gradient methods and Quasi-Newton method.

Linear programming and applications:

Basic concepts in linear programming, Degenerate LP's – graphical solution, natural occurrence of linear constraints, the simplex method of solving linear programming problems, standard LP form, obtaining a first feasible solution, the revised simplex method, sensitivity analysis, duality in linear programming, the Karmarkar algorithm, LP applications.

Optimization of Unit operations-1 recovery of waste heat, shell & tube heat exchangers, evaporator design, liquid liquid extraction process, optimal design of staged distillation column.

Optimization of Unit operations-2 Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor, chemostat, optimization of thermal cracker using liner programming.

Genetic Algorithms: (Qualitative treatment) Working principles, differences between GAs and traditional methods, similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, real coded GAs, Advanced Gas

VII. Class Schedule : 3 Classes a week each of 55 minutes

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√					√			√
2	√								√
3	√								√
4	√								√

IX. Evaluation of students

Component	**Duration**	**Weightage**

Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	20
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announce in the class

XI. Notice

To be announce in the class

Course Coordinator

CML 423

Department	**: Chemical Engineering**
Course No.	**: CML424**
Course Title	**: Petroleum Refinery Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

A brief review of the basic principles and existing techniques of petroleum refinery such as exploration of crude oil, characterization and fractionation into usable petroleum products. Recent advancements in secondary processes on the above areas to meet the revised standard and specification of the petroleum products. This course will end up with understanding of the fundamentals of refinery and present and future requirements of the refinery/oil sector.

II. Pre-requisites:

CML 361, CML366

III. Textbooks:

1. Modern Petroleum Refining Processes, Bhaskara Rao B.K., Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi., Edition 3rd
2. Petroleum Refining Engineering, Nelson W.L.., Tata McGraw Hill Publication Co. Ltd. (1985), 4th Edition.
3. Petroleum Refining Technology and Economics, Gary J.H. & Handwerk G.E., Marcel Dekker, Inc., New York, 3rd Edition
4. Petroleum Refining Manual, Noel H.M., Publisher Reinhdd Pub. Corp., New York.
5. Modern Petroleum Technology, Hobson G.D. & Rohl W., Applied Science Publication, 4th Edition.

IV. Objectives:

1. To develop the fundamentals of refining of petroleum crude oil and its fractionation in different useful petroleum products.
2. The student will be aware to the product quality, related environmental concern and the standards by applying the different primary, secondary and advanced refinery processes.
3. The student will be aware to problems and remedies in petroleum sector.
4. To develop the skill and knowledge for upgradation of petroleum refineries as per present and future demand.
5. To develop the responsibility of technological inputs related to energy and environmental demand.

V. Outcomes:

At the end of the course, the student will understand the fundamentals and advances in refinery sector. Students will gain detailed knowledge of exploration of crude oil, its fractionation into different useful petroleum products, their quality, related environmental concerns and the standard by the recent and updated technology. The students will be able to visualize the scenario of refinery in India and abroad and can work in refineries and R&D sector of the related area.

VI. Expanded Course description:

Unit I (6 hrs) : Fundamental principles of origin and occurrence of petroleum crude and its exploration, Composition of petroleum, classification and physical properties, Characterization of crude oil and petroleum products, status of petroleum refining in India, future refining trends.
Unit II (6 hrs): Crude oil Distillation Process, Pretreatment of crude, atmospheric and vacuum distillation process
Unit III (6 hrs) : Secondary conversion processes: Thermal and catalytic cracking, Catalytic reforming, Pyrolysis
Unit IV (6 hrs): Heavy Residue Upgradation Technologies: Hydrocracking, Hydrotreating, visbreaking and coking, alkylation, Isomerisation, dehydrogenation processes, polymerization.
Unit V (6 hrs): Lubricating oil, grease and Bitumen: Dewaxing and deoiling, deasphalting, lube hydrofinishing, bitumen air blowing, Sweetening and Desulphurization, Hydrodesulphurisation of petroleum products.
Unit VI (6 hrs): Energy conservation in petroleum refineries. New Trends in petroleum refinery operations, Biorefinery concept.

VII. Class Schedule : Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√	√				√	√	
2	√	√	√		√	√	√	√	√
3	√	√	√	√	√	√	√	√	√
4	√	√	√	√	√	√		√	
5					√	√	√	√	√

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours
To be announced in the class.

XI. Notice
Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator

CML424

Department	**: Chemical Engineering**
Course No.	**: CML425**
Course Title	**: Membrane Technology**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The core subject CML 425 Membrane Technology covers concept, design and application of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation

II. Pre-requisites:

Heat Transfer, Fluid Mechanics

III. Textbooks:

1. Geankoplis, Transport Processes And Separation Process principles, Prentice-Hall of India Private Ltd , New Delhi.
2. Richardson J.F., Harker J.H., Chemical Engineering, Vol. II, Butterworth Heinemann, New Delhi.2006.
3. Nath K., Membrane Separation Process, Prentice-Hall of India Private Ltd , New Delhi 2008

IV. Objectives:

1. To introduce the concept of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation
2. To design of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation etc.
3. To introduce application of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration etc.

V. Outcomes:

Students will gain fundamentals, design approach and its application for various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation

VI. Expanded Course description:

Principles, characteristic, and classification of membrane separation processes; Membrane materials, structures, and preparation techniques; Membrane modules; Plant configurations.

Membrane characterization: Pore size and pore distribution; Bubble point test; Challenge test; Factors affecting retentivity, concentration polarization, gel polarization, fouling, cleaning and regeneration of membranes.

Mechanisms of separation: Porous membranes, dense membranes, and liquid membranes.

Membrane separation models: Irreversible thermodynamics; Capillary flow theory; Solution

diffusion model; Viscous flow models; Models for separation of gas (vapour) mixtures;

Science and technology of microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation, liquid membrane permeation, gas permeation.

Membrane reactors: Polymeric, ceramic, metal and bio-membrane

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√			
2	√	√				√	√	√	
3					√	√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CML425

Department	**: Chemical Engineering**
Course No.	**: CML426**
Course Title	**: Polymer Processing**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

Basics on different types of polymers, structure-property relationship, different processing techniques for polymers, their rheology, testing for various properties, management of polymer wastes and its recycling are stressed in this course.

II. Pre-requisites: None

III. Textbooks:

1. Gruenwald G, Plastics - How Structure Determines Properties, Hanser Publishers, 1993
2. Baird D. G. and Collias D. I., Polymer Processing Principles and Design, Butterworth-Heinemann, 1995
3. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons Inc., New York, 2nd edition, 1998.
4. J.S.Anand, K.Ramamurthy, K.Palanivelu, How to identify Plastics by Simple Methods, CIPET, Chennai, 2nd edition.
5. Anthony L. Andrady (Ed.), Plastics and the Environment, Wiley Interscience, New York.

IV. Objectives:

1. To understand the basics on polymers and methodologies to improve the properties of polymeric materials.
2. Provide students with a basic understanding of polymer processing techniques and rheological behavior.
3. Increase the student's ability to identify plastics by simple tests.
4. To understand standard testing methods for evaluation of different properties.
5. To enhance knowledge on importance of plastic waste management and recycling techniques.

V. Outcomes:

At the end of the course, the students would able to explain the polymer processing techniques and have knowledge to opt a particular technique for production of specific products. The students will learn effective ways of handling polymer wastes (without having any environment issues).

VI. Expanded Course description:

1. Introduction:

Comparison of thermoplastics and thermoset plastics; Thermoset plastics - Types of resins, Interpenetrating Polymer Networks (IPN); Thermoplastics- Types of aliphatic and aromatic thermo plastics, copolymers, Blends and alloys; Liquid crystal plastics; cellular plastics; oriented plastic materials.

