Course Book

for

B.Tech. Chemical Engineering

Course Structure and Syllabus for batch admitted in 2026

Department of Chemical Engineering

Visvesvaraya National Institute of Technology

Nagpur 440 010 (India)

2026

Proposed Credit Structure for B. Tech Chemical Engineering

	Category	Symbol	%	Credit Req.	Proposed	I	II	III	IV	V	VI	VII	VIII
1	Basic Sciences	BS	10%	12–16	**16**	**8**	**8**	**0**	**0**	**0**	**0**	**0**	**0**
2	Engineering Sciences	ES	10%	12–16	**16**	**9**	**7**	**0**	**0**	**0**	**0**	**0**	**0**
3	Institute Core	IC	1%	2	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**
4	Humanities	HU	2%	3	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5	Departmental Core	DC	41%	66–78	**75**	**0**	**3**	**17**	**17**	**18**	**17**	**3**	**0**
6	Mandatory Non-Credit	MNC	List of Courses	At least 4 courses	**--**								
7	Institute Elective	IE	4%	6-12	**6**	**0**	**3**	**3**	**0**	**0**	**0**	**0**	**0**
8	Departmental Elective	DE	Min26.25 %	Min.42	**42**	**0**	**0**	**6**	**6**	**6**	**6**	**12**	**6**
9	Humanities & Magt	HM**	0–4%	0-6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
10	Open Course	OC**	0-4%	0-6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Total			**Min.160**	**Min.160**	**20**	**23**	**26**	**23**	**24**	**23**	**15**	**6**
							43		**49**		**47**		**21**

B. Tech. : 160 credits

B. Tech. with Honors: 160 + 15 credits (five department electives from any one basket of electives)

Minor in Chemical Engineering: 160 + 15 credits (for other department)

B. Tech Chemical Engineering Semester I

Code	Course	Type	L-T-P	Credits	Pre-requisites
CHLA101	Chemical Science for Materials and Energy Systems	BS	3-0-0	3	None
CHPA102	Chemistry	BS	0-0-2	1	None
CSLA101	Computer Programming	ES	3-0-2	4	None
EELA102	Electrical Engineering	ES	3-0-0	3	None
EEPA102	Electrical Engineering	ES	0-0-2	1	None
MALA101	Mathematics–I	BS	3-1-0	4	None
MELA102	Basic Engineering Graphics	HU	2-0-2	3	None
MEPA101	Engineering Workshop	ES	0-0-2	1	None
SAAA101	Health Information and Sports–Part I	MNC	0-0-2	0	None
SAAA103	Life Skills Management	0-0-2	0	AU	None
	Total Credits			20	

B. Tech Chemical Engineering Semester II

Code	Course	Type	L-T-P	Credits	Pre-requisites
AMLA152	Engineering Mechanics	ES	3-0-0	3	None
AMPA152	Engineering Mechanics	ES	0-0-2	1	None
ICLA101	Institute Core	IC	2-0-0	2	None
MALA102	Mathematics–II	BS	3-1-0	4	None
HULA101	English and Corporate Communication	ES	2-0-2	3	None
PHL103	Physics	BS	3-0-0	3	None
PHP103	Physics	BS	0-0-2	1	None
IELA101	Institute Elective-I	IE	3-0-0	3	None
CMLA101	Introduction to Chemical Engineering	DC	3-0-0	3	None
SAA102	Health Information and Sports–Part II	MNC	0-0-2	0	None
	Total Credits			23	
Certificate Exit Additional Course					
CMP3xx	Chemical Engineering	DC	0-0-2	1	None

Summer internship of minimum 6 weeks – 1 Credit

B. Tech Chemical Engineering Semester III

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML201	Chemical Process Calculations	DC	3-0-0	3	None
CML202	Fluid Mechanics	DC	3-0-0	3	None
CML203	Mechanical Operations	DC	3-0-0	3	None
CML204	Chemical Engineering Thermodynamics-I	DC	3-0-0	3	None
CHL263	Organic Chemistry and Synthesis	DC	3-0-0	3	None
CMP203	Mechanical Operations	DC	0-0-2	1	None
CMP204	Technical Analysis	DC	0-0-2	1	None
IELxxx	Institute Elective-II	IE	3-0-0	3	None
AULxxx	Mandatory Non-Credit Category-I	MNC	0-0-2	0	None
Core Credits=17					
ELECTIVE					
CMLxxx	Elective - 1	DE	3-0-0	3	None
CMLxxx	Elective – 2	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Basics of Chemical Engineering	DM	3-0-0	3	None
Elective Credits=6					
DC+DE=23 Credits					

B. Tech Chemical Engineering Semester IV

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML221	Mass Transfer-I	DC	3-0-0	3	None
CML222	Heat Transfer	DC	3-0-0	3	None
CML223	Chemical Reaction Engineering-I	DC	3-0-0	3	None
CML224	Chemical Engineering Mathematics	DC	3-0-0	3	None

CML225	Chemical Engineering Thermodynamics-II	DC	3-0-0	3	CML204
CMP202	Fluid Mechanics	DC	0-0-2	1	None
CMP322	Heat Transfer	DC	0-0-2	1	None
AULxxx	Mandatory Non-Credit Category-II	MNC	0-0-2	0	None
Core Credits=17					
ELECTIVE					
CMLxxx	Elective – 3	DE	3-0-0	3	None
CMLxxx	Elective – 4	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Chemical Engineering Thermodynamics	DM	3-0-0	3	None
Elective Credits=6					
DC+DE=23 Credits					
Diploma Exit Additional Course					
CMD4xx	Mini Project	DC	0-0-4	2	None

Summer internship of minimum 6 weeks – 1 Credit

B. Tech Chemical Engineering Semester V

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML301	Mass Transfer-II	DC	3-0-0	3	CML221
CML302	Chemical Process Modeling & Simulation	DC	3-0-0	3	None
CML303	Process Control and Instrumentation	DC	3-0-0	3	None
CML304	Chemical Reaction Engineering-II	DC	3-0-0	3	CML223
CML353	Chemical Process Equipment Design	DC	3-0-0	3	None
CMP304	Chemical Reaction Engineering	DC	0-0-2	1	None
CMP321	Mass Transfer	DC	0-0-2	1	None
CMP403	Design	DC	0-0-2	1	None
AULxxx	Mandatory Non-Credit Category-III	MNC	0-0-2	0	None
Core Credits=18					
ELECTIVE					
CMLxxx	Elective – 5	DE	3-0-0	3	None
CMLxxx	Elective – 6	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Chemical Reaction Engineering	DM	3-0-0	3	None
Elective Credits=6					
DC+DE=24 Credits					

B. Tech Chemical Engineering Semester VI

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML351	Chemical Technology	DC	3-0-0	3	None
CML352	Transport Phenomena	DC	3-0-0	3	None
CML354	Energy and Environment	DC	3-0-0	3	None
CML403	Plant Design & Economics	DC	3-0-0	3	None
CMP302	Chemical Process Modeling and Simulation	DC	0-0-2	1	None
CMP303	Process Control and Instrumentation	DC	0-0-2	1	None

AULxxx	Mandatory Non-Credit Category-IV	MNC	0-0-2	0	None
CMD401	Project Phase-I	DC	--	3	None
Core Credits=17					
ELECTIVE					
CMLxxx	Elective – 7	DE	3-0-0	3	None
CMLxxx	Elective – 8	DE	3-0-0	3	None
MINOR for Other Department					
CMPxxx	Chemical Engineering	DM	0-0-2	1	None
CMDxxx	Mini Project	DM	0-0-4	2	None
CMLxxx	Heat, Mass and Momentum Transport	DM	3-0-0	3	None
Elective Credits=6					
DC+DE=23 Credits					
Advanced Diploma Exit is permitted without additional course					

Summer internship of minimum 6 weeks – 1 Credit

B. Tech Chemical Engineering Semester VII#

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CMD402	Project Phase-II	DC	--	3	None
Core Credits=3					
ELECTIVE					
CMLxxx	Elective - 9 / MOOC*	DE	3-0-0	3	None
CMLxxx	Elective – 10 / MOOC*	DE	3-0-0	3	None
CMLxxx	Elective - 11	DE	3-0-0	3	None
CMLxxx	Elective – 12	DE	3-0-0	3	None
Elective Credits=12					
DC+DE=15 Credits					

* Maximum four MOOC/NPTEL/SWAYAM courses are allowed in a complete program and maximum two in a semester only for students going to internship.

VII and VIII semester will be interchanged if student opt for internship in VII semester.

B. Tech Chemical Engineering Semester VIII#Ω

Code	Course Name	Type	L-T-P	Credits
ELECTIVE (two)				
CMLxxx	Elective - 13 / MOOC*	DE	3-0-0	3
CMLxxx	Elective – 14 / MOOC*	DE	3-0-0	3
CMPxxx	Internship	DE	6-0-0	6
Elective Credits=6				
DC+DE=6 Credits				

* Maximum four MOOC/NPTEL/SWAYAM courses are allowed in a complete program and maximum two in a semester only for students going to internship.

VII and VIII semester will be interchanged if student opt for internship in VII semester.

Ω Students must select an appropriate combination of credit points to fulfill the total requirement of 160 credits for degree conferral.

LIST OF PROPOSED HONORS PROGRAM IN CHEMICAL ENGINEERING

Sr. No.	PROPOSED HONORS PROGRAM IN CHEMICAL ENGINEERING
1.	Computation & Design
2.	Chemical Technology
3.	Advanced Chemical Engineering
4.	Bioprocess Technology
5.	Sustainability & Management

ELECTIVES*

(* This is tentative list, few courses may be overlapped in other baskets also. The courses with syllabus overlapping more than 10% will not be allowed. Faculty advisor will check for the same.)

		Computation & Design	L-T-P	Credits
1.	MAL208	Probability Theory and Statistical Methods	3-0-0	3
2.	MLA205	Numerical Methods and Probability Theory	3-0-0	3
3.	CML232	Introduction To Computing Software For Chemical Engineers	3-0-0	3
4.	CML389	Chemical Informatics	3-0-0	3
5.	CML401	Data Analytics For Chemical Engineers	3-0-0	3
6.	CML402	Molecular Simulation And Informatics	3-0-0	3
7.	CML415	Computational Methods In Chemical Engineering	3-0-0	3
8.	CML428	CFD For Chemical Engineers	3-0-0	3
9.	CML432	Computational Transport Processes	3-0-0	3
10	CML435	Computer Aided Design In Chemical Engineering	3-0-0	3
11	CML504	Mathematical Methods In Chemical Engineering	3-0-0	3
12	CML506	Process Analysis, Simulation And Design	3-0-0	3
13	CML521	Chemical Engg. Computational Fluid Dynamics	3-0-0	3
14	CML529	Optimization Techniques In Process Design	3-0-0	3
15	CML536	Analysis And Design Of Experiments	3-0-0	3

		Chemical Technology	L-T-P	Credits
1.	CML336	Polymer Engg.	3-0-0	3
2.	CML372	Paper & Pulp Technology	3-0-0	3
3.	CML388	Pulp And Paper Technology	3-0-0	3
4.	CML390	Technology Of Paints Pigments And Powder Coating	3-0-0	3
5.	CML391	Surface Coating Engineering	3-0-0	3
6.	CML392	Corrosion Engineering	3-0-0	3
7.	CML424	Petroleum Refinery Engineering	3-0-0	3
8.	CML425	Membrane Technology	3-0-0	3
9.	CML426	Polymer Processing	3-0-0	3
10	CML429	Nanotechnology	3-0-0	3
11	CML437	Piping Engineering	3-0-0	3
12	CML468	Ore And Mineral Processing	3-0-0	3
13	CML522	Membrane Separation Processes	3-0-0	3
14	CML524	Polymer Science And Engineering	3-0-0	3
15	CML527	Mineral Beneficiation	3-0-0	3
16	CML535	Advanced Nanotechnology	3-0-0	3
17	CML***	Space Technology for Chemical Engineers	3-0-0	3
18	CML***	Natural Gas Engineering	3-0-0	3

		Advanced Chemical Engineering	L-T-P	Credits
1.	CML383	Advance Heat Transfer	3-0-0	3
2.	CML394	Introduction To Measuring Instruments	3-0-0	3
3.	CML427	Advanced Separation Process	3-0-0	3
4.	CML436	Advanced Separation Technology	3-0-0	3
5.	CML440	Chemical Reactor Analysis	3-0-0	3
6.	CML466	Chemical Plant Design	3-0-0	3
7.	CML481	Instrumental Analytical Techniques	3-0-0	3
8.	CML501	Thermodynamics Of Phase And Chemical Equilibria	3-0-0	3
9.	CML502	Chemical And Catalytic Reaction Engineering	3-0-0	3
10.	CML503	Momentum Mass And Heat Transfer	3-0-0	3
11.	CML505	Industrial Process Control	3-0-0	3
12.	CML507	Novel Separation Processes	3-0-0	3
13.	CML525	Catalysis: Theory And Practice	3-0-0	3
14.	CML528	Interfacial Science And Engineering	3-0-0	3
15.	CML533	Mass Transfer With Chemical Reaction	3-0-0	3

		Bioprocess Technology	L-T-P	Credits
1.	CML471	Biotechnology & Biochemical Engineering	3-0-0	3
2.	CML508	Biorefinery Engineering	3-0-0	3
3.	CML509	Bioprocess Engineering	3-0-0	3
4.	CML510	Biological Transport Phenomena	3-0-0	3
		All BPT based core subjects	3-0-0	3
5.	CML2**	Microbiology for Engineers	3-0-0	3
6.	CML2**	Biochemistry	3-0-0	3
7.	CML2**	Fermentation Technology	3-0-0	3
8.	CML2**	Cell Biology for Engineers	3-0-0	3
9.	CML3**	Downstream Processing	3-0-0	3
10	CML3**	Computational Techniques and Biostatics	3-0-0	3
11	CML3**	Molecular Biology and Genetic Engineering	3-0-0	3
12	CML3**	Biopharmaceutical Technology	3-0-0	3
13	CML3**	Industrial Biotechnology and Bioprocess Applications	3-0-0	3
14	CML3**	Nanotechnology for Bioprocess Technology	3-0-0	3
15	CML3**	Membrane Applications in Bioprocess Technology	3-0-0	3
16	CML4**	Bioreactor Design and Scale up	3-0-0	3
17	CML4**	Bioinformatics and Computational Biology	3-0-0	3
18	CML4**	Bioreactor Design and Scale up	3-0-0	3
19	CML4**	Systems Biology	3-0-0	3

		Sustainability & Management	L-T-P	Credits
1.	CML233	Environmental Engineering	3-0-0	3
2.	CML231	Material Science And Engineering	3-0-0	3
3.	CML422	Plant Utility	3-0-0	3
4.	CML467	Materials In Chemical Industries	3-0-0	3
5.	CML234	Industrial Waste Treatment	3-0-0	3
6.	CML342	Safety And Risk Analysis	3-0-0	3
7.	CML393	Innovative Design	3-0-0	3
8.	CML364	Green Chemistry & Engg.	3-0-0	3
9.	CML439	Energy Management	3-0-0	3
10.	CML442	Reliability Engineering	3-0-0	3
11.	CML475	New And Renewable Energy Engineering	3-0-0	3
12.	CML479	Entrepreneurship Development	3-0-0	3
13.	CML491	Project Planning And Management	3-0-0	3
14.	CML526	Total Quality Management	3-0-0	3
15.	CML530	Process Intensification	3-0-0	3
16.	CML532	Energy Technology And Conservation	3-0-0	3
17.	CML534	Reliability Analysis In Process Industry	3-0-0	3

Course Details

B. Tech Chemical Engineering Semester I

Code	Course	Type	L-T-P	Credits	Pre-requisites
CHLxxx	**Chemical Science for Materials and Energy Systems**	BS	3-0-0	3	None
CHP102	**Chemistry**	BS	0-0-2	1	None
CSL101	**Computer Programming**	ES	3-0-2	4	None
EEL102	**Electrical Engineering**	ES	3-0-0	3	None
EEP102	**Electrical Engineering**	ES	0-0-2	1	None
MAL101	**Mathematics–I**	BS	3-1-0	4	None
HULxxx	**English and Corporate Communication**	HU	2-0-2	3	None
MEP1xx	**Engineering Workshop**	ES	0-0-2	1	None
SAA101	**Health Information and Sports–Part I**	MNC	0-0-2	0	None
	Total Credits			20	

Course Code & Course Title:	**CHLxxx Chemical Science for Materials and Energy Systems**		
Course Type:	BS		
Name of the program (s):	B.Tech. Chemical Engineering		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1.	**Course Objective:** i. To understand the fundamental principles of Water treatment, electrochemical phenomenon including corrosion, electrochemical series and battery Technology. ii. To explore the chemistry components and applications of fuel and lubricants. iii. To gain knowledge of chemistry of Engineering materials high energy materials and catalysis.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand the fundamentals of water chemistry, electrochemistry
CO2	Understanding the fundamentals of fuels, lubricants and spectroscopic techniques.
CO3	Gaining the knowledge of the material synthesis and chemistry of engineering materials.
CO4	Recognize the role of high energy materials, adsorption and the catalytic process.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Water Chemistry: Sources, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Chemistry involved in sedimentation, coagulation and sterilization. Softening of water, lime- soda process. Ion-exchange process (zeolite and ion exchange resin) and numerical problem. Boiler troubles, causes and effects, methods of prevention.		CO1	2
Electrochemical Phenomenon and Corrosion: Electrochemical and galvanic series, polarization, decomposition potential, over voltage. Introduction to electrochemical characterization techniques – potentiometry, conductometry, cyclic voltammetry.		CO1	2

Theories of corrosion, types of corrosion, factors influencing corrosion. Corrosion Control: Design and material selection, anodic and cathodic protection, protective coatings, corrosion inhibitors.		
Battery Technology: Introduction, types and properties of batteries: Primary cells, Secondary cells (Lithium-ion battery: Chemistry involved, Cathode materials, Anode materials, Electrolytes and Separators). Fuel Cells. Solar cells.	CO1	1
Fuels and Lubricants: Fuels: Classification of fuels, Solid Fuels, Calorific Value, proximate and ultimate analysis, Carbonization, Liquid fuels, Knocking in I/C engine, Octane no, cetane no, combustion problems. Biofuels. Lubricants: Mechanism of friction, Classification: Solid, Semisolid, Liquid. Properties and applications of lubricants.	CO2	2
Spectroscopy: Interaction of radiation with matter, Molecular/Atomic Spectroscopy: Principles and applications of optical (UV-Vis) spectroscopy, Atomic absorption spectroscopy, Flame photometry, Inductively coupled plasma – Optical emission spectroscopy (ICP-OES), Vibrational (IR and Raman) spectroscopy and interpretation.	CO2	2
Industrially relevant processes for materials synthesis: Chemical methods of material synthesis: Sol-gel, co-precipitation, Pechini's method. Emulsions. Introduction to PVD and CVD, thin films. Thermochemistry, Heat and energy changes, Phase transitions.	CO3	1
Chemistry of Engineering Materials: Cement: Introduction, manufacturing and properties, fly ash utilization. Polymers: Structure property relationship. Synthesis, properties and applications of industrial grade polymers [polyester, polyethylene terephthalate (PET), silicone, nylon, polyurethane, isoprene and Bakelite]. Conducting Polymers.	CO3	2
Chemistry of High Energy Materials: Explosives: Introduction. Analytical techniques: trace and bulk level, requisites, oxygen balance, classification, properties and applications. Rocket propellants.	CO4	1
Adsorption and Catalysis: Physical adsorption, chemisorption, Freundlich's expression, Langmuir adsorption isotherm.	CO4	1

Industrial applications of adsorption, Heterogeneous Catalysis.		

4.	Text books

i) Dara, S. S. and S.S. Umare, A Text Book of Engineering Chemistry (Twelfth edition); S. Chand, 2014. ISBN-13: 8121903592-978
ii) Jain and Jain, Engineering Chemistry, 17th Eds; Dhanpat Rai publishing. ISBN-13: -978 9352165728
iii) Shashi Chawla, A Text Book of Engineering Chemistry. ISBN-13: 8177001938-978

5.	Reference Book(s) and Other Required Material

i) An Introduction to Electrochemistry, S. Glasstone, 2nd Edition, East west press (Pvt.) Limited. ISBN-13: 978-8176710138.
ii) P.W. Atkins, Physical Chemistry, Oxford University Press. ISBN-13: 978-0198814740.
iii) Bradley D. Fahlman, Materials Chemistry, 4th Eds; Springer, 2023. ISBN-13: 978-3031187834

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

Course Code & Course Title:	**CHP 102 Chemistry Laboratory**		
Course Type:	BS		
Name of the program(s):	B.Tech. Chemical Engineering		
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objectives:** To develop skills and capabilities of students in applying knowledge of chemistry for practically solving real life problems. Provide thorough understanding of the subject as many experiments are based on theory course.

2.	**Course Outcomes:**
CO1	Knows the proper procedures and regulations for safe handling and use of chemicals, and can follow the proper procedures and regulations for the safe handling when using chemicals.
CO2	Are able to design, carry out, record and analyze the results of chemical experiments. Are skilled in problem solving, critical thinking and analytical reasoning.
CO3	Ability to use modern instrumentation for chemical analysis and measurements.
CO4	Are able to communicate the results of their work to chemists and non-chemists.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Water and waste water analysis: Determination of Hardness Alkalinity Dissolved oxygen and free chlorine Chloride, fluorides and COD Trace metal in water using Ion –selective electrodes, arsenic, lead, mercury		CO1, CO2, CO4	3
Determination of capacity of ion exchange resin		CO1, CO2, CO4	1
Analysis of ores and alloys: Determination of copper in brass Calcium in limestone and dolomite.		CO1, CO2, CO4	2

Demonstration experiments on instrumental methods of analysis: pH-metric and conductometric titration Colorimetric determination Turbidity by nephelometer Flame photometry Flashpoint of lubricants Viscosity of lubricants Calorific value of solid fuels Proximate analysis of coal	CO1, CO2, CO3, CO4	4
Chemical kinetics / Adsorption: Determination of rate constant. Verify Freundlich Adsorption isotherm (study adsorption of acetic acid on activated charcoal)	CO1, CO2, CO4	2
Synthesis of paracetamol and aspirin, and its characterization.	CO1, CO2, CO4	2

4.	**Text books**

i) Dara, S.S. and S.S. Umare, A Text Book on Experiments and calculations in Engineering Chemistry (Ninth edition); S. Chand, 2015. ISBN-13: 812190-978 8641

ii) Shashi Chawla, Essentials of Experimental Engineering Chemistry, (Fourth Edition); Dhanpat Rai & Co. ISBN: 9788177000160.

5.	**Reference Book(s) and Other Required Material**

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

CO4	1	1	1	1	1	-	1	1	1	2	1	1	-	-	-

High - 3; Medium – 2; Low – 1;

Course Code & Course Title:	CSL101 Computer Programming		
Course Type:	DC		
Name of the program(s):	B.Tech. Computer Science & Engineering		
L – T – P	3-0-2	No. of Credits	4
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)			

Course Objective:

i) To develop students' proficiency in structured programming using C by teaching them essential constructs (variables, data types, operators, I/O, control flow), foundational problem-solving algorithms, modular and structured data handling (arrays, functions, structures), and basic file operations—empowering them to design, implement, and debug efficient, maintainable programs for real-world computational tasks.

1.	Course Outcomes (Min. 3 & Max. 5):
CO1	Remember and understand the fundamental programming constructs—such as program structure, data types, operators, expressions, and formatted I/O
CO2	Implement computational logic using decision structures and loops to solve problem
CO3	Analyze and modularize solutions using arrays, strings, and user-defined functions (including recursion) to implement algorithms
CO4	Apply and design structured data and persistent storage solutions by using C structures (including nested and arrays of structs) and basic file-handling operations (text and binary I/O).

2.	Detailed Description of the Course		
	Topics	CO(s) Addressed	Duration in weeks
1	Introduction: Fundamentals of Computer programming, Program development and execution, basics of algorithms and flow charts and the software development lifecycle.	CO1	1.5
2	Basic constructs of C programming: Structure of Programs, Keywords and Identifiers, Variables and Data Types, Operators and Expressions (Precedence and Associativity, Type Conversions), Formatted Input/Output.	CO1	1.5
3	Control Flow: Decision Making and Branching (if, if-else), Loops (while, for). Algorithms such as swapping two variables, reversing digits, character-to-number conversion, generating primes, GCD, smallest divisor, factorial, and Fibonacci generation through loops, nested-loop pattern printing.	CO1,CO2	3
4	Data Organization & Modularity: Arrays and Strings (1-D arrays, 2-D arrays, basic string operations), Functions	CO3	3

	(user-defined functions, scope and lifetime of variables, recursive functions); Algorithms like array reversal, finding maximum number in a set, factorial computation, Fibonacci sequence generation, reversing the digits of an integer; sorting and searching techniques and comparison		
5	Composite Data Types: structures, defining struct types, declaring instances, accessing members using the dot operator, memory layout and padding. Array of Structures: Declaring arrays whose elements are structures; Nested Structures: Embedding one struct type within another (either defined separately or inline), accessing nested members.	CO4	3
6	File handling: Opening and creating files, Closing files, Text file reading, Text file writing, Binary file reading, Binary file writing.	CO4	2

3.	**Text books (Theory and Practical):**
	1. How to Solve It by Computer by R. G. Dromey. ISBN-13. 978-8120303881 2. The C Programming Language by Brian Kernighan and Dennis Ritchie. ISBN:9780131101630

4.	**Reference Book(s) and Other Required Material**
	1. Algorithms in C by Robert Sedgewick ISBN-13:9780-0201314526 2. Algorithms (4th Edition) by Robert Sedgewick & Kevin Wayne ISBN-13: 978-0321573513 3. Introduction to Algorithms (commonly known as *CLRS*) by Cormen, Leiserson, Rivest & Stein ISBN-13: 978-0262033848

5.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**				
Code	**Type**	**Structure L+T+P**	**Credits**	**Evaluation Weightage (%)**	
				Method	**Range**
L	Lecture with built-in practical	L:3 T:0 P:4	L+0.5P	Mid Semester Exam.	25
				End Semester Exam.	50
				Quiz	10

				Continuous Evaluation-I (Pr.)	7.5
				Continuous Evaluation-II (Pr.)	7.5

6.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

Sr. No.	**Sample Lab Assignments**	**CO Addressed**
1	Basic Input-Output/Data types/data operators Program to Swap two numbers. Calculation of simple interest and compound interest.	CO1
2	Conditional Statements/ Loops Input month number and print number of days in a month Factorial Of a given number. Check the entered no is prime or not. Print patterns using nested loops.	CO1, CO2

3	Arrays : 1-D array, 2-D array , Strings : String functions, string.h library Input two sorted arrays and merge to one array. Search element from an array. Reverse an array element.	CO2, CO3
4	Functions, Recursion and Structures. Call a simple function to find the sum of digits of a number. Recursive function to generate fibonacci series. Addition of complex numbers using structure. Store multiple records of student details using an array of structures.	CO3, CO4
5	File handling. Count the number of words and characters in a given text file. Replace the specific line from a file. Copy the content of source file into destination file	CO4

Course Code & Course Title:	**EELXXX Electrical Engineering**		
Course Type:	ES		
Name of the program(s):	B.Tech. - CSE, CHEM, ECE, MECH		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	NIL		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**
	i. To learn basic ideas and principles of Electrical Engineering ii. Understanding the details of electrical machines.

2.	**Course Outcomes: Students will be able to**
CO1	Understand the basics of electrical components and power system.
CO2	Calculate DC, AC, and magnetic circuits parameters using KCL and KVL.
CO3	Determine performance parameters of transformers.
CO4	Evaluate performance of electrical machines.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Electrical Circuits: Circuit elements: resistance, inductance, and capacitance; voltage and current sources, definition, ideal and practical sources, source conversions, Kirchhoff's Laws and star-delta transformation.		CO1	2
Magnetic Circuits: Flux, MMF, reluctance; analogy with electric circuits; simple calculations for composite magnetic circuits.		CO1	2
AC Circuits: Periodic signals, average and R.M.S. values, phasor representation, steady-state analysis of ac circuits with sinusoidal excitation, reactance and impedance, series and parallel AC circuits, power factor, active, reactive and apparent power, series and parallel resonance, principle of generating single-phase and three-phase voltages, Balanced three-phase AC systems: Voltages, currents, and powers in star and delta connected load.		CO2	3.5
Single phase Transformers: Construction, types, basic principles, EMF equation, ideal and practical transformers, equivalent circuits, voltage regulation, and efficiency.		CO3	2.5

DC Motors: Construction, types, applications, significance of Back EMF, Speed and Torque equations, speed control, and need of motor starter.	CO4	1.5
Induction Motors: Three-phase induction motor—construction, types, applications, revolving magnetic field, principle of operation, synchronous speed, rotor speed, slip, power flow diagram, torque equation, and T-s characteristics, Block diagram of induction motor drive. Single-phase induction motors— principle of operation, types and applications.	CO4	1.5
Introduction to Generation, Transmission and Distribution of Electricity	CO1	1

4. Textbooks

i) D. C. Kulshreshtha, Basic Electrical Engineering, Second Edition, McGraw-Hill, 2019, ISBN: 9353167213.

ii) S.K. Bhattacharya , Basic Electrical and Electronics Engineering, Second Edition, Pearson Education, 2017, ISBN: 9789332586505.

5. Reference Book(s) and Other Required Material

i) Edward Hughes, Electrical and Electronic Technology, Tenth Edition, Pearson Education, 2010, ISBN: 9788131733660.

ii) Kothari D.P. and Nagrath I.J., Basic Electrical Engineering, Fourth Edition, McGraw-Hill, 2019, ISBN: 9353165725.

iii) N. K. De, G. D. Roy, T. K. Bhattacharya,IIT Kharagpur, Basic Electrical Technology, Web course of NPTEL

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Sem: 20-30 Marks, End Sem: 50-60 Marks, Quiz/Internal assessment: 10-20 Marks, Total 100 Marks

7. Relationship of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1			1	2		3				

CO2	2	2	1	1	1			1	2		3				
CO3	3	2	1	1	1			1	2		3				
CO4	3	2	1	1	1			1	2		3				

Course Code & Course Title:	**EEPXXX Electrical Engineering Laboratory**		
Course Type:	ES		
Name of the program(s):	B.Tech. - CSE, CHEM, ECE, MECH		
L – T – P	0-0-2	**No. of Credits**	1
Pre-requisites: Course Code(s) & Name(s)	NIL		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**
	i. To verify basic ideas and principles of various Electrical Circuits. ii. Understanding the principle and operation of electrical machines.

2.	**Course Outcomes: Students will be able to**
CO1	Understand behaviour of R, L, C circuit elements, voltage and current sources.
CO2	Appreciate and analyse magnetic circuits.
CO3	Familiar with various machines operations
CO4	Verify various parameters of three phase circuits.

3.	**Detailed Description of the Course**	
Topics (List of Experiments)	**CO(s) Addressed**	**Duration in Weeks**
1. Study and verification of Kirchhoff's Laws applied to direct current circuit.	CO1	1
2. Determination of B-H curve of a magnetic material	CO2	1
3. Study of AC series circuits.	CO1	1
4. Study of AC Parallel circuits.	CO1	1
5. To determine Voltage regulation and efficiency of a single-phase transformer by direct loading.	CO3	1
6. Reversal of direction of rotation of a three-phase induction motor.	CO3	1
7. To study balanced three phase circuit- star connection.	CO4	1
8. To study balanced three phase circuit- delta connection.	CO4	1
9. Speed control of a DC motor by varying- a. Field current with armature voltage kept constant b. Armature voltage with field current kept constant.	CO3	1
10. Assessment 1 + Assessment 2 + Quiz / Viva	All COs	5

4. Textbooks

i) B.S. Umre and D. P. Kothari, Laboratory Manuals for Electrical Machines, 2nd Edition, I. K. International, 2018, ISBN: 978-93-85909-75-7

ii) S. G. Tarnekar and P. K. Kharbanda, Laboratory Courses in Electrical Engineering, 3rd Edition, S. Chand, ISBN: 9788121901048.

5.	**Reference Book(s) and Other Required Material**

i) D. C. Kulshreshtha, Basic Electrical Engineering, Second Edition, McGraw-Hill, 2019, ISBN: 9353167213.

ii) P. Tiwari & S. Gairola, Electrical Engineering Laboratory Practice, First Edition, S.K. Kataria & Sons, 2012, ISBN: 978-81-89757-89-2.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Continuous Evaluation, Total 100 Marks

7.	**Relationship of Course Outcomes to Program Outcomes:**

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

Course Code & Course Title:	**MAL101-MATHEMATICS-I**		
Course Type:	DC		
Name of the program(s):	B.Tech.(CME, CIV, CSE, ECE, EEE, MIN)		
L – T – P	3-1-0	**No. of Credits**	4
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s)& Name(s)			

1.	**Course Objective:** The objective of this subject is to expose students to understand the basic importance of Differential calculus, Integral calculus, Infinite series, and Matrix theory in science and engineering.

2.	**Course Outcomes (Min. 3 & Max. 5):** After completing this course, students will be able to
CO1	Test the convergence of sequence and series.
CO2	Deal with differential calculus of functions of single variable and its applications.
CO3	Understand concepts of integration of functions of single variables and their applications.
CO4	Understand basic concepts of matrix theory and can apply it to solve problems of Engineering
CO5	

3. Detailed Description of the Course		
Topics	**CO(s) Addressed**	**Duration in weeks**
Sequences and Series: Sequences of real and complex numbers, Monotonic sequence, Bounded Sequences, Convergence of Sequence. Infinite series, tests of convergence (Comparison test, Ratio test, Root test, Raabe's test, Logarithm test and Integral test statements only), absolute and conditional convergence, power series, radius of convergence.	**CO1**	3-4 weeks
Differential Calculus of function of single variable: Review of limit, continuity, and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with Lagrange's form of remainder, curve tracing.	CO2	3-4 weeks
Integral Calculus: Fundamental theorem of Integral calculus, mean value theorems, evaluation of definite integrals. Differentiation under integral sign	CO3	3-4 weeks

including variables limits-Leibnitz rule (without proof). Applications in area, length, volumes, and surface of solids of revolutions. Improper integrals and tests for convergence, Beta and Gamma functions,		
Matrices: Gauss-Elimination and Gauss-Jordan Elimination methods for solving system of linear equations, Rank of matrix, consistency of a system of equations, linear dependence and independence, linear and orthogonal transformations, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, reduction to diagonal form, Hermitian and skew Hermitian matrices, Quadratic forms.	CO4	3-4 weeks

4. Text books

i) Jain,R.K. and Iyengar, S.R.K., Advanced Engineering Mathematics; Narosa Publishers.

ii) James Stewart, Calculus-Early transcendental, 5th edition, Thomson™ Brooks/Cole-Indian Edition, 2007

iii) Kreyszig, E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons.

iv) Thomas, G. B. and Finney, R. L., Calculus and Analytic Geometry, 9th Edition, Addison-Wesley Longman, Inc.

5. Reference Book(s) and Other Required Material

i) Piskunov, N., Differential and Integral calculus, Vol.1, Vol.2 MIR Publishers, Moscow–CBS Publishers and Distributors (India).

ii) Sudhir R. Ghorpade, Balmohan V. Limaye, A Course in Calculus and Real Analysis, 2nd Edition, Springer, New York, NY. 2018.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

CO4	3	2	1								2			
CO5														

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	**HULxxx English and Corporate Communication**		
Course Type:	**IC**		
Name of the program(s):	**B.Tech**		
L – T – P	**2-0-2**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**HUL101**		

1.	**Course Objective:**

To impart the students with the skills they need in their academics and later in their professional pursuit

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Acquaint learners with basic of communication
CO2	Familiarize learners with nuances of corporate communication
CO3	Emphasize the importance of verbal and non-verbal communication
CO4	Discuss key features of corporate communication
CO5	Prepare learners for workplace challenges

3.	**Detailed Description of the Course**		
Topics		**CO(s)**	**Duration in weeks**
Introduction to Communication • Principles of Communication • Channels of Communication • Inclusive Communication Practices • Speaking and Listening Skills for Communication		CO1	2
Introduction to Corporate Communication • Different Forms of Corporate Communication • Factors Influencing Corporate Communication • Interpersonal Communication • Communication for Effective Leadership		CO2	2
Verbal and Non-verbal Communication • Reading and Writing Skills for Corporate Communication • Nonverbal Communication in Corporate Setting • Interview and Group Discussion • Presentation Skills		CO3	4
Features of Corporate Communication • Levels of Corporate Communication • Barriers to Communication • Organizational Communication		CO4	2

• Dos and don'ts of corporate communication		
Strategies of Communication • Negotiating Conflict and Management • Crisis Communication • Emotional Intelligence and Stress Management • Ethics in Corporate Communication	CO5	2

4.	Text books

i) Joep Cornelissen, *Corporate Communication: A Guide to Theory and Practice*, 6th Edition, SAGE Publications, 2020, ISBN 1526491982.
ii) Meenakshi Raman and Prakash Singh, *Business Communication*, 2nd Edition, Oxford University Press, 2012, ISBN 9780198077053.
iii) Shirley Taylor and V. Chandra, *Communication for Business: A Practical Approach*, 1st Edition, Pearson, 2010, ISBN 9788131727652.