2. Processing:

Basics of process design, Classification & general aspects ofprocesses - molding& forming operations, Post die processing; Decoration of plastics - Printing, Vacuum Metalizing, In-mold decoration.Additives & Compounding - Different types of additives**,** Batch mixers, continuous mixers, Dispersive and distributive mixing, Characterization of mixed state.

Fundamentals on Viscous & Viscoelastic behavior of polymer melt, Rheological measurements and Polymer processability. Non isothermal aspects - Temperature effect on rheological properties, Crystallization, Morphology & Orientation, plastic memory, Molecular weight effects on processing and properties.

3. Properties & Testing of plastics:

Basic concepts of testing,National & International standards, Test specimen preparation, Pre conditioning & Test atmosphere.

Identification of plastics by simple test - Visual examination, Density, Melting point, Solubility test, Flame test, Chemical tests.

Effect of shape & structure on material properties, Long - term & short - term mechanical properties, crazing, Permeability & barrier properties, Environmental-stress cracking, Melt flow index, Heat deflection temperature, Vicat softening temperature, Glass transition temperature, thermal conductivity, Co-efficient of thermal expansion, Shrinkage, Thermal stability, Flammability.

4.Waste management & Recycling:

Plastics waste and the associated problems, Integrated waste management - source reduction, recycling & sustainability correlation, energy recovering process. Environmental issues, policies and legislation in India.

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course objectives	Program outcomes								
	a	B	c	d	e	f	g	h	i
1						✓		✓	
2	✓	✓				✓		✓	
3			✓			✓		✓	
4			✓			✓		✓	
5		✓			✓	✓	✓	✓	✓

IX. Evaluation of students

Component	**Duration**	**Weightage**

Session 1 Exam	1 hour	20
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML426

Department	**: Chemical Engineering**
Course No.	**: CML427**
Course Title	**: Advance Separation Process**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

A brief review of the existing separation technologies such as adsorption-based separation, membrane separation, cryogenic separation, multi-component distillation, and biotechnology based separation. Recent advancements on the above areas and new separation processes such supercritical extraction, hybrid systems, reactive separation etc. will be covered. This course will terminate with several design projects on real life problems.

II. Pre-requisites: None

III. Textbooks:

1. Separation Process Principles, Seader J. D., Henley E. J., Wiley, 2001, 2nd Edition
2. Chemical Engineering Vol. 2, Richardson J. F., Harker J. H., Elsevier, 2002, 5th Edition.
3. Natural Extract using Supercritical CO_2, Mukhopadhyay M., CRC Press, 2000, 1st Edition.
4. Membrane Separation Processes, Nath K., Prentice Hall of India, 2008, 1st Edition.
5. Bio-separations: Principles and Techniques, Sivasankar B., Prentice Hall of India, 2005, 1st Edition.

IV. Objectives:

1. Continuous research and development activities across the world have enhanced the scope of chemical engineering application in the field of separation technology. This course gives the basic overview of the existing technologies such as adsorption, membrane separation, cryogenic separation and biotechnological separation.
2. It also covers upcoming topics such as reactive distillation, supercritical fluid extraction etc.
3. Another interesting feature of this course is that it gives the students a perspective of the application of these technologies via projects related to recent research topics.

V. Outcomes:

At the end of the course, the student will understand the advances in conventional and new separation processes. The students will be able to apply these principles for the separation of various components by considering their advantages and disadvantages for application and design.

VI. Expanded Course description:

Course content: Unit I + Any four Units from Unit II to Unit VIII

Unit I (4 hrs): Overview of Separation Processes:Introduction / Revision of various Conventional Separation Processes and their applications, advantages, and disadvantages, Need of advance Separation processes, types, Problems.

Unit II (8 hrs):Reactive Separations: Introduction, Concept of reactive separations, types of reactive separations, reactive distillation, membrane based reactive separations, reactive extraction, reactive

adsorption, reactive absorption, reactive crystallization, applications, design aspects, scope for future, Problems.

Unit III (8 hrs):Hybrid Separations: Introduction, Concept of hybrid separations, types of hybrid separations, networking or combination of various separation processes, applications, design aspects, scope for future, Problems.

Unit IV (8 hrs):Membrane Separations: Introduction, type of membrane separations, membrane, membrane materials, ultrafiltration, microfiltration, nanofiltration, reverse osmosis, pervaporation, type of membrane modules, membrane fouling, concentration polarization, various mathematical models for membrane processes, application, design considerations, Problems.

Unit V (8 hrs):Supercritical Fluid Extraction: Introduction, Concept of super critical extraction, factors affecting supercritical extraction, properties of supercritical fluid, applications, design considerations, Problems.

Unit VI (8 hrs):Multi-component Distillation: Introduction, need of multi-component distillation, methods of multi-component distillation, design methods of multi-components distillation Problems.

Unit VII (8 hrs):Chromatographic Separation: Introduction, Principles, Classifications, High performance liquid chromatography, ion exchange chromatography, affinity chromatography, reversed phase chromatography, gas chromatography, application, Problems.

Unit VIII (8 hrs):Bio-separation Processes: Introduction, overview of bioseparations, cell disruption, filtration, centrifugation, adsorption, extraction, membrane separation, precipitation, chromatographic separation, Applications, Problems.

Unit VIII (8 hrs):Electro-kinetic Separation: Introduction, Various methods, Electrophoresis, Capillary electrophoresis, Isoelectric focusing, Esotachophoresis, Electro-floatation, Applications, Problem.

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√		√					√	
2	√	√	√			√		√	
3	√	√	√			√	√	√	

IX. Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests, Quizes and Assig.	-	20
End Semester Exam	3 hours	50

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator:

CML427

Department	**: Chemical Engineering**
Course No.	**: CMP427**
Course Title	**: Separation Process**
Course Type	**: Elective**
Course Credits	**: 1**

I. Course description:
Lab experiments on various equipments / instruments related to separation process.

II. Pre-requisites: None

III. Textbooks:
1) Separation Process Principles, Seader J. D., Henley E. J., Wiley, 2001, 2nd Edition
2) Chemical Engineering Vol. 2, Richardson J. F., Harker J. H., Elsevier, 2002, 5th Edition.
3) Natural Extract using Supercritical CO_2, Mukhopadhyay M., CRC Press, 2000, 1st Edition.
4) Membrane Separation Processes, Nath K., Prentice Hall of India, 2008, 1st Edition.
5) Bio-separations: Principles and Techniques, Sivasankar B., Prentice Hall of India, 2005, 1st Edition.

IV. Objectives:
1. To give the exposure of various equipments
2. Handing the instruments related to separation process.
3. Designing the experiments

V. Outcomes:
At the end of the course, the student will understand the basic concepts and operations of various lab equipments / instruments related to separation process.

VI. Expanded Course description:
Study of Membrane Bioreactor

Study of Pervaporation (1)

Study of pervaporation (2)

Study of fermentor : Ethanol production

Study of fermentor: Carboxylic acid production

Study of Reactive Extraction (1)

Study of Reactive Extraction (2)

Study of Supercritical Extraction (Design)

Study of Multi-component Distillation (Design)

Study of hybrid separation (Design)

Study of Membrane Filtration (Design)

Total Experiments to be conducted / designed: Eight

Any six from first eight + Any two from remaining

VII. Class Schedule

Two hours per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1			√					√	
2		√	√			√		√	
3	√	√	√			√	√	√	

IX. Evaluation of students

Component	**Duration**	**Weightage**
Internal	2 hrs per week	60
Class tests, Quizes and Assignments	-	20
Final Submission andviva	--	20

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber and Chemical Engineering Notice Board.

Course Coordinator

CMP427

Department	**: Chemical Engineering**
Course No.	**: CML428**
Course Title	**: CFD for Chemical Engineers**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The course covers the fundamentals of Computational Fluid Dynamics (CFD). The CFD techniques that can be applied for solving practical problems in fluid flow / heat transfer is discussed. Illustration on application of CFD in solving industrial problem is discussed.