5.	Reference Book(s) and Other Required Material

i) Ashraf Rizvi, Effective Technical Communication, 2nd Edition, McGraw Hill Education, 2017, ISBN 9352605780.
ii) Courtland L. Bovee, John V. Thill, et al., Business Communication Today, 14th Edition, Pearson, 2018, ISBN 9789353062682.
iii) Mary Ellen Guffey and Dana Loewy, Business Communication: Process and Product, 10th Edition, South-Western College Publishing, 2021, ISBN 0357129237.
iv) Paul A. Argenti, Corporate Communication, 7th Edition, McGraw-Hill Education, 2016, ISBN 9814636193.
v) Sharon Gerson and Steven Gerson, Technical Communication: Process and Product, 8th Edition, Pearson Education India, 2014, ISBN 9332518599.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Examination – 20 Marks

Teacher Defined Assessment – 20 Marks

End Semester Examination – 60 Marks

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1										3					
CO2									3						
CO3							3			3	3				
CO4								3							

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Week 1. Ice Breaker

Week 2. Oral Presentation

Week 3. Listening Activity

Week 4. Role Play

Week 5. Group Discussion

Week 6. Writing Activities

Week 7. Peer Interview

Week 8. PPT Presentation

Week 9. Debate

Week 10. Corporate Meeting

Week 11. Case Study

Week 12. Interviewing Strangers

Course Code & Course Title:	MEP1xx - Engineering Workshop		
Course Type:	ES		
Name of the program(s):	B.Tech.		
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)	NIL		
Course Equivalence: Course Code(s)& Name(s)	NIL		

1.	Course Objective:

The objectives of the course are

i. To make the students aware with various skills involved in basic engineering processes for manufacturing and assembly.
ii. To make students aware of various basic engineering processes like cutting, filing and joining and to have hands on experience for the same.

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Acquire skills in basic engineering practice.
CO2	Identify the hand tools and instruments.
CO3	Gain measuring skills.
CO4	Obtain practical skills in the various trades.
CO5	Enhance psycho motor skills and attitude

3. Detailed Description of the Course		
Topics	**CO(s) Addressed**	**Duration in weeks**
Fitting: Use and setting of fitting tools for chipping, cutting, filing, and marking, center punching, drilling, and tapping. Term work to include one job involving following operations: Filing to size, drilling and tapping.	CO1 to CO5	04
Welding: Use and setting of tools and equipments for edge preparation for welding jobs and Arc welding for Jobs like, Lap welding of two plates, butt welding of plates.	CO1 to CO5	04
Machining: At least one metal turning job is to be demonstrated.	CO1 to CO5	02
CNC Machines: One job on CNC Lathe and CNC Milling machine to be demonstrated.	CO1 to CO5	01
Plumbing: Use and setting of hand tools like hacksaws, Vices, V blocks, Taps, Tap wrenches, Pipe Course Book First Year B. Tech. (2024-2025) wrenches, Pipe threading dies, pipe bending dies, Pipe cutters, callipers etc for plumbing works. At least one job/ demonstration involving threading and joining of pipes.	CO1 to CO5	01

4.	Text books

i) Hajra Choudhury, S. K., Hajra Choudhury, A. K., & Roy, Nirjhar, *Elements of Workshop Technology (Volume I: Manufacturing Processes)*, 14th (or 16th revised) Edition, Media Promoters & Publishers (Mumbai, India), 2008 (revised); ISBN 978-8185099149.

ii) Hajra Choudhury, S. K., Hajra Choudhury, A. K., & Roy, Nirjhar, *Elements of Workshop Technology (Volume II: Machine Tools)*, 16th Edition (Revised & Enlarged), Media Promoters & Publishers Pvt. Limited, 2014, ISBN 978-8185099156

5.	Reference Book(s) and Other Required Material

i) Chapman, W. A. J., *Workshop Technology, Part I: Theoretical and Practical Workshop Technology*, 5th Edition, CBS Publishers & Distributors, 2001, ISBN 978-81-239-0401-6.

ii) Chapman, W. A. J., *Workshop Technology, Part II: Machine-Shop Practice and Workshop Calculations*, 3rd Edition, Edward Arnold (Publishers) Ltd., 1997, ISBN 978-0713134893.

iii) Chapman, W. A. J., *Workshop Technology, Part III: Special Workshop Practice*, 3rd Edition, Edward Arnold (Publishers) Ltd., 1961, ISBN 978-0713134992.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	SAA101 - Health Information and Sports–Part I		
Course Type:	MNC		
Name of the program(s):			
L – T – P	0-0-2	No. of Credits	0
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s)& Name(s)			

1.	Course Objective:
	a) To provide information about physical, physiological & psychological aspects of sports & physical. b) To create awareness among the students about their health status, by conducting various physical fitness tests and suggest them suitable remedial physical fitness program. c) To make students aware about the rules and regulation of different games & sports. d) To provide opportunity to mingle with each other through participating in different physical education & sports activities. e) To deliver the knowledge of daily calorie requirement to manage the obesity

2.	Course Outcomes:
CO1	Enriched proper knowledge among the students about emerging issues such as health & fitness, wellness etc.
CO2	Students will become aware about the sense of discipline & dedication in general life, develop the spirit of team work through various physical education & sports activities.
CO3	Development of rational thinking and scientific temper among the students.

3.	Detailed Description of the Course	
Topics	CO(s) Addressed	Duration in weeks
Introduction to psychological problem of a sports person	CO1, CO2, CO3	8-12
Warming up, cooling down & full body stretching and its importance	CO1, CO2, CO3	8-12
Obesity & its Management: Daily caloric requirements and daily energy expenditure	CO1, CO2, CO3	8-12

Scientific principles of training	CO1, CO2, CO3	8-12
Health &performance related physical fitness	CO1,CO2,CO3	8-12

4.	**Practical**	
Topics	**CO(s) Addressed**	**Duration in weeks**
i) Practice of skills of major games like: Badminton, Table Tennis, Chess, Yoga, Basketball, Football, Handball, Cricket, Kho-Kho , Lawn Tennis, Throw ball, Athletics &Kabaddi	CO1,CO2,CO3	8-12
ii) Screening of health related physical Fitness	CO1,CO2,CO3	8-12
iii) Participation in Intramural Sports Program	CO1,CO2,CO3	8-12
iv) Preparation for Physical Efficiency Test Level-1	CO1,CO2,CO3	8-12

5.	**Reference Books & other required materials**
i)	Arnold G. Nelson,(2007),"Stretching Anatomy" Human Kinetics: Online available : https://www.therajordanmassage.com/doc/3_%20Stretching%20Anatomy.pdf
ii)	Matt Jarvis, Sports Psychology, Taylor & Francis e- library, 2005
iii)	Tudor O Bompaand G Gregory Haff, Periodization theory & methodology of training, 5th Edition, Human Kinetics 2009

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Continuous evaluation Assessment- End Semester 100%

B. Tech Chemical Engineering Semester II

Code	Course	Type	L-T-P	Credits	Pre-requisites
AML152	Engineering Mechanics	ES	3-0-0	3	None
AMP152	Engineering Mechanics	ES	0-0-2	1	None
ICLxxx	Institute Core	IC	2-0-0	2	None
MAL102	Mathematics–II	BS	3-1-0	4	None
MELxxx	Basic Engineering Graphics	ES	2-0-2	3	None
PHL103	Physics	BS	3-0-0	3	None
PHP103	Physics	BS	0-0-2	1	None
IELxxx	Institute Elective-I	IE	3-0-0	3	None
CML1xx	Introduction to Chemical Engineering	DC	3-0-0	3	None
SAA102	Health Information and Sports–Part II	MNC	0-0-2	0	None
	Total Credits			23	
Certificate Exit Additional Course					
CMP3xx	Chemical Engineering	DC	0-0-2	1	None

Summer internship of minimum 6 weeks – 1 Credit

L-T-P=3-1-0 Means, Three Theory Hrs + One Tutorial hrs + Zero Laboratory or Practical Hrs per Week.

L-T-P=0-0-2 Means, Two Hrs of Laboratory Practical per Week

Course Code & Course Title:	**AML 152 Engineering Mechanics**		
Course Type:	**ES**		
Name of the program(s):	B.Tech. in Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**-**		

1.	**Course Objective:** *To expose the students to the basic concepts of mechanics such as force, moment, static equilibrium, etc. to analyse basic force systems, and introduce basic concept of stress and strain.*

2.	**Course Outcomes:**
After completion of this course, student shall acquire:	
CO1	*Knowledge of basic theory and principles of forces, equilibrium and their engineering applications.*
CO2	*Knowledge of properties of planar section.*
CO3	*Ability to draw internal forces for beams with various boundary conditions under given set of loading.*
CO4	*Knowledge of the concepts of stresses and strains and their importance for engineering analysis and design.*

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Force systems: Planar force system, Moment of a force about a point and about an axis, Couple, Moment.		CO1	02
Equilibrium: Free Body Diagram, Equilibrium of statically determinate planar force systems, Analysis of statically determinate truss. Friction: inclined plane, wedge, ladder friction.		CO1	03
Properties of Plane area: Centroid and Moment of Inertia, Parallel Axis Theorem, Perpendicular Axis Theorem.		CO2	02
Internal forces in member: Determination of Axial Force (Axial Force Diagram), Shear Force (Shear Force Diagram), Bending Moment (Bending Moment Diagram) and Twisting Moment Diagram.		CO3	02
Concept of stress and strain: Normal and Shear Stress and Strain, Stress-Strain Curve, Hook's Law, Modulus of Elasticity, Poisson's		CO4	03

Ratio, Modulus of Rigidity, Bulk Modulus, Shear Modulus, Thermal Stresses.		
Determination of stress: Stress across a Rectangular Section due to bending moment, Stress across a Rectangular Section due to Shear Force.	CO4	02

4. Text books

i) Beer, F. P., Johnston, E. R., Jr., Cornwell, P. J., Mazurek, D. F., & Sanghi, S., Vector Mechanics for Engineers: Statics and Dynamics. 10th ed., McGraw-Hill Education, 2019.

ii) Beer, F.P., Johnston, E.R., DeWolf, J.T., and Mazurek, D.F., Mechanics of Materials. 6th ed., McGraw-Hill, 2012

iii) Hibbeler, R. C. Engineering Mechanics. 7th ed., Pearson Education, 2004.

5. Reference Book(s) and Other Required Material

i) Meriam, J. L., and L. G. Kraige. Engineering Mechanics: Dynamics. 7th ed., John Wiley & Sons, 2012.

ii) Popov, E. P. Engineering Mechanics of Solids. Prentice Hall, 1990.

iii) Pytel, Andrew, and Ferdinand L. Singer. Strength of Materials. Harper & Row Publishers, 1987.

iv) Shames, I. H. Engineering Mechanics: Statics and Dynamics. Pearson Education Asia Pvt. Ltd., 1996.

v) Timoshenko, S. Strength of Materials, Part 1: Elementary Theory and Problems. CBS Publishers and Distributors, 2021.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		2			1			2				1	2	1	
CO2	2	1	1	1	1	1			2				2	2	2	
CO3	2	2	1	1	1	1			2				1	1	1	
CO4						1		1	1	2			3	2	2	

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	**AMP 152 Engineering Mechanics Laboratory**		
Course Type:	**ES**		
Name of the program(s):	B.Tech. in Chemical Engineering		
L – T – P	0-0-2	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**-**		

1.	**Course Objective:** To expose the students to simple practical experiments based on fundamental concept of mechanics

2.	**Course Outcomes:**
After completion of this course, student shall acquire:	
CO1	*Knowledge of experimental verification of laws of mechanics.*
CO2	*Knowledge and ability to compare theoretical results with the experimental one.*
CO3	*Knowledge of frictional resistance between two surface and ability to determine coefficient of friction.*
CO4	*Knowledge of mechanical properties of metals and ability to obtain the same through experiment.*

3.	**Detailed Description of the Course**		
Topics (Any Eight)		**CO(s) Addressed**	**Duration in weeks**
Introduction to Engineering Mechanics		CO1	1
Proving the Law of Polygon of Forces		CO1, CO2	1
Verification of Lami's Theorem		CO1, CO2	1
Determination of forces in truss members by analytical and experimentally		CO2	1
Determination of Reactions of a Simply Supported Beam		CO1, CO2	1
Determination of Coefficient of Static Friction		CO3	1
Determination of centroid of Planar Figures		CO1, CO2	1
Tension Test on Metal Specimen		CO1, CO4	1
Bending Test on Wooden Beam		CO1, CO4	1
Shear test on metal specimen		CO1, CO4	1

4.	Text books

i. Beer, F. P., Johnston, E. R., Jr., Cornwell, P. J., Mazurek, D. F., & Sanghi, S., Vector Mechanics for Engineers: Statics and Dynamics. 10th ed., McGraw-Hill Education, 2019.
ii. Beer, F.P., Johnston, E.R., DeWolf, J.T., and Mazurek, D.F., Mechanics of Materials. 6th ed., McGraw-Hill, 2012
iii. Hibbeler, R. C. Engineering Mechanics. 7th ed., Pearson Education, 2004.

5.	Reference Book(s) and Other Required Material

i. Meriam, J. L., and L. G. Kraige. Engineering Mechanics: Dynamics. 7th ed., John Wiley & Sons, 2012.
ii. Popov, E. P. Engineering Mechanics of Solids. Prentice Hall, 1990.
iii. Pytel, Andrew, and Ferdinand L. Singer. Strength of Materials. Harper & Row Publishers, 1987.
iv. Shames, I. H. Engineering Mechanics: Statics and Dynamics. Pearson Education Asia Pvt. Ltd., 1996.
v. Timoshenko, S. Strength of Materials, Part 1: Elementary Theory and Problems. CBS Publishers and Distributors, 2021.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7.	Relationship of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2	2				3	3	1	1	2	1	1	
CO2	3	2		2	2				3	3	1	1	2	1	1	
CO3	2	2	1	1	1	1			2				1	1	1	
CO4						1		1	1	2			3	2	2	

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CL***: Environmental Studies		
Course Type:	IC		
Name of the program(s):			
L – T – P	2 – 0 - 0	No. of Credits	02
Pre-requisites: Course Code(s) & Name(s)	--		
Course Equivalence: Course Code(s) & Name(s)	--		

	Course Objective
1.	To introduce various natural resources, their importance and status.
2.	To introduce the concepts of ecosystem, their structure and functions.
3.	To introduce the concept of biodiversity conservation.
4.	To introduce possible causes of various forms of environmental pollution and their consequences, methods of prevention.
5.	To introduce various social and climatic changes due to pollution.

1.	Course Outcomes (Min. 3 & Max. 5):
CO1	Understand about various natural resources, their importance and status.
CO2	Understand the concepts of ecosystem and biodiversity, their structure, functions and conservation.
CO3	Understand the causes of various forms of environmental pollution and their consequences, and methods of prevention.
CO4	About the various changes in social and climate due to pollution and population and the environment.

2.	Detailed Description of the Course		
	Topics	**CO(s)**	**Duration in weeks**
	Natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources,Land resources.	CO1	04
	Ecosystem: Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Food chain, food webs and pyramids. Biodiversity and its conservation: Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global,	CO2	03

national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation.		
Environmental pollution: Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes.	CO3	06
Social issues and environment: Sustainable development, Water conservation, Rain water harvesting, Watershed management, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accident, Environmental rules and regulations. Human population and environment: Population growth, Environment and human health, Human rights, Value education, Role of information technology in environment and human health.	CO4	02

3.	**Text books**

i) Rajgopalan R., Environmental Studies, 3rd Edition, Oxford University Press, 2023. ISBN: 13. 9789354978944

ii) Benny Joseph, Environmental Studies, 3rd Edition, McGraw Hill, 2017. ISBN: 10. 9352605179

iii) Erach Barucha, Environmental Studies, 3rd Edition, Universities press (India), 2025, ISBN: 9789389211788

4.	**Reference Book(s) and Other Required Material**

i) Rao M.N. and Rao H.V.N., Air Pollution, 1st Edition, McGraw-Hill Publishing Company Limited, 2007. ISBN: 13, 978-0074518717.

ii) Rao C.S., Environmental Pollution Control Engineering, 3rd Edition, Wiley Eastern Limited, New Age International Limited, 1995. ISBN: 13. 978-9386649898.

5.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Mid Term Examination: 30 Marks

Continuous Assessment (Seminars): 10 Marks

End Term Examination: 60 Marks

Total Marks: 100

6.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

7.	List of Indicative Laboratory Experiment (if applicable):

NA

Course Code & Course Title:	MAL102 – Mathematics II		
Course Type:	BS (Basic Science)		
Name of the programme(s):	B.Tech.(CME, CIV, CSE, ECE, EEE, MIN)		
L – T – P	(3 – 1 – 0)	**No. of Credits**	**4**
Pre-requisites: Course Code(s) & Name(s)	-		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:** To expose students to multivariable calculus (differential and integral), vector calculus, and ordinary differential equations with an emphasis on engineering applications.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Deal with differential calculus of functions of several variables and their applications.
CO2	Understand concepts of multiple integrals and their applications in engineering problems.
CO3	Understand the concepts of vector calculus and its applications in engineering and science.
CO4	Solve standard classes of ordinary differential equations related to science and engineering.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Calculus of functions of several variables: Limits, continuity and differentiability; partial derivatives and geometry; tangent plane and normal line; Euler's theorem for homogeneous functions; total differential and chain rule; Jacobians; Taylor formula; extrema (maxima, minima, saddle points); Lagrange multipliers.		CO1	3
Multiple integrals: Double integrals; change of order and change of variables; applications to area, volume, mass, centre of gravity. Triple integrals; change of variables; applications to volume, mass, centre of mass and moments of inertia.		CO2	3
Vector calculus: Scalar and vector fields; gradient and directional derivative; divergence and curl; solenoidal and irrotational fields. Line, surface and volume integrals; Green's, Stokes' and Gauss' divergence theorems (statements and applications).		CO3	3
Ordinary differential equations: First-order equations—exact equations, integrating factors, reducible to exact, linear and Bernoulli, orthogonal trajectories; existence and uniqueness (statement), Picard's iteration (statement). Second and higher order linear ODEs with constant		CO4	3

coefficients; linear independence; method of variation of parameters; Cauchy–Euler equations; systems of linear ODEs (overview).		

4.	Text books

i) Jain, R. K., and Iyengar, S. R. K., Advanced Engineering Mathematics, 4th ed., Narosa Publishing House, 2014.

ii) James Stewart, Calculus-Early transcendentals,5e, Thomson™ Brooks/Cole -Indian Edition, 2007

iii) Kreyszig, E., Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2011.

iv) Thomas, G. B., and Finney, R. L., Calculus and Analytic Geometry, 9th ed., Addison-Wesley, 1996.

5.	Reference Book(s) and Other Required Material

i) Ghorpade, S. R., and Limaye, B. V., A Course in Multivariable Calculus and Analysis, Springer, 2010.

ii) Greenberg, M. D., Advanced Engineering Mathematics, 2nd ed., Pearson Education, 2002.

iii) Piskunov, N., Differential and Integral Calculus (Vol. 1 & Vol. 2), Mir Publishers/CBS Publishers and Distributors (India).