II. **Pre-requisites:** Numerical methods, Fluid mechanics

III. Textbooks:

1. H. K. Versteeg and W. Malalasekera, An introduction to CFD, Longman Scientific and Technical, 1st edition, 1995.
2. S. V. Patankar,Numerical heat transfer and fluid flow, Mc Graw-Hill Book Company, 1st Edition, 1980.
3. P. S. Ghoshdastidar, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st edition, 1998.
4. K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publications, 2nd Edition, 2003.
5. Anderson. J., Computational Fluid Dynamics: The Basics with Applications, Mc-Graw Hill, 1995.

IV. Objectives:

To introduce students to applied computational fluid dynamics (CFD) and to teach them how to solve a fluid flow problem using different numerical techniques available for CFD.

V. Outcomes:

At the end of the course, the student will have understood the principles of computational fluid dynamics, the various numerical techniques available and be in a position to intelligently use this CFD techniques for simulation of practical problems in fluid flow / heat transfer.

VI. Expanded Course description:

Introduction

History, Comparison of the three basic approaches for engineering problems in solving by analytical, experimental and computational methods, Beam advance in computational techniques, Softwares available for CFD.

Problem Formulation

Formulation of problem, Physical and mathematical classification of problems, Types of governing differential equations.

Discretisation

Truncation and Round-off error; Explicit and Implicit approaches; Basic of finite difference method, Finite element method, Finite volume method and Spectral method, Treatment of boundary conditions.

Numerical Solution of Heat Conduction Problems

Steady-state problems, One dimensional heat conduction transfer through a pin-fin, Two dimensional conduction through a plate unsteady state problem, One dimensional transient heat conduction, Explicit and implicit methods, Assessing accuracy and stability of numerical methods.

Numerical Solution of Fluid Flow Problems

Types of fluid flow and their governing equation, Viscous incompressible flows calculation of flow field using the stream function-vorticity method, Calculation of boundary layer over a flat plate, Numerical algorithm for solving complete Navier-Stokes equation-MAC method SIMPLE algorithm, Introduction to standard κ-ε model for turbulent incompressible flow, Project problem.

Introduction of Commercial CFD Packages

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses to Program Outcomes				Program Outcomes								
Type	Credit	Course No	Course Titles	a	b	c	d	e	f	g	h	i
T	6	CML480	CFD for Chemical Engineers									

IX. Evaluation of students

Component	**Duration**	**Weightage**

Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10
End Semester Exam	3 hours	55

X. **Chamber Consultation Hours**
To be announced in the class.

XI. **Notice**
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML428

Department	**: Chemical Engineering**
Course No.	**: CML429**
Course Title	**: Nano Technology**
Course Type	**: Core**
Course Credits	**: 3**

I. Course description:

This course provides new technology and platform for students to learn and apply knowledge of nanotechnology to develop new and improved quality product.

This enables students to learn concepts like CNT's, Nanofluids, Polymer Nanocomposites, Synthesis of various Nanomaterials and it's applications in various fields as per their requirement

II. Pre-requisites:

No pre-requisites

III. Textbooks

1. Gipzjpmg Cap, Ying Wang, Nanostructures and Nanomaterials(synthesis properties and applications, 2nd Edition, USA 2011
2. Jurgen Schulte, Nanotechnology (strategies, industry trends and applications, Willey ,1st Edition, England 2005
3. S.Reich, C.Thomsen, J.Maultzsch, *Carben Nanotubes (Basic concept and physical property, Wiley-VCH,1st Edition, 2004, Weinheim*

IV. Objectives:

1. To give the exposure of various equipments
2. Handing the instruments related to separation process.
3. Designing the experiments

V. Outcomes:

Synthesis of various nanoparticles are performed and their themal property using analytical equipments are done

VI. Expanded Course description:

Introduction to Nanotechnology,

Physical chemistry of solid surfaces: Electrostatic stabilization, steric stabilization

Synthesis of Nanomaterials: Matrix mediated growth technique, sol-gel method, Chemical precipitation method etc,

Application in Chemical Technology: Polymer Nanocomposites-Synthesis, characterization, mechanical, thermal properties etc

Application in Carbon nano tubes: Synthesis, characterization, SWNT,MWCNT, different models used for CNT, method of synthesis-Arc discharge method, lasor ablation method, CVD method etc

Application in drug delivery,
Application in nanofluids: Synthesis of various kind of nanofluids, application in Thermal conductivity, heat transfer coefficient, heat exchanger applications, study of dimensionless analogy, etc
Study of Characterization of nanoparticles techniques: XRD, TEM,SEM,AFM,DSC, TGA,DMA, Rheometer etc

VII. Class Schedule

Three lectures of 60 minutes each per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√		√	√
2	√	√				√	√	√	
3	√	√							
4	√					√		√	√
5	√					√			

Course Objectives

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CML 429

Department	**: Chemical Engineering**
Course No.	**: CMP429**
Course Title	**: Nanocomposite Technology Laboratory**
Course Type	**: Elective**
Course Credits	**: 1**

I. Course description:

Lab experiments on various equipments / instruments related to Nanocomposite materials

Pre-requisites:

Nanotechnolgy

II. Textbooks

4. Gipzjpmg Cap, Ying Wang, Nanostructures and Nanomaterials(synthesis properties and applications, 2nd Edition, USA 2011
5. Jurgen Schulte, Nanotechnology (strategies, industry trends and applications, Willey ,1st Edition, England 2005
6. S.Reich, C.Thomsen, J.Maultzsch, *Carben Nanotubes (Basic concept and physical property, Wiley-VCH,1st Edition, 2004, Weinheim*

III. Objectives:

1) To understand knowledge of new technology
2) To understand the knowledge of Engg/Technology along with science
3) To understand the synthesis rout of Nano particles
4) To understand the applications in various Engg/Tech towards development of new product
5) To understand the approach for modeling for synthesis rout

IV. Outcomes:

At the end of the course, the student will understand the basic concepts and operations of various lab equipments / instruments related to separation process.

V. Expanded Course description:

1. To find glass transition temperature using DSC
2. To find M.P. of Composites using DSC
3. To find Degradation temperature of Composites using TGA
4. To find Rheological behavior of nanofluids of TiO2 Water/EG/Parafine Rheometer
5. To find Tan Delta of Composites Rheometer

6. To find Young's modulus of composites DMA
7. To find Storage modulus of composites DMA
8. To analyze relaxation modulus vs. decay time effect of samples nanomemrane/composites DMA
9. To find effects of thermal aging on melt properties of composites Rheometer
10. Estimation of Polymer Lifetime by TGA Decomposition Kinetics

VI. Class Schedule

Three lectures of 60 minutes each per week.

VII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√	√				√		√	√
2	√	√				√	√	√	
3	√	√							
4	√					√		√	√
5	√					√			

Course Objectives

VIII. Evaluation of students

IX. Chamber Consultation Hours

To be announced in the class.

X. Notice

Notice will be displayed on Notice Board near to Chamber.

Course Coordinator
CMP 429

Department	**: Chemical Engineering**
Course No.	**: CML430**
Course Title	**: Ore and Mineral Processing**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

The course covers the fundamentals of mineral processing , aspects of sampling, particle characterization, comminution and classification, physical processes of mineral concentration involving dense media and gravity separation, magnetic and electrostatic separation and ore sorting techniques, Froth flotation technique etc.

II. Pre-requisites: Mechanical Operations

III. Textbooks:

1. Elements of Mineral Dressing Author Gaudin A.M.;, Publisher New York Edition2nd Edition
2. Mineral Processing Author Pryor E.J; Publisher Kluwar Academic Publishers Edition3rd Edition
3. Elements of Mineralogy Author Rutley F. Publisher Thomas Murray & Co., London
4. A Text Book of Ore Dressing, Author Robert H. & Locke, Richards C.E; Publisher McGraw Hill Co.