6.	Evaluation Details:

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not applicable for this course

Course Code & Course Title:	MELXXX - Basic Engineering Graphics		
Course Type:	ES		
Name of the program(s):	B. Tech.		
L – T – P	2-0-2	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s)& Name(s)			

1.	Course Objective:

1. To understand the principles and methods of projections as per the National Standards.
2. To develop the visualization skills for the interpretation of the use of various objects like lines, planes, solids, sections of solids & development of lateral surfaces.
3. To acquire skills to interpret and convert multi-view drawings into single-view drawings and vice versa.
4. To understand and acquire basic skills in Computer-Aided Drafting.
5. Students will be able to create, assemble, and generate professional engineering drawings from 2D and 3D models using a CAD software package

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Students will be able to understand the conventions and standards for engineering drawing.
CO2	Students will be able to apply the knowledge of projections and methods to prepare the drawing for lines, planes, solids, sections of solids and development of lateral surfaces.
CO3	Students will be able to visualize and convert 2D to 3D drawing and vice versa.
CO4	Students will be able to understand and apply Computer Aided Drafting in real practice
CO5	Students will be able to create, assemble, and generate professional engineering drawings from 2D and 3D models using a CAD software package.

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Introduction to BIS SP-46-2003, Use of various drawing instruments, Concept of scales, Representative Fraction (RF) and dimensioning.		CO1	01
Conversion of Pictorial views to orthographic/ profile views		CO3	1.5
Projections of points, lines, plane on principle planes		CO2	1.5
Projection of right regular solids inclined to both the planes. Section and development of surfaces of solids. (Preferably in normal position).		CO2	03
Drawing isometric views and projection from orthographic projection.		CO3	02
Introduction to Computer Aided Drafting (CADr)- Basic commands for Setting, Drawing, Editing, Writing, Dimensioning and other features.		CO4	02
3D modelling: 3D tools, bar/commands for creation of a solid model. Orthographic projections from 3D model. Assembly drawings of simple parts.		CO5	03

4.	Text books

i) Bhatt, N. D., Panchal, V. M., & Ingle, P. R., *Engineering Drawing (Plane and Solid Geometry)*, 53rd Edition, Charotar Publishing House Pvt. Limited, 2013, ISBN 978-93-80358-83-3.

ii) Dhananjay, A. J., *Engineering Drawing: With An Introduction To Auto Cad*. Tata McGraw-Hill Education Private Limited, 2010, ISBN 978-0-07-064837-1.

5.	Reference Book(s) and Other Required Material

i) Engineering Drawing Practices for School & Colleges SP46:2003, Bureau of Indian Standards, 2003, ISBN 81-7061-019-2

ii) Kuthe A.M., Computer Graphics including CAD, AutoCAD & C, 1st Edition, S.Chand, 2005, ISBN 9788121924610.

iii) Zeid I., CAD / CAM Theory & Practice, 3rd Edition, Tata McGraw-Hill, 1991, ISBN-0070728577.

6.	Evaluation Details:

Assessment: Mid Sem 30 % + TA 10 to 20% + End Sem 50 to 60%

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative practical Assignments

1. Orthographic Projection of objects
2. Projection of points and lines
3. Projections of planes
4. Projection of regular solids
5. Projection of sections of a solid
6. Development of the lateral surfaces of a solid
7. Isometric projection of objects.
8. 2D drawing/orthographic views using CAD software.

9. 3D models/part drawing using CAD software.

Course Code & Course Title:	**PHL103 Physics**		
Course Type:	**BS**		
Name of the program(s):	B Tech		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**

1. To provide a strong foundation in physics in preparation for technical or scientific career.
2. To develop skills that enables to function as productive, qualified engineering professionals in areas where traditional science and engineering disciplines overlap.
3. Create awareness about the importance of continued professional development.

2.	**Course Outcomes (Min. 3 & Max. 5):** Student will be able to:
CO1	Understand the concepts of quantum mechanics and its application
CO2	Comprehend the primitive crystal systems through packing density and Miller indices.
CO3	Develop an understanding for basics of semiconductors based on band theory applied to electronic devices
CO4	Understand the concept of ultrasonics and their applications
CO5	Learn the basics of LASERs and its applications in optical fibers

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Quantum Mechanics: Origin of quantum mechanics, Compton effect, Concept of matter waves, Davisson and Germer's experiment, Heisenberg's Uncertainty principle, Schrodinger's Wave equation and its application and Quantization of energy.		CO1	3
Elementary crystal structure: Unit cell and its characteristics in SC, BCC, FCC crystal structure, Miller indices, Bragg's Law, inter-planer spacing.		CO2	2
Semiconductor Physics: Formation of energy bands in solid, classification of solids: intrinsic and extrinsic semiconductor, Fermi level in an intrinsic and extrinsic semiconductor, Hall effect, PN junction diode and BJT		CO3	3
Ultrasonics: Piezoelectricity, magnetostriction, ultrasonic waves and their application in non-destructive testing, sensors.		CO4	2
LASER Optics: Introduction to LASER, Spontaneous and Stimulated Emission, Different types of CW & Pulse lasers & their characteristics, Principle & characteristics of optical fibres, Different types of optical fibres		CO5	2

4.	Text books

i) M N Avadhanulu, P. Kshirsagar, A Textbook of Engineering Physics, 2017, S Chand Publications ISBN 13: 9789352833993

5.	Reference Book(s) and Other Required Material

i) A.J. Dekker, Solid State Physics, MacMillan, Student Edition (2000) ISBN-13. 9780333918333

ii) B.B. Laud, Lasers and nonlinear optics, New Age International limited (1991). ISBN-13. 978-9393159670.

iii) B. G. Streetman, Solid State Electronics, Prentice Hall India (2nd Edition) (1986) ISBN-13. 978-0134363790

iv) B. E. Conway Electrochemical Supercapacitors Scientific Fundamentals and Technological Applications 2013 Springer US ISBN : 9781475730586

v) David J. Griffiths, Introduction to Quantum Mechanics, Cambridge India (2016) ISBN-13. 978-1107179868

vi) Kenneth Krane; Modern Physics, John Wiley Eastern (2nd Edition); (1998) ISBN-13, 978-0471828723

vii) Resnick, Walker and Halliday, Fundamental of Physics, John Willey and Sons. Inc, 6th Edition (2005). ISBN · 9788126508235

viii) S.M. Sze Semiconductor devices (Physics and Technology), II Edition, Wiley India Pvt. Ltd. ISBN-13. 978-0470873670

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Sem: 30 Marks,

End Sem: 50 Marks,

Quiz/Internal assessment: 20 Marks,

Total 100 Marks

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

CO3	3	2	2			2	1					1			
CO4	3	2	2			2	1					1			

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	**PHP103 Physics Lab**		
Course Type:	**BS**		
Name of the program(s):	B Tech (MME/CIV/CME)		
L – T – P	0-0-2	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**

1. The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies.
2. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipment.
3. Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

2.	**Course Outcomes (Min. 3 & Max. 5):** Student will be able to:
CO1	Apply the concepts of quantum mechanics.
CO2	Apply the understanding for basics of semiconductors based on band theory applied to electronic devices
CO3	Gain hands on experience of studying the characteristics of Ultrasonic waves
CO4	Understand the principle of LASER and apply it in optical fibers

3.	**Detailed Description of the Course**		
st of experiments		**O(s) Addressed**	**Duration in weeks**
1.	To study the characteristics of Photocell and to determine the work function of the cathode material.	CO1	1
2.	To calibrate an electromagnet and to study the dependence of Hall voltage on magnetic field and current through the sample.	CO2	1
3.	To study the I/P, O/P and transfer characteristics and to determine ‘α’ of transistor in common base mode	CO2	1
4.	To study the forward and reverse characteristics of semiconductor diode.	CO2	1
5.	To determine the energy band gap in a semiconductor using reverse biased p-n junction diode.	CO2	1
6.	To determine the velocity of ultrasonic waves in a liquid	CO3	1
7.	To determine numerical aperture of the optical fibre	CO4	1
8.	To determine wavelength of He-Ne LASER	CO4	1

4.	**Text books**

1. Experiments of Engineering Physics M.N. Avadhanulu, A.A. Dani, P.M. Pokley, S Chand

Publishers (2003) ISBN-13- 978-8121912235

2. A Textbook of Engineering Physics Practical C. S. Robinson, Ruby Das, Lakshmi Publications Pvt Limited (2016) ISBN-13- 978-9380386867

5.	**Reference Book(s) and Other Required Material**

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Continuous evaluation

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

Course Code & Course Title:	CMLxxx Introduction to Chemical Engineering		
Course Type:	DC		
Name of the programme(s):	B.Tech. Chemical Engineering		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1.	Course Objective:

Course Objective 1: To provide student with an understanding of the field, its scope and their role as a chemical engineer

Course Objective 2: To provide students with basic principles of chemical engineering and its application to chemical engineering

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Understand the chemical sector
CO2	Understand the role of chemical engineers
CO3	Understand the sequence of processing steps in chemical industry
CO4	Understand the environmental impact of chemical industries

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Chemical engineering profession, and its applications in day today life and chemical industry		CO1, CO2	6
Basic chemical engineering principles		CO2	8
Various chemical industries (food, pharmaceutical, biotechnology, agrochemicals, dyes, petrochemicals, oils and surfactants, etc.)		CO1, CO2	8
Overview of chemical processes - various unit operations involved in the process		CO3, CO4	8
Life cycle assessment, environment impact, control and automation, batch to continuous process, current trends		CO2, CO3, CO4	6

4.	Text books

i) Kenneth A. Solen and John N. Harb, Introduction to Chemical Engineering: Tools for Today and Tomorrow, A first year integrated course, 5th Edition, Wiley, 2014, ISBN: 978-0470885727

ii) S. Pushpavanam, Introduction to Chemical Engineering, PHI Pvt Ltd, 2012, ISBN: 978-81-203-4577-5

5.	Reference Book(s) and Other Required Material

iv) Morton Denn, Chemical Engineering : An Introduction, 1st Edition, Cambridge University Press, 2011, ISBN: 978-1139138741

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

i) Assignment – 20%

ii) Mid Sem Evaluation – 30%

iii) End Sem Evaluation -50%

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	SAA102- Health Information and Sports-Part II		
Course Type:	MNC		
Name of the program(s):	SAA102 Health Information and Sports-Part II		
L – T – P	0-0-2	No. of Credits	0

1.	Course Objective:
	a. To make the students understand the importance of doing regular physical activities and the effect of exercise on various physiological systems b. To provide information about the scientific principles of training and their implications in various games & sports c. To provide the basic information about avoiding the injuries and it's management d. To make the students understand about the importance of physical activities & sports in managing the stress in day to day life e. To make students aware about the rules and regulation of different games & sports

2.	Course Outcomes:
CO1	The students will be able to design their own physical fitness training program
CO2	The students will be able understand how to handle their stress by participating in regular physical activities
CO3	The students will follow proper exercise pattern to avoid injuries
CO4	The students will understand how yoga helps to manage stress and improve their academic performance

3.	Detailed Description of the Course	
Topics	**CO(s) Addressed**	**Duration in weeks**
Periodization: Preparatory period, competition period and transitional period	CO1,CO2,CO3, CO4	8-12
Effects of exercise on various physiological systems	CO1,CO2,CO3, CO4	8-12
Therapeutic exercises & therapeutic modalities	CO1,CO2,CO3, CO4	8-12
The science of stress & it's yogic management	CO1,CO2,CO3, CO4	8-12

4.	Practical	
Topics	**CO(s) Addressed**	**Duration in weeks**

Practice of skills of major games like: Badminton, Table Tennis, Chess, Yoga, Basketball, Football, Handball, Cricket, Kho-Kho, Lawn Tennis, Throw ball, Athletics & Kabaddi	CO1,CO2,CO3,CO4	8-12
Participation in Intramural Sports Program	CO1,CO2,CO3,CO4	8-12
Preparation for Physical Efficiency Test Level-2	CO1,CO2,CO3,CO4	8-12

5.	**Reference Books & other required materials**
Tudor O Bompa and G Gregory Haff, Periodization theory & methodology of training, 5th Edition, Human Kinetics 2009	
Skot K Powers and Edward T Howley, Exercise Physiology Theory & application to fitness and performance , 10th Edition, Mc Graw Hill Education 2015	
William E. Prentice, Therapeutic Modalities for sports medicine & athletic training,6th Edition, Mc Graw Hill Education 2009	

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Continuous evaluation Assessment- End Semester 100%

Course Code & Course Title:	**CMP 3xx Chemical Engineering Laboratory**		
Course Type:	DC		
Name of the programme(s):			
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objectives:** To understand the basic principle of Chemical Engineering subjects like fluid mechanics, mechanical operations, heat transfer, mass transfer and chemical reaction engineering

2.	**Course Outcomes:**
CO1	Are able to design, carry out, record and analyze the results of chemical engineering experiments.
CO2	Are skilled in problem solving, critical thinking and analytical reasoning.
CO3	Ability to use modern instrumentation for chemical engineering analysis and measurements.
CO4	Are able to communicate and the results of their work to industry.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Friction in Pipeline (To determine the friction coefficient factor for different size as well as different material of pipes.) Pressure Measurement (Pressure measurement in pipeline)		CO1, CO2, CO4	2
Sedimentation (To carry out the batch sedimentation test and use the results to design a Thickener) Jaw crusher (To perform the sieve analysis of the product obtained from Jaw crusher and verify the power law).		CO1, CO2, CO4	2
Heat transfer trough lagged pipe Emissivity of a surface		CO1, CO2, CO3, CO4	2
Vapour-Liquid Equilibria Set up Liquid-air Diffusion (To determine the diffusion co-efficient of an organic vapor in air).		CO1, CO2, CO4	2

Study the kinetics of reaction for all the combination for given three CSTR in series Study the kinetics of reaction for all the combination for given PFR and CSTR in series	CO1, CO2, CO4	2

4.	Text books

i. J.P. Hollman, Heat Transfer, McGraw Hill, 10th Edition, 2017.

ii. R.E. Treybal, Mass Transfer Operations. McGraw Hills, 3rd Edition, 2017.

iii. R.B. Bird, W. Stewart and E.N. Lightfoot, Transport Phenomena. John Wiley & Sons, 2nd Edition, 2006.

iv. Levenspiel O., Chemical Reaction Engineering. Wiley India Pvt. Ltd., 3rd Edition, 2021.

5.	Reference Book(s) and Other Required Material

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

B. Tech Chemical Engineering Semester III

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML201	Chemical Process Calculations	DC	3-0-0	3	None
CML202	Fluid Mechanics	DC	3-0-0	3	None
CML203	Mechanical Operations	DC	3-0-0	3	None
CML204	Chemical Engineering Thermodynamics-I	DC	3-0-0	3	None
CHL263	Organic Chemistry and Synthesis	DC	3-0-0	3	None
CMP203	Mechanical Operations	DC	0-0-2	1	None
CMP204	Technical Analysis	DC	0-0-2	1	None
IELxxx	Institute Elective-II	IE	3-0-0	3	None
AULxxx	Mandatory Non-Credit Category-I	MNC	0-0-2	0	None
				Core Credits=17	
ELECTIVE					
CMLxxx	Elective - 1	DE	3-0-0	3	None
CMLxxx	Elective – 2	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Basics of Chemical Engineering	DM	3-0-0	3	None
				Elective Credits=6	
				DC+DE=23 Credits	

Course Code & Course Title:	CML201 Chemical Process Calculations		
Course Type:	DC		
Name of the program(s):	B.Tech. Chemical Engg.		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1.	Course Objective:

Course Objective 1: To understand the fundamental concepts and calculations of process calculation.

Course Objective 2: To understand the material balance in various unit processes and unit operations.

Course Objective 3: To understand the energy balance related to various process equipments.

Course Objective 4: To understand the various heats and their calculations related to chemical reactions including combustion.

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Ability to sort a process into different unit operations and processes and apply basic chemical calculations to it
CO2	Ability to apply material balances to different physical steps in a process
CO3	Ability to quantify heat and energy changes accompanying unit operations and unit processes
CO4	Ability to effectively combine the knowledge of material and energy calculations for processes

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Fundamental concepts, gas relationship, molarity, molality, normality, partial pressure, pure component volume and the related calculations.		CO1	1
Material balance in various unit processes and unit operations.		CO2	3
Material balance with chemical reactions		CO2	3
Fuels and combustion calculation, proximate and ultimate analysis, adiabatic reaction temperature, air to fuel ratio, complex processes calculation.		CO2	2
Energy balance related to various process equipment. Calculation of standard heat of reaction from the heat of formation and heat of combustion, thermo chemistry, energy balance in various unit operations, the heat of solutions, the heat of neutralization etc.		CO3	4
Humidity and saturation and their applications fundamental concepts of material balance.		CO2, CO4	1

4.	Text books

i) Bhatt B.I. and Thakore S.B. Stoichiometry, 5th Edition, McGraw Hill Education, 2017.
ii) Felder R.M., Rousseau R.W. and Bullard L.G.; Elementary Principles of Chemical Processess. 4th Edition, Wiley, 2004
iii) Himmelblau D.M.; Basic Principles and Calculations in Chemical Engineering, 8th Edition, Prentice Hall of India Ltd, 2015.
iv) Narayanan K V and Lakshmikutty B, Stoichiometry and Process Calculations, Prentice Hall of India Pvt Ltd, New Delhi 2006

5.	Reference Book(s) and Other Required Material

6.	Evaluation Details:

iv) Assignment – 20%
v) Mid Sem Evaluation – 30%
vi) End Sem Evaluation -50%

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		2							3	2	2	
CO2	3	3	3			1	2						2	2	2	
CO3	3	3	3	2			2						2	2	2	
CO4	3	3	3	2			2			2			2	2	2	

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	CML 202 & Fluid Mechanics		
Course Type:	**DC**		
Name of the programme(s):	Sachin A. Mandavgane		
L – T – P	3-1-0	**No. of Credits**	**4**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

1. To introduce students to basics of fluid properties and fluid statics
2. To introduce energy and mass balance equations
3. To study fluid flow through pipe and flow measurement instruments
4. To study fluid transportation through pipe and solid bed
5. To perform fluid mechanics calculation of a process plant

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Students will know properties of the fluid
CO2	Students will be able to design a storage tank
CO3	Students will be able to know nature of flow through pipe
CO4	Students will be able to select pump for a given system
CO5	Students will be able to know nature of flow through porous media

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Properties of Fluid: Pressure, density, specific weight, viscosity, dynamic and kinemetic viscosity, Newton's law of viscosity and its applications	CO1	
	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, Types of fluid Flows: Steady and unsteady, Uniform and non-uniform, Fluid Dynamics: Bernoulli's equation for incompressible fluid flow, Engineering applications of energy equation,	CO2 CO3	

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. Pitot – static probe, Current meters,Venturimeter, Orificemeter, Rotameter, Nozzlemeter, Notches & weirs	CO4	
Flow Over Immersed Bodies: Packed bed and fluidized bed Pumps: definition and classifications - Centrifugal pump: classifications, working principles , specific speed, efficiency and performance curves cavitations in pumps -	CO5	

4.	**Text books**

i) Gupta Santosh & Gupta Vijay, 'Fluid Mechanics and its applications', New Age International Publishers.