IV. Objectives:

1. The objective of this course is to understand the fundamentals of minerals processing
2. To give the basic principles of different unit operation used in mineral dressing
3. To identify various processes and equipment used in mineral processing.

V. Outcomes:

At the completion of the course students will be able to understand the different steps used for the processing of various minerals.

-

VI. Expanded Course description:

1.Mineralogy:

Studies of important metallic and non metallic minerals, their characteristics, origin etc. application of non metallic minerals. Sea as a source of minerals. Status of mineral beneficiation industry in India. Study of some representative beneficiation practices with flow sheets. Sampling methodology and equipments.

2.Comminution:

Primary, secondary and special crushers and their performances. Cylindrical and cylindro-conical ball mills, Rod mills, Tube / Pot mills and their performances, capacities, reduction ratios etc. Dry and Wet Grinding. Open and closed circuit grinding. Work Index calculations. Interlocking and liberation of minerals.

3.Screening:

Sizing and Classification: Standard screening tests and graphical representations of the results.Particle size distribution, Sorting, Sizingand Pneumatic classifiers and their performances.Thickeners, Hydrocyclones etc.Theory and practice of sedimentation and filtration.Working of Rotary vacuum filters.

4.Gravity Concentration Techniques:

Principles of Jigging, Tabling and Heavy Media Separation. Processes with equipments used, important controlling factors in operation and application.Beneficiation practice for arsenopyrite containing scheelite.

5.Froth Flotation:

Natural and Artificial Floatability of minerals. Frothers, Collectors, Depressants, Activators / Deactivators, PH Modifiers, etc. Flotation machines.Study of representative sulphide and non sulphide minerals and non metallic ores.Multistage flotation and Column Flotation.

6.Electrostatic and Magnetic Separation:

Principles of Electrostatic and Magnetic Separation (Dry and Wet type). Separation units used in practices and examples in the industries.Calculation of Recovery and ratio of concentration and Mass balance calculations in ore dressing. Industrial set up of Ore Dressing plant.

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√						√	√	
3	√	√				√	√	√	

IX. Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

X. Chamber Consultation Hours

To be announced in the class.

XI. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 430

Department	**: Chemical Engineering**
Course No.	**: CML433**
Course Title	**: Environmental Engineering Laboratory**
Course Type	**: Elective**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to understand and perform the experiment related to the basic environmental engineering and its application to chemical engineering

Syllabus:

1. Collection of particulate matter using Air sampler.
2. Determination of NO_x and SO_x and CO.
3. Determination of relative humidity of atmosphere.
4. Determination of dissolve oxygen and carbon dioxide.
5. Estimation of B.O.D.
6. Determination of physical properties of water
   a) Density b) pH
   c) Surface tension d) turbidity e) conductance.
7. Chromatographic Separation of compounds.
8. Determination of Cu, Ni, and Co in solution by spectrophotometry.
9. Determination of available chlorine/ free chlorine/Chloride in given water samples.
10. N.P.K. content estimation of soil.
11. Semi-micro determination of nitrogen, sulphur, and halogens.
12. Study of Solvent - Extraction technique for metal ion determinations.

References

1. David L; Weber W.J. Environmental Engineering Handbook, Physico-Chemical Processes for Water Quality Control, Lewis Publishers.
2. Rao M.N. and Dutta A.K., Waste Water Treatment, Oxford & IBH Publishing Co. Pvt. Ltd.
3. Pandey G.N. and Camey G.C., Environmental Engineering,. Tata – McGraw Hill Book Co., New Delhi (1989)

Class Schedule Three 2 hour session per week.

Relationship of Course Objectives to Program Outcomes:

Course Out come	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√		√			√			
2	√		√			√			

Evaluation of students

Component	Duration	Weightage
Practical performance & Record submission	2hour per session	50
Sliptest –I	15 min	10
End Semester Exam	30min	30
viva	10min	10

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CMP431

Department	**: Chemical Engineering**
Course No.	**: CMP434**
Course Title	**: Industrial Waste Treatment Laboratory**
Course Type	**: Elective**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to understand and perform the experiment related to basic industrial waste treatment and its application to chemical engineering

Syllabus:

1. Determination of BOD in the given waste water sample
2. Determination of Dissolved oxygen in the given waste water sample
3. Determination of COD in the given waste water sample
4. Determination of solid content in the given waste water sample
5. Estimation of chloride in a sample (by Moher's Method)
6. Determination of hardness of water by complexometric titration method
7. Determination of acidity/alkalinity of given waste water sample
8. Standard plate count test, bacteriological study.
9. To study water quality test.
10. To study the waste water treatment by Adsorption.
11. To study the waste treatment using membrane separation.
12. To study the monitoring of NOx, SOx, Particulate matter in the ambient air.
13. To study the analysis of physical parameter (moisture content, bulk density, sp. Gravity etc.) of solid waste.

Total experiments to be conducted : Any 10 from above list

References:

1. Industrial Waste Treatment, Nemerow N.L,Butterworth-Heinemann 1st Ed.
2. Pollution Control in Process Industries,S. P. Mahajan, Tata McGraw Hill,1st
3. Industrial Waste Treatment Handbook, Frank Woodard, Butterworth-Heinemann,1stEd.
4. Industrial Pollution Prevention Handbook, Freeman H. M., McGraw Hill,1st Ed.

Class

Course Out come	Programme outcomes

Schedule Three 2 hour session per week.

Relationship of Course Objectives to Program Outcomes:

	a	b	c	d	e	f	g	h	i
1	√		√			√			
2	√		√			√			

Evaluation of students

Component	**Duration**	**Weightage**
Practical performance & Record submission	2hour per session	50
Sliptest –I	15 min	10
End Semester Exam	30min	30
viva	10min	10

Chamber Consultation Hours

To be announced in the class.

Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CMP434

Department	**: Chemical Engineering**
Course No.	**: CML431**
Course Title	**: Entrepreneurship Development**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:

Basics on different types of entrepreneurs, steps involved in setting up a business, tools for running a successful business are stressed in this course.

II. Pre-requisites: None

III. Objectives:

Based on the topics discussed in the class, Student shall be able to prepare a business plan more accurately and able to start up a business.

IV. Outcomes:

9. Explain the requirements to become an entrepreneur.
10. Prepare a Business Plan
11. Describe the strategies for running a business

V. Expanded Course description:

Introduction: Entrepreneur - Traits of Entrepreneurs - Types of Entrepreneurs - Intrepreneur Diffenernce between Entrepreneur and Intrapreneur - Entrepreneurship in Economic Growth, Factors affecting Entrepreneurical Growth.

Motivation : Major motives influencing Entrepreneur- Achivement Motivation Training, Self Rating, Business game, Thematic Apperception Test - Stress Management. Entrepreneurship Development Programs - Need, objectives.

Business : Small Enterprises-definition, Classification - Characteristics, ownership structure-Project Formulation – Steps involved in setting up a Business - Identifying, Selecting a good business opportunity Market survey and Research, Techno economic Feasibility Assessment - Preliminary Project Report-Project Appraisal-Sources of information-Classification of needs and Agencies.

Financing & Accounting : Need-Sources of Finance, Term Loans, Capital structure, Financial Institutions, Management of working capital,Costing Break Even Analysis, Network analysis Techniques of PERT/CPM - Taxation - Income Tax, Excise Duty - Sales Tax.

Support To Entrepreneurs : Institutional Support to Entrepreneurs-Sickness in small Business - Concept, Magnitude, Causes and Consequences, Corrective measures - Government Policy for small Scale Enterprise - Growth strategies in small Industry - Expansion, Diversification, Joint venture, Merger, sub-contracting.

VI. Text Books:

6. Sharma D. D, Total Quality Management, Sultan Chand and Sons, New Delhi.
7. Gupta C. B. and Srinivasan P., Entrepreneurship Development, Sultan Chand and Sons, New Delhi

VII. Reference Books:

1. Khanka S.S, Entrepreneurial Development, S.Chand & Co. Ltd NewDelhi, 1999
2. Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi
3. Rathore B.S. and Dr. Saini J. S , A Handbook of Entreprenuership, Aapga Publications, Panchkula (Haryana).
4. EDII - Faculty & External experts - A Hand Book for new Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1986.

VIII. Class Schedule

Three 55 minutes sessions per week.

IX. Relationship of Course Outcomes to Program Outcomes:

Course Outcomes	Program outcomes								
	a	b	c	d	e	f	g	h	i
1				✓	✓	✓	✓	✓	
2				✓	✓	✓	✓		✓
3				✓	✓	✓	✓	✓	✓

X. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	20
Session 2 Exam	1 hour	20
Business Plan	-	15
Seminar	-	05

End Semester Exam	3 hours	40

XI. Chamber Consultation Hours

To be announced in the class.

XII. Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML431

Department	**: Chemical Engineering**
Course No.	**: CML432**
Course Title	**: Computational transport processes**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand the solving technique for basic transport processes and its application to chemical engineering

Syllabus:

Integral laws for conservation of mass, momentum, angular momentum and energy; Constitutive laws, Differential forms of mass conservation equation, Bernoullis equation; Navier-Stokes, Equations; Differential form of Energy equation. Applications of integral and differential conservation equations. Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes

Governing equations for Fluid flow systems; Solutions of linear and non-linear algebraic equations, Time marching solutions; Discretization of derivatives-finite difference; Finite volume method

Applications of fluid dynamics in modeling flow through porous media and through capillaries, Modeling flow through the human circulatory systems, Drug delivery.

Text Books :

1. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 1980.

2. D. A. Anderson, J. C. Tannehill and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer Hemishphere Publishing Corporation, 1984A

3. K. Muralidhar, T. Sundararajan Computational Fluid Flow and Heat Transfer Narosa Publishing House Second Edition

Class Schedule:
Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√						√	√	
3	√	√				√	√	√	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 432

Department	**: Chemical Engineering**
Course No.	**: CML433**
Course Title	**: Project Planning and Management**
Course Type	**: Elective**
Course Credits	**: 3**

I. Course description:
Intensive coverage of management in a wide range of project applications from concept through operations. Planning, scheduling, controlling, economic analysis, quality control and customer satisfaction are stressed in this course".

II. Pre-requisites: None

III. Textbooks:
1. Mantel, Samuel, Meredith and others, Project Management: Core Text Book, Wiley India Pvt. Ltd., 1st Edition, 2006.
2. S. Choudhary, Project Management, McGraw Hill India.

IV. Objectives:
Provide students with a basic understanding of project management principles and practices.

Increase the student's ability to function effectively on a project team.

Increase the student's ability to function effectively as a project manager.

Improve the student's ability to communicate effectively both orally and in writing.

V. Outcomes:
At the end of the course, the student will understand the project management principles. The students will be able to communicate effectively both orally and in writing.

VI. Expanded Course description:

1. The World of Project Management:

Project Management, Project Management vs General Management, Life cycles of projects, Project selection methods, Case studies, Examples.

2. The Manager, The Organization and The Team:

PM's role, PM's responsibilities to the project, Selection of project manager, Project management as a Profession, Fitting projects into the parent organization, Project team, Case studies.

3. Planning the Project:

The contents of a project plan, Planning process, Work breakdown structure, Multidisciplinary teams, Case studies.

4. Budgeting the Project:

Methods of budgeting, Cost Estimating, Improving cost estimates, Budget uncertainity and risk management, Case studies.

5. Scheduling the Project:

PERT and CPM networks, Project uncertainity and risk management, Simulation, Gnatt chart, Extensions to PERT and CPM, Case studies.

6. Allocating Resources to the Project:

Expediting a project, Resource loading, Resource leveling, Allocating scarce resources to projects

VII. Class Schedule

Three 55 minutes session per week.

VIII. Relationship of Course Objectives to Program Outcomes:

Contribution of Courses to Program Outcomes				Program Outcomes								
Type	Credit	Course No	Course Titles	a	b	c	d	e	f	g	h	i
T	6	CML491	Project Planning and Management									

IX. Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	20
Class tests and Assignments	-	10

End Semester Exam	3 hours	55

X. Chamber Consultation Hours
To be announced in the class.

XI. Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML433

Department	**: Chemical Engineering**
Course No.	**: CML434**
Course Title	**: Computational methods in Chemical Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic different numerical technique and its application to chemical engineering

Syllabus:

This course focuses on the use of modern computational and mathematical techniques in chemical engineering. Starting from a discussion of linear systems as the basic computational unit in scientific computing, methods for solving sets of nonlinear algebraic equations, ordinary differential equations, and differential-algebraic (DAE) systems are presented.

Application of root finding techniques to chemical engineering problems. Linear/nonlinear simultaneous equation, modeling of chemical engineering phenomenon and solving by different Numerical methods. Curve fitting to chemical engineering problems.

Finite difference solution for the second order ordinary differential equations. Finite difference

solution for one dimensional heat equation (both implicit and explicit) use of computer for solving the numerical.

References

1. Steven C. Chapra &Raymond P Canale, Numerical Methods for Engineers, 4th Edition, Tata McGraw Hill, New Delhi.
2. Santosh Gupta, Numerical Methods for Engineers, New Age Internationa Publishers.New Delhi

Class Schedule

Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√						√	√	
3	√	√				√	√	√	

Evaluation of students

Component	Duration	Weightage
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours

To be announced in the class.

Notice

Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 434

Department	**: Chemical Engineering**
Course No.	**: CML435**
Course Title	**: Computer Aided Design in Chemical Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic application of different software's and its application to chemical engineering

Syllabus:

Elements of digital computer architecture, computer logic, central processing unit, main memory, Input / Output devices, operation systems – Software languages hierarchy, Assembly language and high level languages - graphic software, language selection, programmed development. Physical properties evaluation, Thermodynamic properties of gases and binary mixtures, methods of calculations, Vapor-liquid equilibrium data for ideal and non-ideal mixtures. Bubble points and dew points, flash distillation calculation. Equipment design. Development of software for the following systems: Heat exchange systems. Double pipe and shell & tube exchangers – Pumps, pipings and pressure drop calculations. Equipment design like evaporator, single and multiple effects, Distillation systems, crystallizer, Absorber and stripper – Liquid – Liquid extraction. Process dynamic simulation - Distillation column, Reactors, Absorbers, evaporators and crystallizers. Introduction to simulation packages like GPSS, CSMP.

References:

1. Afgan N.H. and Schlunder, C.V. Heat Exchangers-design and theory , Scripta Book, Washington, 1974.
2. Bhattacharya and Narayanan, Computer aided design of Chemical Process equipments , New Central Book Agency,

Calcutta (1992)

3. Crowe C.M. et. al., Chemical plant simulation-An Introduction to Computer aide steady-state process analysi, Prentice
Hall, 1971
4. Franks R.G.E., Modeling and simulation in Chemical Engineering, Wiley Inter Science, 1972.
5. Groover M.P., Timmers E.W., Computer Aided Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 1985
6. Henley E.J., and Rusen F.M., Material and Energy Balance Computations, John Wiley, New York, 1969.
7. Holland C.D., Fundamentals and modeling of simulation process, Prentice Hall (1975).
8. Leeshey M.E, Computer aided process plant design, Gulf Publishing Co.
9. Myers, A.L. and Seeden, W.D., Introduction to Chemical Engineering and Computer Calculations, Prentice Hall, 1976.
10. Nashelsky L., Introduction to Digital Technology, John Wiley and Sons, New York, 1983.
11. Prausnitz, S., Computer calculations in Multi Component vapor liquid equilibria Prentice Hall, 1980.
12. Smith B.D., Design of Equilibrium Stage Processes, McGraw Hill Book Co. New York.

Class Schedule

Three 55 minutes session per week.