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

iii) Noel de Nevers, Fluid Mechanics for Chemical Engineers, TATA McGraw Hill 3rd Edition, 2011

iv) Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill International Edition, 2005

5.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Component	Duration	Weightage
Mid Sem	1.30 hour	30
Design of Storage tank	One week	10
Design Project on Fluid Mech	One Month	20
End Semester Exam	3 hours	40

6.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	CO/P O	1	2	3	4	5	6	7	8	9	10	11			
CO 2	CO1	3	3	3	3										
CO 3	CO2	3	3	3						2	2				

CO 4															
CO 5	CO3	3	3	3						1	1				

High - 3; Medium – 2; Low – 1;

7.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML203 Mechanical Operation		
Course Type:	**DC**		
Name of the programme(s):	B.Tech in Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**

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

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Able to describe properties of particulate solid and particle size analysis calculations
CO2	To understand screening equipment and equipment for size reduction
CO3	To understand filtration, sedimentation and centrifugal separation
CO4	To understand motion of particles through fluid, agitation and mixing, different conveying system for handling of solids

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Size Analysis: Particle size distribution, Screen analysis. Properties of particulate solid, surface area distribution of powders.		CO1	02
Equipment for size reduction: crushing and grinding equipments and their characteristic, open and close circuit grinding., power laws. Types of Screening Equipments and their application		CO2	02
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.		CO3	03
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.		CO4	04

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.	CO4	01
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.	CO4	01

4. Text books

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education
ii) C.M. Narayannan and B.C. Bhattacharyya,Mechanical Operation for Chemical engineering, Third edition, Khanna Publishers,2014,81-7409-036-3
iii) D.V.Subba Rao, Mineral Beneficiation :A concise basic course, CRC Press, ISBN 978-0-203-84789-3(ebook)

5. Reference Book(s) and Other Required Material

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Christie J. Gean Koplis Transport processes & Unit Operation Prentice Hall International
ii) Coulson J. M. and Richardson J.F; Chemical Engineering Vol. 1& 2 Publishers: Butter worth – Heinemann Ltd. 2001-2002
iii) McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering McGraw Hill, New York ,2001, 6th Edition

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

- Class Tests and Assignments: 20%
- Mid-Semester Exam (1.5 Hours): 30%
- End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	3	3							3	3	3	3
CO 2	3	3	1	3	3							3	3	3	3
CO 3	3	3	1	3	3							3	3	3	3

CO 4	3	3	1	3	3							3	3	3	3
CO 5	3	3	1	3	3							3	3	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML204 Chemical Engineering Thermodynamics-I		
Course Type:	DC		
Name of the program(s):	B.Tech. Chemical Engg.		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1.	Course Objective:

Course Objective 1: Understand and apply the first and second laws of thermodynamics to processes.

Course Objective 2: Analyze energy and material balances for various chemical engineering systems.

Course Objective 3: Understand and predict fluid behaviour under different conditions.

Course Objective 4: Develop an understanding of thermodynamic properties and their relationships.

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	To understand the fundamental concepts and I Law of Thermodynamics and its applications.
CO2	To understand the PVT behavior of pure substances.
CO3	To understand the II Law of Thermodynamics and its applications.
CO4	To understand the Thermodynamic properties of pure substances.

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
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		CO1	4
PVT behavior of gases: Ideal gas, definition, ideal gas law, equation of state for real gases, graphical representation of P-V-T behavior, T-V 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.		CO2	4
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.		CO3	3

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	CO4	2
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.	CO3	1

4. Text books

i) Smith J.M., Van Ness H.C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 2005.

ii) Peter Atkins., Physical Chemistry, Oxford, Tenth Edition.

5. Reference Book(s) and Other Required Material

6. Evaluation Details:

i) Assignment – 20%

ii) Mid Sem Evaluation – 30%

iii) End Sem Evaluation -50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3	3
CO2	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3	3
CO3	3	3	3	3	3	-	-	-	3	3	3	2	3	3	3	3
CO4	3	3	3	2	3	-	-	-	3	3	3	2	3	3	3	2

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	(CHL-263) ORGANIC CHEMISTRY AND SYNTHESIS		
Course Type:	**DC**		
Name of the programme(s):	B.Tech. CHEMICAL ENGINEERING		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	Course Objective:

The prime objective of this course is to present sound knowledge of chemistry fundamentals, mechanisms, various reagents, useful in laboratory practice, and orientation towards common industrial processes mainly involving oxidation, amination, by reduction and ammonolysis, alkylation, esterification, etc., besides the importance of technology development with a view of environment safety, hazards, and energy.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Ability to understand chemical reactions, mechanisms, and stoichiometry
CO2	Analytical ability, interpretation skills, and calculations
CO3	Ability to explain, reason, logic, and a wider review of the subject
CO4	Ability to apply techniques, concepts self -explanative diagrams, graphs, abstracting-
CO5	---

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
OXIDATION		CO1,2,3,4	2
AMINATION BY AMMONOLYSIS		CO1,2,3,4	3
AMINATION BY REDUCTION		CO1,2,3,4	3
NITRATION		CO1,2,3,4	1
ESTERIFICATION		CO1,2,3,4	2
ALKYLATION		CO1,2,3,4	3
POLYMERS		CO,1,2,3,4	1

4.	**Text books**

i) Groggins P. H, Unit Processes in Organic Synthesis, Fifth Edition, McGraw-Hill,2001, ISBN-10 : 0074621432, link: https://www.amazon.in/Processes-Organic-Synthesis-PhilipGroggins/dp/0074621432

ii) Dr.Jagdamba Singh, Advanced Organic Chemistry, Pragati Prakashan, Meerut,2016, ISBN : 978-93-89961-41-6 Link: https://pragatiprakashan.co.in/chemistry-book-publishers?page=2

iii) Morrison Boyd and Bhattacharjee, Organic Chemistry,7 th edition ; Prentice Hall, Inc,2010, ISBN-10 -9788131704813 Link : https://www.amazon.in/Organic-Chemistry-Sixth-Morrison-Boyd/dp/B07BCJ4FML

5. Reference Book(s) and Other Required Material

i) Doraiswamy L.K.; Organic Synthesis Engineering, Academic Press, American.Chemical.Society, NewYork,2001, ISBN.0-19-509689-4. link: https://isbnsearch.org/isbn/0195096894

ii) Venkateswarulu D.; Manual of Chemical Technology, Vol. I and II, Educational Development Centre, I.I.T. Madras, 1977, link:https://books.google.co.in/books/about/CHEMTECH.html?id=6dXycQAACAAJ&redir_esc=y

iii) Shreve R.N. and Brink H.A., Chemical Process Industries, McGraw-Hill Book Co. 4th Edition, 1977.ISBN-10 : 0070571457, link: https://www.amazon.in/Chemical-Process-Industries-Randolph-Norris/dp/0070571457

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Course Assessment (Total100 marks) • One Mid Semester Examination (30 marks) • One End Semester Examination (50 marks), and • Teacher Defined Assessment (20 marks) through tests, quizzes, assignments, seminars, group discussions, etc.

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

Course Code & Course Title:	CMP203 Mechanical Operation laboratory		
Course Type:	**DC**		
Name of the programme(s):	B.Tech in Chemical Engineering		
L – T – P	0-0-1	**No. of Credits**	**01**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**

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 and sieve analysis etc.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To understand importance and construction of various mechanical operations used in process industry.
CO2	To apply principles of mechanical operation for handling and operating various equipment and inter prating the observation to do calculation.
CO3	To experience of handling different unit operations.

3.	**Detailed Description of the Course**		
List of experiment in mechanical Operation lab: * (Any 10 experiments will be perform out of the total below listed experiments)		**CO(s) Addressed**	**Duration in weeks**
1. Ball mill: to determine the critical speed of ball mill and to verify power law		CO1, CO2, CO3	1
2. Elutriator: to determine the separation efficiency		CO1, CO2, CO3	1
3. Stroke's law: to verify drag coefficient and particle Reynold's number graph /plot		CO1, CO2, CO3	1
4. Effectiveness of screen: to determine effectiveness of screen through sieve analysis		CO1, CO2, CO3	1
5. Sedimentation: to design the area of a thickener		CO1, CO2, CO3	1
6. Vibrating screen		CO1, CO2, CO3	1
7. Jaw crusher		CO1, CO2, CO3	1
8. Leaf filter: to determine the cake and filter medium resistance		CO1, CO2, CO3	1
9. Magnetic separation		CO1, CO2, CO3	1
10. Sampling techniques: to perform cone and quartering sampling method		CO1, CO2, CO3	1
11. Plate and frame filter press (study experiment)		CO1, CO2, CO3	1

12. Spiral concentrator: to separate two particles through flowing film concentrator	CO1, CO2, CO3	1
13. Cyclone separator: to separate dust particle from air	CO1, CO2, CO3	1

4. Text books

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education
ii) C.M. Narayannan and B.C. Bhattacharyya,Mechanical Operation for Chemical engineering, Third edition, Khanna Publishers,2014,81-7409-036-3
iii) D.V.Subba Rao, Mineral Beneficiation :A concise basic course, CRC Press, ISBN 978-0-203-84789-3(ebook)

5. Reference Book(s) and Other Required Material

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Christie J. Gean Koplis Transport processes & Unit Operation Prentice Hall International
ii) Coulson J. M. and Richardson J.F; Chemical Engineering Vol. 1& 2 Publishers: Butter worth – Heinemann Ltd. 2001-2002
iii) McCabe W.L., Smith J.C. and Harriot P., Unit Operations of Chemical Engineering McGraw Hill, New York ,2001, 6th Edition

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

- Class Tests and viva: 20%
- Continuous evaluation base on performance, writes up, report submission, calculation :70%
- Research activity: 10%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

* (Any 10 experiments will be perform out of the total below listed experiments)

Course Code & Course Title:	**CMP-204 Technical Analysis Lab**		
Course Type:	**DC**		
Name of the programme(s):	**B. Tech**		
L – T – P	**P**	**No. of Credits**	**01**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**

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

2.	**Course Outcomes:**
CO1	Describe the basic concepts
CO2	Analyze the given sample

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	1. Estimation of silica content (analysis of ordinary portland cement To estimate the silica content (analysis of ordinary portland cement (OPC)). **2. Depression of freezing point** Study of depression of freezing point of the solution. **3. Gravimetric analysis of a phosphorus-containing fertilizer** To determine the percent phosphorous in a sample of fertilizer using Lab-Gravimetric analysis. **4. Synthesis of Biodiesel from Vegetable Oil** To synthesize biodiesel from vegetable oil and determine its physical properties. **5. UV Spectroscopy** To Determine the concentration of compounds using UV spectroscopy techniques. **6. Determination of Na_2CO_3 content of washing soda** **7. Sugar analysis using Benedict's reagent** To determine (semi-quantitatively) the concentration of reducing sugar in an unknown sample **8. Study Experiment on Gas Chromatography** **9. Joule Thomson Effect: Experiment, Coefficient, Inversion Curve and Applications** (Demo Exp.)	CO1	6.5

1. **Estimation of silica content (analysis of ordinary portland cement** To estimate the silica content (analysis of ordinary portland cement (OPC)). 2. **Depression of freezing point** Study of depression of freezing point of the solution. 3. **Gravimetric analysis of a phosphorus-containing fertilizer** To determine the percent phosphorous in a sample of fertilizer using Lab-Gravimetric analysis. 4. **Synthesis of Biodiesel from Vegetable Oil** To synthesize biodiesel from vegetable oil and determine its physical properties. 5. **UV Spectroscopy** To Determine the concentration of compounds using UV spectroscopy techniques. 6. **Determination of Na_2CO_3 content of washing soda** 7. **Sugar analysis using Benedict's reagent** To determine (semi-quantitatively) the concentration of reducing sugar in an unknown sample 8. **Study Experiment on Gas Chromatography** 9. **Joule Thomson Effect: Experiment, Coefficient, Inversion Curve and Applications** (Demo Exp.)	CO2	6.5

4. Text books

i) Puri, Sharma And Pathania, Principles of Physical chemistry, 50th edition, Vishal Publications, Jalandhar, 2025, ISBN 978-9391247898.

5. Reference Books

i. Narayan K.V., a text book of Chemical Engineering Thermodynamics, 2nd edition, PHI Learning Private Limited, 2013, ISBN 13: 978-81-203-4747-2.
ii. Smith J.M., Van Ness H. C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 9th edition, McGraw Hill, 2021, ISBN 978-1-259-69652-7.
iii. S.R. Kale & R.R. Kale, Practical Biochemistry & Clinical Pathology, 29th Edition, Nirali Prakashan, 2020, ISBN-13: 978-8185790466.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

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

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

Relationship of Course Outcomes to Program Outcomes (CMP 265 Technical analysis)

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO265.1	*3*	*3*	*-*	*3*	*1*	*2*	*3*	*-*	*3*	*3*	*-*	*3*	*3*	*3*	*-*	*3*
CO265.2	*3*	*3*	*-*	*3*	*1*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*-*	*3*
CML204	*3*	*3*	*-*	*3*	*1*	*2*	*3*	*2*	*3*	*3*	*2*	*3*	*3*	*3*	*-*	*3*

8.	**List of Indicative Laboratory Experiment (if applicable):**

Nil.

Course Code & Course Title:	CMLxxx Basics of Chemical Engineering		
Course Type:	DM		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	3-0-0	No. of Credits	03 credits
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	Course Objective:
	• To be aware about the basic calculations in chemical processes mainly the stoichiometry, material and energy balance • To provide basic knowledge of the unit operation and processes • To impart knowledge on the process flow of various chemical products • To provide knowledge on the overall synthesis of the various chemical products

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Students will be able to do material and energy balance calculations for a chemical process
CO2	Students will understand the basic principles, working and construction of various unit operations
CO3	At the end of the course, the students will be able to develop the process flow diagrams involved in the large-scale synthesis of various chemical products
CO4	Students shall acquire knowledge on the development of science and technology of various chemical process industries

3. Detailed Description of the Course		
Topics	CO(s) Addressed	Duration in weeks
Stoichiometry, molarity, molality, normality, Degrees of freedom, fundamental concepts of material balance, material balance in various unit processes and unit operations, material balance with chemical reactions, combustion, energy balance related to various process equipment.	CO1, CO2, CO3, CO4	3-4
Size reduction, screening, size separation and filtration	CO1, CO2, CO3	2
Basics of instrumentation diagrams and process symbols	CO2, CO3	2
Petroleum refining process – crude desalting, atmospheric and vacuum distillation of crude, hydrotreating, hydrocracking, fluid catalytic cracking (FCC), catalytic reforming, alkylation, Fischer-Tropsch (FT) process, deasphaltation and dewaxing of crude, vis-breaking and delayed coking	CO2, CO3, CO4	3-4

Manufacturing of fertilizers – ammonia, urea, NPK, monoammonium phosphate (MAP), diammonium phosphate (DAP), super phosphate (NSP), triple super phosphate (TSP) and nitrophosphates.	CO2, CO3, CO4	2
Carbon footprint, water footprint for chemical process plant using suitable software like GaBi	CO3, CO4	1-2

4. Text books

i) C. E. Dryden (revised by M. Gopala Rao & Marshall Sittig), Outlines of Chemical Technology, Revised Edition, Affiliated East-West Press Pvt. Ltd., 1997, ISBN: 9788185938790.

ii) David M. Himmelblau, James B. Riggs Basic Principles and Calculations in Chemical Engineering, 8th Edition, PHI Learning / Prentice Hall, 2014 (Eastern Economy Edition), ISBN: 9788120348653.

iii) Walter Bader & Julius Banchero, Introduction to Chemical Engineering, McGraw-Hill, 1955.

5. Reference Book(s) and Other Required Material

i) P. H. Groggins, Unit Processes in Organic Synthesis, 5th Edition, McGraw-Hill, 2004, ISBN: 9780074621431.

ii) Richard M. Felder, Ronald W. Rousseau Elementary Principles of Chemical Processes, 3rd Edition, John Wiley & Sons, 2005 ISBN-13: 9780471720638.

iii) T. G. Austin and S. Shreve, Chemical Process Industries, McGraw-Hill, 5th Edition, 2017, ISBN: 9781259029455

iv) Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill, 2017, ISBN-13: 9780072848233.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 20-30

Teacher Defined Assessment : 20

End Semester Exam : 50-60

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2								3	3	1	2
CO2	3	2	2	1	2								3	2	2	1
CO3	2	2	3	1	2	1	1			1			2	2	3	1
CO4	2	3	3	2	2	1	1			1			2	3	3	2

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

B. Tech Chemical Engineering Semester IV

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML221	Mass Transfer-I	DC	3-0-0	3	None
CML222	Heat Transfer	DC	3-0-0	3	None
CML223	Chemical Reaction Engineering-I	DC	3-0-0	3	None
CML224	Chemical Engineering Mathematics	DC	3-0-0	3	None
CML225	Chemical Engineering Thermodynamics-II	DC	3-0-0	3	CML204
CMP202	Fluid Mechanics	DC	0-0-2	1	None
CMP322	Heat Transfer	DC	0-0-2	1	None
AULxxx	Mandatory Non-Credit Category-II	MNC	0-0-2	0	None
				Core Credits=17	
ELECTIVE					
CMLxxx	Elective – 3	DE	3-0-0	3	None
CMLxxx	Elective – 4	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Chemical Engineering Thermodynamics	DM	3-0-0	3	None
				Elective Credits=6	
				DC+DE=23 Credits	
Diploma Exit Additional Course					
CMD4xx	Mini Project	DC	0-0-4	2	None

Summer internship of minimum 6 weeks – 1 Credit

Course Code & Course Title:	CML 221 & Mass Transfer 1		
Course Type:	**DC**		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**CML 203 & Mechanical Operation**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective: This course will provide basic knowledge of mass transfer operations and aims to develop skills for designing commercial separation equipments**

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Apply fundamentals of diffusion for gas, liquid and solid phase to solve engineering problems
CO2	Analyse complex purification systems and derive governing equations.
CO3	Understand the concept of mass transfer coefficients and design system with practical constraints.
CO4	Evaluate the industry implication of separation process.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Introduction to mass transfer operations, Diffusion in gases, liquids, and solids. Steady state and unsteady state operations.		CO1	4 weeks
Individual and overall mass transfer coefficients, Theories, analogies of mass transfer.		CO2	3 weeks
Inter-phase mass transfer operation and Coefficients, Design of gas, liquid and solid contact equipment's like distillation column, spargers, scrubbers, wetted wall tower, fractionation tower and their types		CO3	4 weeks
Adsorption: Adsorption isotherms, adsorption agents, equipment's for adsorption, pressure swing adsorption technology, adsorption phenomena Drying: Constant rate and falling rate periods, equilibrium moisture contents, drying equipment's, rotary dryers, drum dryers, vacuum dryers, Spray dryer, fluidized bed dryers, dryer calculations and dryer selection criteria. Crystallization: Theory of Crystallization, various equipment's for crystallization, their operational and design characteristics.		CO4	5 weeks

Humidification: Equipment's operational characteristics, design procedures and selection criteria along with mass transfer calculations		

4. Text books

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) C. J. Geankoplis, Transport processes and separation process principles, PHI publication

ii) Treybal R.E., Mass Transfer Operations, McGraw Hill Book Co., New York 1980, 3rd Edition

iii) McCabe W.L. and Smith J.C. & Harriot, Unit Operations of Chemical Engineering, , McGraw Hill Book Co., New York 1980, 5th Edition

iv) Binay K. Dutta, Principles of Mass Transfer and Separation Process, PHI Learning Pvt. Ltd., New Delhi, Eastern Economy Edition.