Relationship of Course Objectives to Program Outcomes:

Course Objectives	Programme outcomes								
	a	b	c	d	e	f	g	h	i
1	√						√	√	
2	√						√	√	
3	√	√				√	√	√	

Evaluation of students

Component	**Duration**	**Weightage**
Session 1 Exam	1 hour	15
Session 2 Exam	1 hour	15
Class tests and Assignments	-	10
End Semester Exam	3 hours	60

Chamber Consultation Hours
To be announced in the class.

Notice
Notice will be displayed on Chemical Engineering Notice Board.

Course Coordinator

CML 435

Some more electives currently not in operation but can be kept for future requirement

New Course Code	Name of Subject	Credits
CML388	Pulp And Paper Technology	3
CML389	Chemical Informatics	3
CML390	Technology of Paints Pigments and Powder Coating	3
CML391	Surface Coating Engineering	3
CML392	Corrosion Engineering	3
CML436	Advanced Separation Tech.	3
CML438	Piping Engineering	3
CML439	Energy Management	3
CML440	Chemical Reactor Analysis	3
CML441	Process Intensification	3
CML442	Reliability Engineering	3
CMP266	Engineering Drawing and Graphics	1
CMP267	Computer Programming and Applications	1
MAL275	Numerical and Statistical Methods	3

Department	**: Chemical Engineering**
Course No.	**: CML388**
Course Title	**: Pulp And Paper Technology**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic paper and pulp technology and its application to chemical engineering

Syllabus:

Introduction, raw materials for paper making, structure, physical, chemical properties, morphology, reaction of cellulose with different chemicals

Aqueous pulping systems, commercial pulping process, variables associated with raw materials and pulping process, optimization of process parameters, materials and energy balance calculations

Pulp washing, screening, recovery of spent chemicals involving multiple effect evaporators, cascade evaporators, incineration, recaustising and calcinations

Pulp bleaching and stock preparation, internal sizing, filling and loading, colouring, wet end strength additives, surface sizing.

Sheet forming process, Fourdnui and cylinder mould machine, drainage characteristics, water marking, head box, slice, wire, couch, pressing of sheet for water removal.

Paper drying, drying characteristics, heat and mass transfer aspects, ventilation, dryer performance calculations, air-drying, radiant drying

REFERENCES

1. Pulp and Paper: Chemistry and Chemical Technology Vol I to IV, Casey J P, Ed., Wiley Interscience, New York,

2. MacDonald R G, Pulp and Paper Manufacture Vol I to III, 2nd Ed., McGraw Hill, New York.

3.Britt K W, Handbook of Pulp and Paper Technology, Reinhold Publishing Corporation, New York.

4.Pulp and Paper Manufacture , Kocurek, Tappi Publication.

Mark, Handbook of Physical and Mechanical testing of Paper and Board, Vol.I & II, Dekker Publication

Department	**: Chemical Engineering**
Course No.	**: CML389**
Course Title	**: Chemical Informatics**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic chemical informatics and its application to chemical engineering

Syllabus:

Cheminformatics introduction: Indroduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and structure Elucidation.

Representation of molecules and Chemical Reactions: Nomenclature; Different types of notations; SMILES coding; Matrix Representations; Structure of Molfilles and Sdfiles; Libraries and tookits; Different electronics effects; reaction classification.

Representing 2D and 3D structures I. Kinds of 2D structures representation; atom lookup and connection tables; graph theory; SMILES; SD files; representation nuances; descriptors.

Database Design and their Management: Database concepts. Structured Query language. Design of Chemical databases, Data Abstraction; Data Models; Instances and Schemes; E-R Model – Entity and entity sets; Relations and relationship sets; E-R diagrams, Reducing E-R Diagram to tables, Network Data Model: Basic concepts, Hierarchical data Model: Basic concepts, Metadatabases, Indexing and Hashing, Text Databases, Introduction to Distributed Database Processing, Data Security. Intefacing programs with databases.

Calculation of physical and chemical data, molecular mechanics, Descriptors for chemical compounds, Methods for data analysis, Artificial intelligence systems in Chemical Engineering, Chemical Markup Language (CML).

Prediction of physical and chemical properties, Structure– Spectra correlations, Chemical reactions and synthesis design, Drug design, elements of bioinformatics and genomics.

Introduction to computational fluid mechanics, Applications of CFD in modeling flow through porous media and through capillaries, Modeling flow through the human circulatory systems, Drug delivery.

Text Books

1. Andrew Bender, Jonathan M Goodman, Cheminformatics, Oxford University Press-2007

2. Gasteiger J. and Engel T., Chemoinformatics, A Text Book, Wiley VCH.

3. Stuart Schreiber, Tarun M. Kapoor, , Chemical Biology: From Small Molecules to Systems Biology and Drug Design Chemical Release 2001.

Department	**: Chemical Engineering**
Course No.	**: CML390**
Course Title	**: Technology of Paints Pigments and Powder Coating**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic technology related to paint, pigment, powder coating and its application to chemical engineering

Syllabus:

Historic development of paint industry, paint components and their roles, classification of paints, organic file formers, chemistry of film formers, water thinabble coatings. Drying and semidrying oils like linseed, tung, castor, soyabean oil, their occurrence, compositions and properties. Drying index and its significance, Modification of oils for surface coatings like malenised, styrenated and vinylated oils.

Classification of resins, natural resins like rosin, shellac, cashew nut shell liquid and synthetic resins like phenolics, epoxy, polyester, polyurethane & acrylic resin.

Paint machineries like ball mill, attritor, dynomill, triple roll mill, edge runner, sand mill, working mechanism and selection of machinery for a particular end use.

Principles of formulations of various types of paints like primer, synthetic enamels, wall finishes, wood finishes, computerized colour matching system, testing and analysis of paints, paint film defects and their remedies.

Industrial paints like stoving paints, acrylic paints, bicycle paint, marine paints, acid & alkali resisting paints, automotive paints, method of applications, powder coating, compositions, applications and comparison with normal liquid paints.

Pigment classification, properties, industrial pigments like Titanium dioxide, zinc sulphide lithophone, chrome pigments, red oxide pigment, black pigment, organic pigment, tonners and speciality pigment.

References:

1. W M Morgans, Outline of Paint Technology, CBS Pub, New Delhi

2. Zeno Wieks Jr, Frank Jones, S Peter Peppar, Organic Coating Science and Technology Vol I & II, Wiley Interscince Pub, New York, 1992

3. R Lambourene, Ellis Horwoor Ltd, Paint and Surface Coating, John Wilet & Sons, New York, 1987

4. R Lambourene, Ellis Horwoor Ltd, Paint and Surface Coating, John Wilet & Sons, New York, 1987.

Department	**: Chemical Engineering**
Course No.	**: CML391**
Course Title	**: Surface Coating Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic surface coating industries and its application to chemical engineering

Syllabus:

Preparation of Pigments: White Pigments. Red pigments; orange and yellow pigments; green, blue and black pigments.

Drying Oils and Driers; Solvents and Plasticisers: Resins, gums; waxes and bitumens, varnishes and lacquers; paints and enamels; cellulose ester products;synthetic resins and finishers; paint chemistry.

Paints plant; varnish plant; manufacture operation; factory cost accounting; research, development and control; fire protection; safety and health.

References

1. Tracton A. A., Coatings Materials and Surface Coatings, CRC Press, 2007
2. Bieleman J., Additives for Coatings, John Wiley & Sons, 2008
3. Schweitzer P. A., P.E., Paint and Coatings, CRC Press, 2005

Department	**: Chemical Engineering**
Course No.	**: CML392**
Course Title	**: Corrosion Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic aspect of corrosion theory and its application to chemical engineering

Syllabus:

Thermodynamics and Kinetics of electrochemical corrosion:

Enabling theory for corrosion, thermodynamics aspectrs of corrosion reactions, anerset equation. Basic wet corrosion cell, electrode potential, potential- ph diagram, kinetics of corrosion reactions, Butler-Volmer equation, polarization, mixed potential theory, passivity, immunity.