5. Reference Book(s) and Other Required Material

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Coulson J.M. and Richardson J.F, Chemical Engineering Vol. I, II & III, Pergamon Press, New York 1977

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam: 25 %
Assignments/Presentation/Viva/Quiz: 20 %
End Semester Exam: 55 %

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Course Code and Name:	**CML 222- Heat Transfer**		
Course Type:	DC		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-1-0	No. of Credits	4
Pre-requisites: Course Code(s) & Name(s)	Maths, CML204-Chemical Engg. Thermodynamics I, CML202-Fluid Mechanics		
Course Equivalence: Course Code(s) & Name(s)	**NIL**		

1.	**Course Objective:** The objective of this course is to study different modes of Heat Transfer, identify, formulate, and solve engineering problems involving conduction, convection, and radiation, apply energy balances and rate equations to model and analyze thermal systems, optimum use and its application in various chemical industries

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To introduce the basic principles of heat transmission by conduction, convection, and radiation
CO2	To identify, formulate, and solve engineering problems involving conduction, convection, and radiation,
CO3	To apply energy balances and rate equations to model and analyze thermal systems.
CO4	To introduce application of heat transfer and its optimum use

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
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.		**CO1**	2-3 Weeks
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.		**CO2**	2-3 Weeks
Condensation and Boiling, Condensation over flat plate, condensation inside and outside the tubes in horizontal, vertical and inclined position,		**CO3**	2-3 Weeks

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.	**CO4**	2-3 Weeks

4. Text books

i) Hollman J.P.; Heat Transfer, McGraw Hill, 1993
ii) Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd.,2008
iii) Cengel Y.A. Heat Transfer: A Practical Approach McGraw-Hill; 2 edition ,2002
iv) Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.
v) Dutta B.K. Heat Transfer; Principles and Applications PHI Pvt.Ltd New Delhi ,2006

5. Reference Book(s) and Other Required Material

i) Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.

6. Evaluation Details:

- Class Tests and Assignments: 15%
- Mid-Semester Exam (1.5 Hours): 25%
- End-Semester Exam (3 Hours): 60%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

Course Code and Name:	**CML 223 Chemical Reaction Engineering-I**		
Course Type:	DC		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-1-0	No. of Credits	4
Pre-requisites: Course Code(s) & Name(s)	**CHL XXX Chemistry, MAL 101 Engineering Mathematics**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:** i. Provide students with a basic understanding of reaction engineering, type of reactions and their mechanisms, reaction kinetics and dependency. ii. Enhance their knowledge on types of reactors, working of reactors and different types of arrangements of reactors. iii. Development of mathematical model equations and applications of it in solving reaction engineering and design problems. iv. Improve the student's ability in deciding type of reactor and their arrangement for achieving desired conversion keeping economy in point of view. v. Building engineering problem solving and critical thinking ability of students keeping in mind economical and sustainable approach to the problem.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Estimate reaction rates and their dependency, conversion and yield, reaction mechanisms and reaction path of a given chemical reaction.
CO2	Processing of various chemical constituents in the reactor and reactor design for different chemical reactions.
CO3	Design of multiple reactors, different types of reactors, sequential arrangement of the reactors, and their performance on product output.
CO4	Isothermal and non-isothermal effects on chemical reaction and design of chemical processes and reactors for a particular duty.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit I: Introduction to CRE: • Basics of 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.	CO1	1.0 (4 Hours)

Unit II: 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.	CO1	1.0 (4 Hours)
Unit III: 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, problems.	CO1	1.0 (4 Hours)
Unit IV: 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 Ideal reactors for a single reaction, ideal batch reactor, steady state mixed flow reactor, steady state plug flow reactor, problems.	CO2	1.0 (4 Hours)
Unit V & VI: Design for Single and Parallel Reactions: • Size comparison of single reactors • General graphical comparison • Multiple reactor system • recycle reactor • Autocatalytic reactions and problems ○ Introduction to design of parallel reactions ○ Qualitative and Quantitative discussion on product distribution Contacting patterns, reactor size and arrangement, selectivity, yield, problems.	CO3	2.0 (8 Hours)
Unit VII: 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 Irreversible series-parallel reactions, Graphical representation, Denbigh reactions and their special cases, problems.	CO3	1.25 (5 Hours)
Unit VIII: Temperature and Pressure Effects: • Single and multiple reactions • Heats of reaction from thermodynamics, equilibrium constant and its dependency, graphical design procedure • Optimum temperature progression, heat effects Adiabatic and non-adiabatic operations, problems.	CO4	1.25 (5 Hours)

4.	**Text books**

- Fogler, H.S., Elements of Chemical Reaction Engineering, 4th Edition, Prentice-Hall, NJ, 2006.
- Froment, G.F. and Bischoff, K.B., Chemical Reactor Analysis, 2nd Edition, John Wiley & Sons, 1990.

- Levenspiel, Octave, Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, 1998.
- Smith, J.M., Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, NY, 1981.

5. Reference Book(s) and Other Required Material

- Richardson, J.F. and Peacock, D.G., Coulson & Richardson's Chemical Engineering, Butterworth-Heinemann.
- Salmi, T.O., Mikkola, J.P., and Warna, J.P., Chemical Reaction Engineering and Reactor Technology.

6. Evaluation Details:

Assessment Component	**Weightage**
Class Tests and Assignments	20%
Mid-Semester Exam (1.5 Hours)	20%
End-Semester Exam (3 Hours)	60%
Total	**100%**

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

- Reaction in Batch reactor
- Reaction in Semi-batch reactor
- Reaction in Plug-flow reactor
- Reaction in Continuous stirred tank reactor

Course Code & Course Title:	CML 224 – Chemical Engineering Mathematics		
Course Type:	**DC**		
Name of the programme(s):	B. Tech.		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1.	**Course Objective:** 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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Able to solve and apply linear algebraic equations in chemical engineering problems.
CO2	Able to solve and apply non-linear algebraic equations in chemical engineering problems.
CO3	Able to solve and apply ordinary differential equations in chemical engineering problems.
CO4	Able to formulate the problem and apply discretisation techniques in chemical engineering problems.
CO5	Able to formulate and solve optimization problems in chemical engineering.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	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; Examples using Comsol Multiphysics Software on Sequence of distillation columns, Reactors linked with pipes, Rectangular fin, Recovery of acetone, etc.	CO1	3
	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; Examples using Comsol Multiphysics Software on Pressure Drop in Pipe, Minimum Fluidization Velocity, Terminal Velocity, Solution of Cubic Equations of State, Bubble Point and Dew Point Temperature Calculations Using Raoult's Law, Bubble Point and Dew Point Temperature Calculation, etc.	CO2	3

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; Examples using Comsol Multiphysics Software on Double Pipe Heat Exchanger, Stirred Tank with Coil Heater, Pneumatic Conveying, Series of Stirred Tanks with Coil Heater, Batch and Stirred Tank Reactors, Plug Flow Reactor, Nonisothermal Plug Flow Reactor, etc.	CO3	3
Finite difference method for solving ODE-BVPs; Finite difference method for solving PDEs; Model Parameter Estimation using linear least squares method; Gauss Newton Method; Curve fitting and regression; Examples using Comsol Multiphysics Software on One-Dimensional Steady Heat Conduction, Chemical Reaction and Diffusion in Pore, etc.	CO4	3
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.	CO5	2

4. Text books

v) Chapra S C, Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw Hill, 1st Edition, 2005.

vi) Ahuja P, Introduction to Numerical Methods in Chemical Engineering. Prentice Hall India, New Delhi, 1st Edition, 2010.

vii) Pushpavanam S, Mathematical Methods in Chemical Engineering. Prentice Hall India, New Delhi, 4th Edition, 2009.

5. Reference Book(s) and Other Required Material

i) Ghoshdastidar P S, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st Edition, 1998.

ii) Gupta S K, Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1st Edition, 1995.

iii) Thomas F and Himmelblau D M, Optimization of Chemical Processes, McGraw Hill, 2nd Edition, 2001.

iv) Finlayson B A, Introduction to Chemical Engineering Computing, Wiley, 2nd Edition, 2014.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam: 20-30 Marks
Teacher Defined Assessment: 20 Marks
End Semester Exam: 50-60 Marks

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	2	-	-	-	3	-	-	-	3	3	-
CO 2	3	3	-	-	3	-	-	-	3	-	-	-	3	3	-
CO 3	3	3	2	2	3	3	-	-	3	2	-	-	3	3	2
CO 4	3	3	3	2	3	2	-	-	3	3	-	-	3	3	3
CO 5	3	3	2	3	3	2	-	-	3	2	-	-	3	3	2

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	**CML – 225 Chemical Engineering Thermodynamics-II**		
Course Type:	**DC**		
Name of the programme(s):	**B. Tech**		
L – T – P	**L**	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**Chemical Engineering Thermodynamics I (CML204)**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**

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

2.	**Course Outcomes:**
CO1	Describe the Thermodynamic properties like free energy, activity, fugacity etc., for pure substances and solve the related problems.
CO2	Describe the thermodynamic properties of solutions and solve the related problems.
CO3	Use the concepts of phase equilibrium and solve the problems.
CO4	Apply the concepts of chemical equilibrium and solve the problems.

3.	**Detailed Description of the Course**	
Topics	**CO(s) Addressed**	**Duration in weeks**
Thermodynamic properties of pure substances: fugacity, fugacity coefficient, compressibility factor, activity.	CO1	1
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.	CO2	4
Criteria of phase equilibrium, Duhem theorem. 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.	CO3	5
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	CO4	3

constant, Effect of parameters like temperature, pressure, composition on the equilibrium conversion.		

4.	Text books

i) Narayan K.V., a text book of Chemical Engineering Thermodynamics, 2nd edition, PHI Learning Private Limited, 2013, ISBN 13: 978-81-203-4747-2.

ii) Smith J.M., Van Ness H. C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 9th edition, McGraw Hill, 2021, ISBN 978-1-259-69652-7.

5.	Reference Books

i) Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960, ISBN 13: 978-0486652429.

ii) Rao Y.V.C., Chemical Engineering Thermo dynamics, University press (INDIA) Ltd., 1997, ISBN 13: 978-8173710483.

iii) S.Sandler, Chemical, biochemical and engineering thermodynamics, 4th edition, John Wiley, 2006, ISBN 13: 978-0471661740.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Component	Duration	Weightage
Mid Term Exam	1.30 hour	30
Class tests and/ Viva	-	20
End Semester Exam	3 hours	50

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

Relationship of Course Outcomes to Program Outcomes (CML225 Chemical Engineering Thermodynamics - II)

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO225.1	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO225.2	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO225.3	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO225.4	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CML225	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2

8.	List of Indicative Laboratory Experiment (if applicable):

Nil

Course Code and Name:	**CMP202 & Fluid Mechanics Lab**		
Course Type:	**DC**		
Name of the programme(s):	**B.Tech. (Chemical Engineering)**		
L – T – P	**0-0-2**	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1	**Course Objective:** 1) To impart the basic concepts of fluid mechanic 2) To develop understanding about flow measurement device 3) Understand frictional losses in pipes 4) The students are exposed to basic theory, calculations and machinery involved in various fluid handling operations

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To understand importance of various Fluid mechanics concept used in process industry.
CO2	To apply principles of basic sciences and chemical engineering for designing various Flow and pressure measuring instruments
CO3	To experience of handling different unit operations

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Friction in Pipeline To determine the friction coefficient factor for different size as well as different material of pipes.		
	Flow Through Notches To determine discharge coefficient C_d through different Notches.		
	Packed Bed Hydraulic study in Packed column.		
	Fluidized Bed To study the relation between the pressure drop & superficial velocity throughout the bed.		
	Pressure Drop In Fittings To study the losses in pressure due to different fitting in pipes.		
	Impact of Jet on Vanes To study flow of fluid through Jet.		
	Pressure Measurement		

Pressure measurement in pipeline.		
Two Phase Flow To study the flow pattern of two phase in singe tube.		
Orifice Meter To determine discharge coefficient $C_{d.}$.		
Venturi Meter To determine discharge coefficient C_d.		
Pitot Tube To determine discharge coefficient C_d & determine point velocity.		

4. Text books

i) Badger & Banchero Introduction to Chemical Enginerring Mc-Graw- Hill Education

ii) G.G. Brown Unit Operation John Willey

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

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

5. Reference Book(s) and Other Required Material

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

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

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

6. Evaluation Details:

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H			H		M	H	M							
CO2	H		H	H			H	M							
CO3	H		H	H	L	M	H	H	M						
CO4															
CO5															

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

Course Code and Name:	**CMP 322- Heat Transfer Laboratory**		
Course Type:	DC		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)	CML222- Heat Transfer		
Course Equivalence: Course Code(s)& Name(s)	**NIL**		

1	**Course Objective:** 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. 4) To introduce application of heat transfer equipments and its optimum use

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	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
CO2	Observation of the steady state temperatures of all equipments
CO3	Determination of 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.
CO4	Application of heat transfer equipments and its optimum use

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
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		**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To study the temperature distribution along the length of a pin fin under free and forced convection heat transfer		**CO1, CO2**	2 Hrs. in a week

	CO3, CO4	
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	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To find out Stefan's Boltzmann constant	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To determine the emissivity of grey surface	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To calculate biot number , fourier number and heat transfer coefficient for unsteady state heat transfer	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To determine cold water side and hot water side heat transfer coefficient, LMTD and overall heat transfer coefficient for parallel and counter flow	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To calculate rate of heat transfer, LMTD and overall heat transfer coefficient for plate type heat exchanger	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To determine the critical heat flux	**CO1, CO2 CO3, CO4**	2 Hrs. in a week
To study the filmwise and dropwise condensation	**CO1, CO2 CO3, CO4**	2 Hrs. in a week

4. Text books

i) Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I, Butterworth Heinemann, New Delhi.

ii) Kern D.Q, Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.

5. Reference Book(s) and Other Required Material

vi) Hollman J.P.; Heat Transfer, McGraw Hill, 1993

vii) Dutta B.K. Heat Transfer; Principles and Applications PHI Pvt.Ltd New Delhi ,2006

6. Evaluation Details:

- Experiments and Journals : 50%
- Slip Tests and Assignments: 20%
- Practical Exam : 30%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	**CML – XXX Chemical Engineering Thermodynamics**		
Course Type:	**DM**		
Name of the programme(s):	**B. Tech**		
L – T – P	**L**	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**CML xxx : Introduction to Chemical Engineering**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**

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

2.	**Course Outcomes:**
CO1	**Describe the Thermodynamic properties like free energy, activity, fugacity etc., for pure substances and solve the related problems.**
CO2	**Describe the thermodynamic properties of solutions and solve the related problems.**
CO3	**Use the concepts of phase equilibrium and solve the problems.**
CO4	**Apply the concepts of chemical equilibrium and solve the problems.**

3.	**Detailed Description of the Course**	
Topics	**CO(s) Addressed**	**Duration in weeks**
Review of Classical Engineering Thermodynamics: Definition of terms and fundamental concepts, Laws of thermodynamics and their applications. Equations of state, free energy, phase rule, properties of pure fluids, fugacity, fugacity coefficient, compressibility factor, activity.	CO1	3
Solution thermodynamics: Ideal and non-ideal gas mixtures and liquid solutions, partial molar properties, physical significance and determination methods, chemical potential. Gibbs-Duhem equation.	CO2	4
Phase Equilibria: Criteria of phase equilibrium, Duhem theorem. Vapour liquid equilibrium, VLE equation, Activity coefficient - equations used for the determination, Thermodynamic consistency	CO3	4
Chemical reaction equilibrium: Criteria of equilibrium, equilibrium constant, Gibbs free energy change, feasibility of chemical reactions, effect of temperature on equilibrium constant, evaluation of van't Hoff constant, Effect of parameters like temperature, pressure,	CO4	2

composition on the equilibrium conversion.		

4.	Text books

i) Smith J.M., Van Ness H. C., and Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 9th edition, McGraw Hill, 2021, ISBN 978-1-259-69652-7.

ii) Narayan K.V., a text book of Chemical Engineering Thermodynamics, 2nd edition, PHI Learning Private Limited, 2013, ISBN 13: 978-81-203-4747-2.

5.	Reference Books

i) S.Sandler, Chemical, biochemical and engineering thermodynamics, 4th edition, John Wiley, 2006, ISBN 13: 978-0471661740.

ii) Rao Y.V.C., Chemical Engineering Thermo dynamics, University press (INDIA) Ltd., 1997, ISBN 13: 978-8173710483.

iii) Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960, ISBN 13: 978-0486652429.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Component	Duration	Weightage
Mid Term Exam	1.30 hour	30
Class tests and/ Viva	-	20
End Semester Exam	3 hours	50

7.	Relationship of Course Outcomes to Program Outcomes:

Relationship of Course Outcomes to Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO.1	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO.2	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO.3	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CO.4	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2
CML	3	3	2	2	1	1	-	-	2	3	-	3	3	3	2	2

8.	

Nil.