Types of corrosion – recognition and mechanisms:

Uniform corrosion, galvanic corrosion, pitting, dealloying, crevice corrosion, intergranular corrosion, filiform corrosion, impingement attack, cavitations, fretting corrosion cracking process.

Corrosion measurements:

Methods of measurement s of corrosion based kn study of various ASTM standards for corrosion – Weight , electrochemical, electrical, thickness.

Corrosion protection and surface engineering :

Principles of different methods of corrosion protection and surface treatment, chemical and clectrochemical surface treatments if metals.

Protective coatings like plating, pvd, cvd,thermal spray, hot dip, applicastion of inhi9bitors, and electrochemical methods for corrosion protection.

Other Corrosion Environment and Materials Selection: selection of corrosion resistant materials for use in acids, alkalies, atmosphere, soils, seawater, freshwater, etc.

References

1. Butlar G. and Ison' HC. K ",'Corrosion and its Prevention in Waters, Leonard Hill- London (1966).

2. Rajgopalan, K.S. ", Corrosion and its Prevention , Chemical Engineering Education Development Centre, I.IT. Madras (1975).

3. Uhlig H. H, Corrosion and Corrosion control., John Wiley and sons (1971).

Department	**: Chemical Engineering**
Course No.	**: CML438**
Course Title	**: Advanced Separation Tech.**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand advance separation technique for separation and its application to chemical engineering

Syllabus:

Separation by phase addition or creation: approximate methods for multicomponent, multistage separations (Fenske-Underwood-Gilliland method, Kremser group method).
Equilibrium-based methods for multicomponent absorption, stripping, distillation, and extraction: Equation-Tearing procedures-Tridiagonal Matrix Algorithm, Bubble-Point (BP) method for distillation, Sum-Rates method for absorption and stripping. Isothermal Sum-Rates method for liquid- Liquid extraction.
Enhanced distillation and supercritical extraction: Reactive distillation process in kinetics, dissociation extraction, reactive extraction technology.
Separation by barriers and solid agents: membrane separations, adsorption, and chromatograph (Transport in membranes, sorbents, equilibrium considerations, kinetic and transport consideration, sorption systems).

References

1. J.D. Seader and E.J.Henley, Separation Process Principles, Wiley, 2nd Edition 2004
2. Geankoplis, Transport Processes And Separation Process principles, Prentice-Hall of India Private Ltd , New Delhi, 4th Edition 2006

Department	**: Chemical Engineering**
Course No.	**: CML438**
Course Title	**: Piping Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic piping engineering and its application to chemical engineering

Syllabus:

Pipe Routing & Drafting: Piping Symbols, Flow Diagrams, Piping Isometrics, General Arrangement Drawings Sections and Elevation, Detail Drawings, Plot Plans, 3D Representations. Piping System Components: Piping Layout, Piping Fittings - elbows, tees, reducers, end caps, Stub Ins, Flanges, Gaskets, Selection & Application of Valves, Pipe Racks, Pipe Supports, Anchors, & Guides, Thermal Insulation. Valves, Flanges & Gaskets Special piping components: Construction working and selection of various components such as steam traps, strainers, sight glass, level gage, expansion bellows, flame arresters, inline mixers and static mixtures.

Valves and other piping components: Functions of valves and their selection, valve materials and, material of construction for the following type: Gate, globe, Needle, piston, Butterflies, plug. Diaphragm, pinch, foot and float valves, Application of various valves and their operational characteristics relevant to piping engineering.

Process equipment : Reactors, Towers, Exchangers, Pressure Vessels, Drums, Furnaces, Process Liquid Storage Tanks, Mechanical equipment - Pumps, Compressors, Turbines Process & Instrumentation Diagrams (P&ID s) / Process Flow Diagrams: Purpose of P& ID s, Stages of Development of P & ID s, Symbolism & Conventions, Process & Instrument Drawings, Process Equipment Relationships, Process Industry Practices.Codes, Specifications, Abbreviations, Piping Abbreviations, Specification ClassesEquipment Layout. Pipe Wall Thickness Calculations, Maximum Allowable Operating Pressure (MAOP), Design Conditions, Design Pressure, Design Temperature.

Selection of various piping materials such as Ferrous, non-ferrous and non-metallic,

Piping fabrication, Precautions, Welder's qualification, Preparations of pipe edges.

Designation of coated electrodes, Requirements of weld tests, Hot bending and cold bending operations, Fabrication specifications.

Standard Piping Details: Underground Piping Systems, Pipe Rack Spacing, Pipe Flexibility, Heat Expansion, Anchors, Shoes, Guides, Field Supports, Dummy Supports, Hanger Rods, Spring Hangers.

References

1. Deutsch D. J., Process piping systems, Chemical engineering magazine. Mc - Graw hill.
2. Littleton C.T., Industrial piping, Mc-Graw hill
3. McAllister E.W.. Pipeline Rules of Thumb Handbook, Gulf Publication, 1979
4. Mcketta J. J., Piping Design Handbook, Gulf Publications, 1992.
5. Rase H. F., Piping design for process plants, John Wiley
6. Watters G.Z., Analysis and Control of Unsteady Flow in Pipelines, Butterworth, 1986.

Department	**: Chemical Engineering**
Course No.	**: CML439**
Course Title	**: Energy Management**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic energy management and its application to chemical engineering

Syllabus:

Energy auditing: Methodology, analysis of past data, measurements of various parameters, portable and on line instruments.

Energy economics: Payback period, Rate of Return, life cycle costing.

Steam Systems: Boiler-efficiency testing, excess air control, Steam distribution and use, steam traps, condensate recovery, flash steam utilization.

Electrical systems: Demand control, power factor correction, load scheduling/shifting. Motor drives – motor efficiency testing, energy efficient motors, and motor speed control.

Lighting: Conservation in Pumps, Fans (flow control), Compressed Air Systems, Refrigeration and conditioning systems, Waste heat recovery, heat pipes.

REFERENCES

1. Murphy W.R., McKay G.A, Energy Management, Murphy Butterworth-Heinemann Ltd., 2001.

2. Turner W.C, Energy Management Handbook –, Fairmont Press, Lilburn, Georgia, 1993.

Department	**: Chemical Engineering**
Course No.	**: CML440**
Course Title	**: Chemical Reactor Analysis**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic reactor analysis and its application to chemical engineering

Syllabus:

Review on Chemical Reaction Engineering
Homogeneous reactor design and analysis-II: Non-ideal reactors- Review of the basic concepts of residence time distributions, single parameter models for real reactor behavior, Macromixing and micromixing, segregated flow model and Zweitering`s analysis of maximum mixedness, IEM and other models for micromixing.
Models for Reactors with Nonideal-Flow Patterns
Adsorption and Ion Exchange, Transient-Response Techniques, Packed-Bed Reactors (including Radial-Flow Reactor), Fluidized-Bed reactors , Gas-Liquid Reactions, Process Intensification and Special Reactors
Applications of Nano Materials in Reaction Engineering (including Photocatalysis, Fuel Cells etc.)

References

1. Chemical Reaction Engineering, Octave Levenspiel, John Wiley & Sons, Singapore, 1998 3rd Edition.
2. Elements of Chemical Reaction Engineering, Fogler H.S., Prentice-Hall, NJ, 2006, 4th Edition.