Course Code & Course Title:	**CMD 4xx Mini Project**		
Course Type:	**DC**		
Name of the programme(s):			
L – T – P	**(0-0-4)**	**No. of Credits**	**2**
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:** 1. To identify and analyze chemical engineering problems requiring innovative solutions. 2. To conduct a comprehensive literature review to establish project scope. 3. To develop a feasible methodology for experimentation or theoretical work. 4. To enhance technical communication through presentations and written reports

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Identify and define a problem in chemical engineering.
CO2	Conduct a thorough literature review to establish a project framework.
CO3	Develop a feasible methodology for experimental or theoretical analysis.
CO4	Present a preliminary project report and communicate objectives effectively.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
Unit 1: Introduction to Problem Formulation • Overview of project planning and research. • Techniques for problem identification and formulation			(4 Hours)
Unit 2: Literature Review and Project Scope • Conducting and documenting a comprehensive literature review. • Defining project objectives and scope.			(6 Hours)
Unit 3: Methodology Development • Designing experimental or computational frameworks. • Tools and techniques for data collection and analysis.			(6 Hours)
Unit 4: Report Preparation and Presentation • Structuring a technical report. • Delivering a clear and concise presentation.			(4 Hours)

4.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]
Component	**Weightage**
Literature Review	20%
Problem Formulation	20%
Proposed Methodology	30%
Presentation and Report	30%

5.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**
CO4	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**2**	**3**	**3**	**-**	**-**
CO5	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3 = Strong correlation, 2 = Moderate correlation, 1 = Weak correlation, - = No correlation

B. Tech Chemical Engineering Semester V

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML301	Mass Transfer-II	DC	3-0-0	3	CML221
CML302	Chemical Process Modeling & Simulation	DC	3-0-0	3	None
CML303	Process Control and Instrumentation	DC	3-0-0	3	None
CML304	Chemical Reaction Engineering-II	DC	3-0-0	3	CML223
CML353	Chemical Process Equipment Design	DC	3-0-0	3	None
CMP304	Chemical Reaction Engineering	DC	0-0-2	1	None
CMP321	Mass Transfer	DC	0-0-2	1	None
CMP403	Design	DC	0-0-2	1	None
AULxxx	Mandatory Non-Credit Category-III	MNC	0-0-2	0	None
				Core Credits=18	
ELECTIVE					
CMLxxx	Elective – 5	DE	3-0-0	3	None
CMLxxx	Elective – 6	DE	3-0-0	3	None
MINOR for Other Department					
CMLxxx	Chemical Reaction Engineering	DM	3-0-0	3	None
				Elective Credits=6	
				DC+DE=24 Credits	

Course Code & Course Title:	**(CML301) Mass Transfer II**		
Course Type:	**DC**		
Name of the programme(s):	**5th Semester B.Tech. Chemical Engineering**		
L – T – P	**3-0-0**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

The objective of this course is to introduce the mass transfer operations and how to quantify, formulate, and solve engineering problems involving different mass transfer operations like distillation, leaching, liquid-liquid extraction, absorption. To demonstrate that how to apply mass balances and its transfer and analyze systems.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To understand the basic concepts and principles of mass transfer operation like distillation, absorption, liquid-liquid extraction, solid-liquid extraction (leaching).
CO2	How to identify, quantify or formulate, and solve the engineering problems involving mass transfer.
CO3	Design and analysis of mass transfer processes and equipments.
CO4	Applications of mass transfer phenomena and its optimum use.
CO5	

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit I (6 hrs) 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.		
	Unit II (8 hrs)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.		
	Unit III (4 hrs) 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.		

Unit IV (6 hrs) 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.		
Unit V (6 hrs) 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.		
Unit VI (6 hrs) 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.		

4. Text books

i) **Coulson, J. M. and Richardson, J. F.,***Chemical Engineering*, Vol. I, II & III, Pergamon Press, New York, 1977.

ii) **Treybal, R. E.,***Mass Transfer Operations*, McGraw Hill Book Co., New York, 1980.

5. Reference Book(s) and Other Required Material

i) **Badger, W. L. and Banchero, J. T.**, *Introduction to Chemical Engineering*, 4th Edition, Tata McGraw Hill Book Co.

ii) **Dutta, Binay K.**, *Principles of Mass Transfer and Separation Process*, PHI Learning Pvt. Ltd., New Delhi.

iii) **McCabe, W. L. and Smith, J. C. and Harriott**, *Unit Operations of Chemical Engineering*, 5th Edition, McGraw Hill Book Co., New York, 1980.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

CO 4	H	M	L	M	L	L	M	L	L						
CO 5															

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML302 Chemical Process Modelling and Simulation (Theory)		
Course Type: DC	**BS/ES/HU/IC/DC/IE/DE/HM/OC**		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

The objective of this course is to introduce mathematical modelling of chemical processes and the use of simulation tools for analysis and design. The course aims to develop steady-state and dynamic models of chemical engineering systems, apply numerical methods for solving model equations, and provide hands-on experience with process simulation software.

2.	**Course Outcomes**
CO1	Formulate mathematical models for chemical process systems using conservation laws
CO2	Develop steady-state and dynamic models of chemical engineering unit operations
CO3	Apply numerical methods to solve algebraic and differential equations arising in process models
CO4	Use process simulation software for modelling and simulation of chemical processes
CO5	Analyze and interpret simulation results for process performance and improvement

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in Weeks**
Introduction to process modelling, classification of models, modelling assumptions, degrees of freedom analysis		CO1	2
Steady-state modelling of unit operations: mixers, splitters, reactors, heat exchangers		CO1, CO2	3
Dynamic modelling: unsteady-state mass and energy balances, lumped parameter models		CO2	3
Numerical methods for process models: solution of linear and nonlinear algebraic equations, ODEs		CO3	3
Introduction to process simulation, flowsheet development, convergence issues		CO4	2
Sensitivity analysis, model validation, and basic optimization concepts		CO5	1

4.	Text books

i. Luyben, W. L., *Process Modeling, Simulation and Control for Chemical Engineers*, 2nd Edition, McGraw-Hill, 1990, ISBN: 9780070391598.

ii. Marlin, T. E., *Process Control: Designing Processes and Control Systems for Dynamic Performance*, 2nd Edition, McGraw-Hill, 2000, ISBN: 9780070393622.

5.	Reference Book(s) and Other Required Material

i) Biegler, L. T., Grossmann, I. E., and Westerberg, A. W., *Systematic Methods of Chemical Process Design*, Prentice Hall, 1997, ISBN: 9780134924220.
ii) Finlayson, B. A., *Introduction to Chemical Engineering Computing*, Wiley, 2nd Edition, 2014, ISBN: 9781118135395.
iii) Aspen Plus / Aspen HYSYS / DWSIM User Manuals.

6.	Evaluation Details:

- Continuous Assessment (Assignments / Quizzes / Mid-Sem): **40%**
- End-Semester Examination: **60%**

Practical Evaluation:

- Continuous Evaluation: **50%**
- End-Semester Practical Examination: **50%**

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	–	2	–	–	–	–	–	–	1	2	–	–
CO 2	3	3	2	2	2	–	–	–	–	–	–	2	3	–	–
CO 3	2	3	2	3	2	–	–	–	–	–	–	2	3	–	–
CO 4	2	3	3	3	3	–	–	–	–	–	–	2	3	3	–
CO 5	2	2	2	2	2	2	2	–	–	–	–	2	2	2	–

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

- Familiarization with process modelling and simulation software

- Steady-state modelling of material and energy balance problems
- Simulation of reactors (CSTR and PFR)
- Simulation of heat exchangers
- Dynamic simulation of simple process systems
- Sensitivity analysis and parametric studies
- Mini project on modelling and simulation of a chemical process

Course Code & Course Title:	**CML303 & Process Control and Instrumentation**		
Course Type:	**DC**		
Name of the programme(s):	**B.Tech. Chemical Engineering**		
L – T – P	**3-0-0**	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

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 come 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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Students shall be able to formulate the dynamic model of different chemical processes.
CO2	Students shall be able to identify the different measuring instruments and their working principle.
CO3	Student shall be able to apply analytical tools and design methodologies to tackle process control problems.
CO4	Student shall be able to apply control schemes along with tuning techniques in chemical processes.

3. Detailed Description of the Course		
Topics	**CO(s) Addressed**	**Duration in weeks**
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.	**CO1**	**4 weeks**
Introduction to set point, disturbance, closed loop and open loop control. Feedback and feed forward configurations, dynamics of feedback control system. Introduction to set point, error, accuracy, sensitivity. Types of controllers, P, PI and PID controllers, controller gain, stability analysis, Routh stability criteria. Bode and Nyquist stability criteria. discontinuous control modes – two position, classical and modern control actions.	**CO3, CO4**	**5 weeks**

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.	**CO2**	**1 week**
Design of controllers using open loop response, Zigeler – Nichols controller settings. Control valve and choice of controller settings. Basic design of pneumatic controllers, electric / electronic controllers. Application of control systems to chemical process equipment such as chemical reactors, heat exchangers, distillation columns, boilers etc.	**CO3, CO4**	**3 weeks**

4. Text books

i) Donald R. Coughanowr and L.B. Koppel, Process Systems Analysis and Control, 1st Edition, McGraw-Hill Book Company, 1965, ISBN 0-07-013210-0.

ii) George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey, 1984, ISBN 0131288480.

iii) R.P. Vyas, An Introduction to Process Dynamics & Control, Central Publication, Nagpur, 2001.

5. Reference Book(s) and Other Required Material

i) Thomas E. Marlin, Process Control, McGraw-Hill, 1995, ISBN 0070393620.

ii) W.L. Luyben, Process Modelling Simulation and Control for Chemical Engineers, 2nd Edition, McGraw-Hill, 1990, ISBN 0070393093.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 20-30 Marks

Teacher Defined Assessment : 20 Marks

End Semester Exam : 50-60 Marks

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**-**	**1**	**3**	**2**	**1**
CO 2	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**1**	**1**	**-**	**2**	**3**	**3**	**2**

CO 3	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**-**	**2**	**2**	**-**	**2**	**3**	**3**	**2**
CO 4	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Nil

Course Code & Course Title:	CML304 Chemical Reaction Engineering		
Course Type:	**DC**		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**CML223 Chemical Reaction Engineering - I**		
Course Equivalence: Course Code(s)& Name(s)	**Nil**		

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

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand & Apply the basic knowledge of chemical reaction engineering in process industry
CO2	Analyse and utilize the knowledge of non ideal flow and various models to evaluate the performance of chemical reactors and equipments and their design for specific applications.
CO3	Analyse and utilize the knowledge of catalysis and catalytic reactors to apply for reactor and catalyst design for various applications and to evaluate their performance specific applications.
CO4	Analyse and utilize the knowledge of kinetics and design for fluid-fluid and fluid-particle reactions to evaluate the performance and their design for specific applications.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in hours**
	Revision of Chemical Reaction Engineering – I Overview and Basics of Chemical Reaction Engineering – II	CO1	2
	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.	CO2	6
	Compartment model, Dispersion model, Tank in Series model for Non ideal flow in reactors.	CO2	6
	Introduction to Heterogeneous Reactions and Solid Catalysed Reactions: Introduction and Spectrum of kinetic regimes, Surface kinetics and rate equation, pore diffusion, porous catalyst, Heat effects, Performance	CO3	6

Equation, Experimental methods and rate equation, Controlling Resistance		
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.	CO3	6
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.	CO4	6
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.	CO4	6

4.	**Text books**
i)	Octave Levenspiel, "Chemical Reaction Engineering" John Wiley & Sons, Singapore, 1998 3rd Edition

5.	**Reference Book(s) and Other Required Material**
i)	Fogler H.S., "Elements of Chemical Reaction Engineering", Prentice-Hall, NJ, 2006, 4th Edition
ii)	G. F. Froment and K. B. Bischoff, "Chemical Reactor Analysis", John Wiley & Sons, Singapore, 1990 2nd Edition.
iii)	Smith J. M., "Chemical Engineering Kinetics", McGraw Hill, N Y, 1981, 3rd Edition

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Component	**Duration**	**Weightage**
Quiz / Assignments / Internal etc.	----	25
Mid Term Examination	1.5 hrs	25
End Term Examination	3 hrs	55

7.	**Relationship of Course Outcomes to Program Outcomes:**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	1	1	1	3	1	1	1	3	3	1	3	2	2	3	3

CO2	2	2	1	1	3	2	1	1	3	3	1	3	2	2	3	3
CO3	2	3	1	1	3	2	1	3	3	3	1	3	2	2	3	3
CO4	2	3	1	1	3	2	1	3	3	3	1	3	2	2	3	3
Avg	**2**	**2**	**1**	**1**	**3**	**2**	**1**	**2**	**3**	**3**	**1**	**3**	**2**	**2**	**3**	**3**

High - 3; Medium – 2; Low – 1

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	**Chemical Process Equipment Design (CML 353)**		
Course Type:	DC		
Name of the programme(s):	B. Tech		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1.	**Course Objective:** 1. Provide students with basic understanding equipment design. 2. To teach students the design of pressure vessel and storage vessel. 3. To teach students the design of complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.) 4. To teach students to apply the design concepts in practical industrial design problem.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Knowledge of basics of process equipment design and important parameters of equipment design
CO2	Ability to design internal pressure vessels and external pressure vessels
CO3	Ability to design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads supports, flanges, nozzle)
CO4	Knowledge of equipment fabrication and testing methods

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
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.		**CO1, CO2 & CO3**	2-3
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.		**CO2 & CO3**	2
Unit-3		**CO2 & CO3**	2

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.	**CO2 & CO3**	2
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	**CO4**	1-2
Unit-6 Design of distillation column, absorption column, and reactors	**CO4**	1-2

4. Text books

i. Process equipment design-vessel design by Lloyd E. Brownell and Edwin Young, John Wiley, New York, 1963.

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

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

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

5. Reference Book(s) and Other Required Material

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

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

iii. 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.

6. Evaluation Details:

- Internal: 20%
- Mid-Semester Exam (1.5 Hours): 30%
- End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	-	2	3	3	3	-	-	3	3	3	3
CO 2	3	3	3	3	1	1	2	2	-	2	-	3	3	3	3
CO 3	3	3	3	3	1	1	2	2	-	2	-	3	3	3	3

CO 4	3	3	3	3	1	1	2	1	-	2	-	3	3	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	CMP 304: Chemical Reaction Engineering II (Lab)		
Course Type:	DC		
Name of the programme(s):	B. Tech. in Chemical Engineering		
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)	CML223: Chemical Reaction Engineering -I		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**

The course aims to:

Provide practical exposure to various chemical reactors and their operating principles.

Enable students to analyse reactor performance and reaction kinetics.

Introduce concepts of residence time distribution (RTD) and its impact on reactor design and operation.

Develop problem-solving skills and teamwork through collaborative experimentation.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Conduct experiments on different types of reactors and analyze their performance.
CO2	Evaluate reaction kinetics using experimental data.
CO3	Perform residence time distribution (RTD) studies and interpret F-curve and C-curve results.
CO4	Apply knowledge of reactor operations to optimize chemical processes.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Students are required to perform any eight of the following experiments during the semester: Reactor Performance Studies 1. Three CSTRs Connected in Series Study the kinetics of reaction for different combinations of three CSTRs in series. 2. PFR and CSTR in Series Analyze the reaction kinetics for a combination of PFR and CSTR in series.		All CO	1 exp. Every week

3. Isothermal Continuously Stirred Tank Reactor Examine the performance of an isothermal CSTR for the reaction between ethyl acetate and NaOH. 4. Isothermal Plug Flow Reactor Evaluate the performance of an isothermal PFR for the reaction between ethyl acetate and NaOH. Residence Time Distribution (RTD) Studies 5. RTD in Plug Flow Reactor Plot the F-curve and C-curve for a given PFR. 6. RTD in Series and Parallel CSTRs Investigate the residence time distribution for series and parallel CSTR configurations. 7. RTD in Packed Bed Reactor Determine the F-curve and C-curve for a packed bed reactor. Batch and Semi-Batch Reactors 8. Semi-Batch Reactor Determine the overall order of reactions for bimolecular reactions. 9. Adiabatic Batch Reactor Study the reaction kinetics under adiabatic conditions. 10. Isothermal Batch Reactor Find the Arrhenius constant using an isothermal batch reactor. Specialized Reactor Studies 11. Condensation Polymerization Reactor Study the polymerization reaction in a condensation polymerization reactor. 12. Fluidized Bed Reactor Analyze the performance of a fluidized bed reactor.		

4.	**Text books**

i) Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons (Indian Adaptation – Wiley India), 2021, ISBN: 9789354244605

ii) H. Scott Fogler, Elements of Chemical Reaction Engineering, 6th Edition, Pearson, 2021, ISBN: 9780135486221

5.	**Reference Book(s) and Other Required Material**

i) Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, 3rd Edition, John Wiley & Sons, 2010, ISBN: 9780470565414

ii) J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw-Hill (originally 1981), ISBN: 9780070587106

iii) Mark E. Davis and Robert J. Davis, Fundamentals of Chemical Reaction Engineering, 2nd Edition, McGraw-Hill Education, 2013, ISBN: 9780073397894.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Component Weightage
Regular Lab Performance 20%
Lab Reports and Assignments 30%
Viva-Voce 10%
End-Semester Practical Exam 40%

7.	**Relationship of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	3	-	-	-	-	-	-	-	3	2	2	3
CO2	3	3	3	2	3	-	-	-	-	-	-	-	3	3	2	3
CO3	2	3	2	-	3	-	-	-	-	-	-	2	2	3	2	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	3
CMP 304	3	3	3	2	3							1	3	3	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

As given in Detailed Description of the Course in point

Course Code & Course Title:	**CMP321 Mass Transfer laboratory**		
Course Type:	**DC**		
Name of the programme(s):	**5th Semester B.Tech. Chemical Engineering**		
L – T – P	**0-0-2**	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**CML221-Mass Transfer I**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Students will understand the basic of chemical engineering and its practical application.
CO2	
CO3	
CO4	
CO5	

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	To determine the Mass Transfer coefficient for Absorption of CO_2 in NaOH solution in packed Column.		
	Study of adsorption of acetic acid on activated charcoal [To verify adsorption isotherms].		
	To determine the number of Heat Transfer Units (HTU) & height equivalent to Theoretical plate (HETP) of Packed distillation column.		
	To study the drying characteristics curve under constant drying condition in rotary vacuum or tray dryer.		
	Diffusion (Liquid – Liquid) –To calculate the diffusion coefficient of vapour in still Air.		
	To study the characteristics of Boiling point diagram.		
	To study the characteristics Cooling Tower experiment.		
	Experiments on Differential Distillation.		
	To determine rate of distillation by Steam Distillation.		
	Performance evaluation of fluid bed dryer.		
	Study of factors affecting rate of Evaporation :-		
	Effect of Surface Area.		

Effect of Temperature.		
Solid liquid extraction		
Liquid – Liquid Extraction– To determine Overall efficiency for a three-stage counter-current and cross current system.		
Diffusion (Liquid–Air):- To find the diffusion coefficient of vapour in still air.		
Experiments on Fractional Crystallization.		
Spray Column Dryer:- To study the Design and operating Principles of Spray Dryer.		
Plate Column Distillation :- to study the Performance of a rectification column.		
Determination of Rate of drying, Free moisture content and bound moisture content.		