3. Chemical Reactor Analysis, G. F. Froment and K. B. Bischoff, John Wiley & Sons, Singapore, 1990 2nd Edition.

4. Chemical Engineering Kinetics, Smith J. M., McGraw Hill, N Y, 1981, 3rd Edition.

5. Doraiswamy, L.K. and Sharma, M.M., Heterogeneous ReactionsVol. I and II, Wiley, 1984

Department	**: Chemical Engineering**
Course No.	**: CML441**
Course Title	**: Process Intensification**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic process intesification and its application to chemical engineering

Syllabus:

Introduction to Process Intensification: History, Philosophy, principles
High Gravity Fields: process fundamentals, Rotating packed Bed, Design, Applications, Scale-up
Spinning Disc Reactor: mathematical models, heat & mass transfer, design, application
Compact multifunctional heat exchangers: types, applications, design
Microreaction technology: enhancement of heat and mass transfer, control and safety, fabrication, application, design
Structured catalyst and reactors: monolithic reactors, catalysts, gas-phase reactions, application, design
Inline and high intensity mixers: concept of mixing, motionless mixers, mixing and reaction, design, gas-liquid mixing, combined heat exchanger and reactors, design, applications
Reactive and hybrid separations: concept of reactive separations, reactive distillation, membrane based reactive separation reactive adsorption, reactive extraction, reactive crystallization, hybrid separations, extractive distillation, adsorptive distillation, , membrane distillation , membrane chromatographic separation, design, applications
Multifunctional reactors: Concept, integration of reaction, mass and heat transfer, design, application, various equipments,
Process synthesis and integration: conventional design, conceptual design, elements, reaction engineering, complex distillation, systems, industrial studies
Process intensification for industrial safety: concept of industrial safety, hazardous reactions and safety, applications, examples
Industrial practice: methodology and applications, commercial examples of process intensification

References

1. Andrzej Stankiewicz, Jacob A. Moulijn, Re-engineering the chemical processing plant :process intensification, Marcel Dekker, Inc., Marcel Dekker, Inc., 1st edition, 2004
2. Cornelis de Weerd, Process Intensification in Practice, John Wiley and Sons, 1st edition, 2005

Department	**: Chemical Engineering**
Course No.	**: CML442**
Course Title	**: Reliability Engineering**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic of reliability in chemical process plant and its application to chemical engineering

Syllabus:

Introduction to probability: review of sets, events, definitions, finite sample spaces and enumeration, conditional probability, partitions theorem, total probability theorem, Bayes' theorem

Reliability Engineering Introduction: concept, terms, definitions, applications, history

Failure distribution: Reliability function, MTF, HRF, bathtub curve, conditional reliability

Constant failure rate model: exponential function, failure modes, applications, two-parameter exponential distribution, Poisson process

Time dependent failure models: Weibull distribution, normal distribution, lognormal distribution

Reliability of systems: serial, parallel configuration, SSF, minimal cuts, minimal paths, common-mode failures, three state devices

State dependent systems: Markov analysis, load sharing systems, standby systems, degraded systems, three state devices

Physical reliability models: covariate, static, dynamic models, physics of failure models

Design for reliability: specification and system measurements, reliability allocation, design methods, failure analysis, system safety and fault tree analysis

Maintainability: analysis of downtime, repair time distribution, stochastic point processes, system repair time, reliability under preventive maintenance

Availability: concepts and definitions, models, system availability, design analysis

Data collection and empirical methods identifying failure and repair distribution

REFERENCES

1. Hines W. W., Montgomery D. C., Goldsman D. M., Borror C. M., Probability and Statistics in Engineering, John Wiley and Sons (Asia) Pte Ltd., Singapore.

2. Ebeling C. E. Introduction to Reliability and Maintainability Engineering, Tata McGraw-Hill, New York

Department	**: Chemical Engineering**
Course No.	**: CMP266**
Course Title	**: Engineering Drawing and Graphics**
Course Type	**: Elective**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to understand and draw basic symbol representation for different accessory in chemical process plant and its application to chemical engineering

Syllabus:

ISI Conventions.(ISI No. 696 – 1960) Covering the standard practice in Machine Drawing and also use of I.S.I. specifications for limits & fits (ISI No. 919 – 1960).

Preparation of free hand proportionate dimensioned sketches & conventions of various elements such as screw threads, fastener (nuts, bolts, studs, locking arrangement, foundation bolts etc.) Rivets and riveted joins, welded joints.

Exercises in converting pictorial & isometric views into orthographic projection, sectioned views. Preparation of details & assembly drawings of simple machine parts such as keys, cotters, pin, pulleys, cottered joints & knuckle joints Bearing, shaft couplings. Various flanges & pipe connections. A valve, cocks, traps. Fixed and flexible joints, Expansion joints.

Minimum 10-12 Imperial size sheets (A-1) covering the above syllabus should be drawn out of which 1/3rd should be drawn using computer software likes AutoCAD

REFERENCES

1. Bhatt N.D.; Elementary Engineering Drawing, Charotar Publishing House.

2. Mathur M.L. and Vaishwanar R.S.; Engineering Drawing and Graphics, Jain Brothers, New Delhi – 1993.

3. Narayana K.L. and Kannaiah P, Engineering Graphics, Tata McGraw Hill Co. Ltd., 2000.

4. Neumann W. M. and Sproul R.F, Principles of Computer Graphic, McGraw Hill 1989.

Department	**: Chemical Engineering**
Course No.	**: CMP267**
Course Title	**: Computer Programming and Applications**
Course Type	**: Elective**
Course Credits	**: 1**

Objective: Objective of this subject is to expose students to understand basic computer programming and its application to chemical engineering

Syllabus:

Concept of Algorithm: Termination and correctness, Algorithms to programs; Specification, stepwise refinement technique, problem solving using Pascal

Computer Architecture: ALU, CPU, I/O devices, system softwares, operating systems, compilers, multiuser environments.

Computer programming and numerical methods, computer-programming languages, C & C^{++} programs for matrix operations, programs for estimating roots of polynomials.

Programs for numerical integration, Trapezoidal and simphsons rules, regression analysis, programs for solution of ordinary differential equations, programs for interpolation and extrapolations.

TEXT BOKS

1. Adams J.M., Computers Application Implications, John. Wiley Co. (1975).

2. Saran S., Swami P.K, Singh, K.K. Shah I.M. and Lal D.;, Computer Programming and Numerical Methods, Metropolitan Book Corp. Ltd., New Delhi

3. Syal I.C. and Gupta S.P, Computer Programming and Engineering Analysis, A.H. Wheeler Co.

Department	**: Chemical Engineering**
Course No.	**: MAL275**
Course Title	**: Numerical and Statistical Methods**
Course Type	**: Elective**
Course Credits	**: 3**

Objective: Objective of this subject is to expose students to understand basic numerical and statistical methods and its application to chemical engineering

Syllabus:

Approximations and errors in computation and their evaluation, rounding – off and truncation; absolute, relative and percentage errors. Solution of non-linear algebraic and transcendental equations, Bisection, false position, Newton–Raphson, Iterative methods and generalized Newton's method for multiple roots.

Newton – Raphson, Iterative, false-position and bisection methods; generalized Newton's for multiple roots. Solutions of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularization, Jacobi and Gauss-Seidel methods, Cubic spline and Gaussian quadrature formula.

Numerical solutions of ODE by Taylor series, Euler's modified method, Runge-Kutta method, Milne's method and their applications. Approximation of derivative (Ordinary & Partial), Boundary value problems by finite difference methods.

Random variable, distribution function of continuous and discrete random variables, mathematical expectation, generating function, Moments, Skewness and Krtosis.

Special probability distributions – Binomial, Poisson's, Normal, Chi-square, t distribution, and F-distributions, confidence intervals for mean and variance.

Tests of hypothesis and significance, tests involving normal distribution, t- distribution chi-square distribution and F distribution.

Correlation and regression: simple and multiple correlation and applications related to Engg. Prblems.

References

1. Grewal B.S.;, Higher Engineering Mathematics, Khanna Publication – 2004

2. Gupta S.C. and Kapoor V.K.;, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, Educational Publisher, New Delhi.

3. Sastry S.S, , Introductory Methods of Numerical Analysis, Prentics – Hall of India Pvt. Ltd., New Delhi – 1995.

4. Spiegel M.R.; Probability and Statistics, Tata McGraw Hill Book.