4.	**Text books**

i) **Badger, W. L.; Banchero, J. T.** *Introduction to Chemical Engineering*, Tata McGraw Hill Book Co.

ii) **Coulson, J. M.; Richardson, J. F.** *Chemical Engineering Vol. I, II & III*, Pergamon Press, New York**, 1977**.

iii) **Dutta, Binay K.** *Principles of Mass Transfer and Separation Process*, Eastern Economy Edition, PHI Learning Pvt. Ltd., New Delhi.

iv) **McCabe, W. L.; Smith, J. C.; Harriot, P.** *Unit Operations of Chemical Engineering*, **5th Edition,** McGraw Hill Book Co., New York, **1980**.

v) Treybal, R. E. *Mass Transfer Operations*, **3rd Edition,** McGraw Hill Book Co., New York, **1980.**

5.	**Reference Book(s) and Other Required Material**

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

Total Experiments to be conducted / designed: 8-10

8.	**List of Indicative Laboratory Experiment (if applicable):**

1. To determine the Mass Transfer coefficient for Absorption of CO2 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 vapor 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 vapor in still 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.

Course Code and Name:	**CMP403- Design Laboratory-II**		
Course Type:	DC		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	0-0-2	No. of Credits	1
Pre-requisites: Course Code(s) & Name(s)	Design lab-I, Chemical Process Equipment Design		
Course Equivalence: Course Code(s)& Name(s)	**NIL**		

1.	**Course Objective:** 1) Design and drawing of 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 etc. 2) To introduce application of design and drawing of chemical equipments

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Design and drawing of 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 etc.
CO2	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 Auto CAD and any others

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Fixed Bed Adiabatic Reactor With Reversed Flow		**CO1, CO2**	2 Hrs. in a week
Reactor With Heat Exchanger Tube		**CO1, CO2**	2 Hrs. in a week
Tubular Reactor For Endothermic Reactions		**CO1, CO2**	2 Hrs. in a week
Shell And Tube Heat Exchanger		**CO1, CO2**	2 Hrs. in a week

Double Pipe Heat Exchanger	**CO1, CO2**	2 Hrs. in a week
Vertical Leaf Filter	**CO1, CO2**	2 Hrs. in a week
Mechanical Agitated Vertical Column	**CO1, CO2**	2 Hrs. in a week
Cyclone Separator	**CO1, CO2**	2 Hrs. in a week
Distillation Column	**CO1, CO2**	2 Hrs. in a week
Pump	**CO1, CO2**	2 Hrs. in a week

4. Text books

i) Joshi M.V., Mahajan V.V, Process Equipment Design, Macmillan India Ltd

ii) Khurmi R.S ,Gupta J.M. A Text Book Of Machine Design, S.Chand &Company Ltd, New Delhi

5. Reference Book(s) and Other Required Material

i) Dawande S.D. Process Design of Equipments, Central Tecno Publication, Nagpur.

6. Evaluation Details:

- Drawings : 60%
- Slip Tests and Assignments: 20%
- Drawing Exam : 20%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

Course Code & Course Title:	CMLxxx Chemical Reaction Engineering		
Course Type:	DM		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	2-1-0	No. of Credits	03 credits
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	Course Objective:
	• Provide students with a basic understanding of basic reaction engineering, type of reactions & kinetics, and reactors and third configurations. • Enhance their knowledge on multiple reactions, catalysis, residence time distribution, and heat effects. • Improve the student's ability in deciding type of reactor and their arrangement for achieving desired conversion keeping economy in point of view

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Apply reaction kinetics to analyse rate expressions, interpret batch reactor data, and evaluate ideal reactors (batch, CSTR, and PFR) for single reactions.
CO2	Analyse reactor performance for multiple reactions, including series–parallel and catalytic systems.
CO3	Design and assess reactor types and configurations using material and energy balances, graphical and computational methods, and simulation tools to achieve desired conversion.

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Introduction to Chemical Reaction Engineering: Classification, rate expressions, batch reactor data and their interpretation. Constant volume and variable volume batch reactor, Integral, differential, and other methods of analysis of kinetic data.		CO1	3
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, Ideal Reactors for a Single Reaction, Ideal Batch, Mixed, Plug flow Reactor. Design for Single Reactions, Size comparison of single reactors, General graphical comparison, Multiple reactor system, Recycle reactor, Autocatalytic reactions.		CO1,CO3	4
Design for Series - Parallel Reactions: Introduction to design of series - parallel reactions, Qualitative and Quantitative discussion on product		CO2, CO3	2

distribution, Contacting patterns, Reactor Size and arrangement, Selectivity, Yield, Successive reversible reactions of different orders, reversible reactions, Irreversible series-parallel reactions, Graphical representation, Denbigh reactions and their special cases.		
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. Typical Catalysts, Catalyst Characterizations, Catalyst Deactivation and Regeneration, Packed bed reactor, Fixed Bed, Fluid Bed, Trickle bed, Slurry Reactors etc.	CO2, CO3	2
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, Catalytic reactions.	CO2	1-2
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.	CO2	1-2
Computation and simulation of plug flow reactor, batch reactor, continuous stirred tank reactor, nonlinear equations with fuel cell applications, chemical reactors with mass transfer limitations, chemical reaction in microfluidic device, optimal cooling of a tubular reactor, optimization of a catalytic microreactor, determination of Arrhenius parameters etc. using COMSOL Multiphysics or suitable open source software.	CO3	2

4. Text books

i) H. Scott Fogler, Elements of Chemical Reaction Engineering, 7th Edition, Pearson, 2025, ISBN: 978-0135337554.

ii) J. M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981, ISBN: 978-0070665743.

iii) Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition (Indian Adaptation), Wiley India Pvt. Ltd., 2021, ISBN: 978-9354244605.

5. Reference Book(s) and Other Required Material

i) Gilbert F. Froment, Kenneth B. Bischoff, and Juray De Wilde, Chemical Reactor Analysis and Design, 3rd Edition, Wiley, 2011, ISBN: 978-0470565414.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 20-30

Teacher Defined Assessment : 20

End Semester Exam : 50-60

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1								1	3	2	1	1
CO2	3	3	2	2	1		1					1	3	3	2	2
CO3	3	3	3	2	3		2				1	2	3	3	3	2

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

B. Tech Chemical Engineering Semester VI

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CML351	Chemical Technology	DC	3-0-0	3	None
CML352	Transport Phenomena	DC	3-0-0	3	None
CML354	Energy and Environment	DC	3-0-0	3	None
CML403	Plant Design & Economics	DC	3-0-0	3	None
CMP302	Chemical Process Modeling and Simulation	DC	0-0-2	1	None
CMP303	Process Control and Instrumentation	DC	0-0-2	1	None
AULxxx	Mandatory Non-Credit Category-IV	MNC	0-0-2	0	None
CMD401	Project Phase-I	DC	--	3	None
				Core Credits=17	
ELECTIVE					
CMLxxx	Elective – 7	DE	3-0-0	3	None
CMLxxx	Elective – 8	DE	3-0-0	3	None
MINOR for Other Department					
CMPxxx	Chemical Engineering	DM	0-0-2	1	None
CMDxxx	Mini Project	DM	0-0-4	2	None
CMLxxx	Heat, Mass and Momentum Transport	DM	3-0-0	3	None
				Elective Credits=6	
				DC+DE=23 Credits	
Advanced Diploma Exit is permitted without additional course					

Summer internship of minimum 6 weeks – 1 Credit

Course Code & Course Title:	CML351 Chemical Technology		
Course Type:	DC		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	3-0-0	No. of Credits	03 credits
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	Course Objective:
	• To study the overall process flow in production of chemical products of importance • To gain knowledge of various unit operation and processes involved in the production process • To gain knowledge in performing overall mass and energy balance of a process • To attain the knowledge of flow/ separation pattern of material • To understand the approach for modelling of a process plant

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	Basic unit process and unit operations involved in production of various chemicals.
CO2	Raw materials, reactions, catalysts, temperature, pressure and time of operation of various unit operations and process involved in production of various organic and inorganic chemicals.
CO3	Production of various intermediate products which serves as main raw materials in manufacture of a specific product.
CO4	Preparation of process flow diagrams involved in production of various chemicals.

3.	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Introduction and overview of Chemical Process Technology. Preparation of process flow diagrams, Instrumentation diagrams and Process symbols.		CO1, CO4	1-2
Petroleum refinery processes: Introduction to crude oil, Crude refining processes (i) physical processes (Desalting/dehydration, Crude distillation, Propane deasphalting Solvent extraction and dewaxing, Blending, (ii) Chemical process (thermal process –Visbreaking, Delayed coking, Flexicoking), Catalytic Processes –Hydrotreating, Catalytic reforming, Catalytic cracking, Hydrocracking, Catalytic dewaxing, Alkylation, Polymerization, Isomerization		CO1, CO2, CO3	4-5

Petrochemical Industries: production of petrochemical feedstocks, olefins and aromatics, intermediates from olefins and aromatics. Manufacture of ethylene, propylene, butylenes, benzene, toluene etc.	CO1, CO2, CO3	2-3
Inorganic Chemical Industries: chloro-alkali industries, manufacture of acids-sulfuric, nitric, phosphoric acids, Fertilizers- ammonia, urea, Ammonium sulfate, ammonium nitrate, Urea, SSP and TSP and miscellaneous fertilizers.	CO1, CO2	2-3
Natural products -manufacture of sugar, starch, and its derivatives, Pulp, Paper, oil and fats, Rayon industries. Edible oils: extraction and refining, fat splitting, soaps and detergents.	CO1, CO2	1
Polymerization industries (ethylene, polyethylene, propylene,polypropylene, butylenes, benzene, toluene, PVC and polyester synthetic fibers etc.	CO1, CO2, CO3	1

4. Text books

i) C. E. Dryden (revised by M. Gopala Rao & Marshall Sittig), Outlines of Chemical Technology, Revised Edition, Affiliated East-West Press Pvt. Ltd., 1997, ISBN: 9788185938790.

ii) R. N. Shreve and J. M. Brink Jr. (later editions by George T. Austin), Chemical Process Industries, 5th Edition, McGraw-Hill, 2017, ISBN: 9780070661677.

5. Reference Book(s) and Other Required Material

i) P. H. Groggins, Unit Processes in Organic Synthesis, 5th Edition, McGraw-Hill, 2004, ISBN: 9780074621431.

ii) P. L. Soni and Kalyal, Textbook of Inorganic Chemistry, 20th Edition, Sultan Chand & Sons, New Delhi, 2013, ISBN: 9788180547922.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 20-30

Teacher Defined Assessment : 20

End Semester Exam : 50-60

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2			1	1		1	1		1	3	2	2	
CO2	3	3	3			2	1		2	1		1	3	3	3	
CO3	2	3	3			2	1		2	1		1	2	3	3	
CO4	3	3	3			3	1		3	1		1	3	3	3	
Avg.	3	3	3			2	1		2	1		1	3	3	3	

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

Course Code & Course Title:	CML 352: Transport Phenomena		
Course Type:	DC		
Name of the programme(s):	B. Tech. in Chemical Engineering		
L – T – P	3-1-0	No. of Credits	4
Pre-requisites: Course Code(s) & Name(s)	CML202: Fluid Mechanics, CML221: Mass Transfer I, CML222: Heat Transfer		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**

The course aims:

To introduce the fundamental principles of momentum, heat, and mass transfer.

To establish a solid theoretical foundation for solving transport phenomena problems.

To develop mathematical and computational skills for modelling transport processes.

To analyse industrial and environmental implications of transport phenomena.

To enhance critical thinking and problem-solving abilities for system design and optimization**.**

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Apply fundamental principles of momentum, heat, and mass transfer to solve engineering problems.
CO2	Analyze complex transport systems using mathematical models and derive governing equations.
CO3	Utilize computational tools to solve transport equations and design systems with practical constraints.
CO4	Evaluate the environmental and industrial implications of transport processes.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit I: Similarities Between Transport Mechanisms, Molecular and convective transport mechanisms, Newton's Law of Viscosity, Fourier's Law, Fick's Law, Dimensionless numbers in transport phenomena	CO1, CO2	1
	Unit II: Inter-phase Transport and Transport Coefficients, Friction factor, heat and mass transfer coefficients, Transport analogies: Reynolds and Chilton-Colburn	CO1, CO2, CO4	3
	Unit III: Shell Momentum Balances, Velocity distributions for laminar flow	CO1, CO2	2

Flow cases: Circular tubes, annuli, falling films, immiscible fluids		
Unit IV: Shell Energy Balances, Temperature distributions in solids and laminar flow, Scenarios involving electrical, nuclear, viscous, and chemical heat sources	CO1, CO2, CO4	2
Unit V: Shell Mass Balances, Diffusion with and without chemical reactions Applications: Stagnant films, porous catalysts, gas absorption	CO1, CO2, CO4	2
Unit VI: Equations of Change for Isothermal Systems, Equations for continuity, motion, energy, and angular momentum, Application in various flow scenarios	CO2, CO3	2

4. Text books

i) İsmail Tosun, Modeling in Transport Phenomena: A Conceptual Approach, 2nd Edition, Elsevier Science, 2007, ISBN: 9780444530219.

ii) R.B. Bird, W. Stewart, E.N. Lightfoot, Transport Phenomena, 2nd Ed., Wiley, 2006. ISBN: 9780470115398.

5. Reference Book(s) and Other Required Material

i) C.J. Geankoplis, Transport Processes and Separation Principles, 5th Ed., Prentice Hall, 2003. ISBN: 978-0134181660

ii) C.O. Bennet, J.E. Myers, Momentum, Heat & Mass Transfer, 3rd Ed., McGraw Hill, 1994. ISBN: 9780070661806

iii) G.S. Laddha, T.E. Degaleesan, Transport Phenomena in Liquid Extraction, Tata McGraw Hill, 1978.

iv) R. Brodkey, H.C. Hershey, Transport Phenomena – A Unified Approach, 2nd Ed., McGraw Hill, 1988. ISBN: 9780070079731

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Class Tests and Assignments: 20%
Mid-Semester Exam (1.5 Hours): 30%
End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	-
CO2	3	3	3	2	2	-	-	-	-	-	-	1	3	3	2	2
CO3	2	2	3	3	3	-	1	-	2	2	2	2	2	2	3	3

CO4	1	1	2	-	-	2	3	3	-	1	-	-	1	1	2	2
CML 352	3	2	3	2	2	1	1	1	1	1	1	1	3	2	2	2

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

NIL

Course Code & Course Title:	CML 354 Energy and Environment		
Course Type:	DC		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**
1.	To investigate various conventional and non-conventional energy sources and their environmental issues.
2.	To understand the alteration in the existing technology for solving environmental concerns and to optimize the energy production.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To analyze and interpret energy production from both conventional and non-conventional resources
CO2	To optimize the energy production by modification in the existing technology
CO3	To identify the environmental concerns related to each and every energy sources
CO4	To resolve the environmental issues by modification in the existing technology

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in hours**
Introductory Concepts • Conventional and non-conventional energy sources; coal, oil and natural gas, solar energy; wind energy; geothermal energy; hydropower; bioenergy; nuclear energy. • Current and future energy requirements in India and across the world and associated environmental problems.		CO1, CO3	4
Coal • Solid fuels, Coal and coal derived fuels; Characteristics, production methods and uses • Coal combustion technology, Carbon capture and sequestration		CO1, CO2, CO3, CO4	7
Oil and Natural Gas • Oil and Natural Gas: Fuels from oil and gases: Characteristics, production methods and uses. • Oil spills and treatment • Natural gas hydrates		CO1, CO2, CO3, CO4	7

Solar, Geothermal and Hydro Energy • Solar Energy: Solar energy utilization, Thermal application and photovoltaic applications • Geothermal energy • Hydro energy utilization, Environmental aspects	CO1, CO2	8
Wind and Bio Energy • Wind Energy: Power extraction by wind turbine, Betz criterion; • Bio Energy: Biomass conversion for fuels; production methods based on thermochemical and bioconversion. Characteristics and uses, Carbon neutrality	CO1, CO2, CO3	6
Nuclear Energy • Nuclear Energy: Nuclear fission fuels processing, Nuclear reactions and nuclear reactors, Nuclear engineering, Environmental aspects.	CO1, CO2	4

4.	**Text books**
i) .	G.N.Rai, "Non conventional energy sources," Khanna Publishers, New Delhi, 2011, ISBN 978-81-7409-073-7.
ii) .	Samir Sarkar, "Fuels and Combustion", 2nd Edn, Orient Longman Publication, 1988, ISBN 978-81-7371-669-0.

5.	**Reference Book(s) and Other Required Material**
i) .	J. G. Speight, Fuel Science & Technology Handbook, Dekker, 1990.
ii) .	V.Balzani and N.Armaroli, Energy sustainable world, Wiley-VCH, 2011
iii) .	G.Boyle, Renewable Energy, Oxford University Press, 2004.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Class Tests and Assignments: 20%
	Mid-Semester Exam (1.5 Hours): 25%
	End-Semester Exam (3 Hours): 55%

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	2	-	-	-	-	-	-	-	1	3	2	-	2
CO2	3	1	3	2	-	-	-	-	1	2	-	1	3	1	3	2
CO3	3	2	-	2	-	3	3	2	-	-	-	2	3	2	-	2
CO4	3	1	3	2	1	2	3	-	1	2	-	1	3	1	3	2

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	**CML403 Plant Design and Economics**		
Course Type:	**DC**		
Name of the programme(s):	**BTech Chemical Engineering**		
L – T – P	**3-0-0**	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**
	Upon completion of the course, students will be able to interpret complex process diagrams and integrate safety features into the design of chemical plants while performing detailed economic and profitability analyses to justify the project's viability in a formal technical dissertation and presentation.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To read complex P&ID diagrams.
CO2	To perform an economic and profitability analysis of a proposed chemical plant.
CO3	To appreciate the importance of safety and incorporate safety features in design.
CO4	To write and present a design dissertation.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Introduction to Plant Design and conceptual design and synthesis of a process flow diagram (PFD), development of PFD from generic BFD. (Block Flow Diagrams, Process Flow Diagrams, P&IDs).		**CO1, CO3**	**4**
Design of Batch Processes.		**CO2**	**3**
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.		**CO1, CO2, CO4**	**3**
Investment, time value of money, different types of interest, CFDs, inflation, Annuities, depreciation, taxation, profitability analysis, criteria for profitability for large projects, NPV, rate of return, evaluation of equipment alternatives, evaluation of risks, sensitivity, and uncertainty analysis.		**CO2, CO4**	**4**

4.	**Text books**

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

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

5.	Reference Book(s) and Other Required Material

i. Study material developed by Kevin Dunn and Dr. Thomas Marlin.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Quiz: 10 %

Project 10%

Mid Sem Exam: 30 %

End Sem Exam: 50 %

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3		3					2			2	2	3	
CO2	2	3	3	2	2					1	3		2	3	3	2
CO3	1	2	3			3	3	3		1			1	2	3	
CO4			2	1					3	3	2	2		1	2	1
Avg	2	2	3	1	3	1	1	1	1	2	2	1	2	2	3	1

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CMP302 – Chemical Process Modelling & Simulation (Laboratory)		
Course Type: DC	**DC**		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	0-0-2	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

The objective of this laboratory course is to provide hands-on experience in modelling and simulation of chemical and bioprocess systems. The course aims to enable students to develop, simulate, and analyze steady-state and simple dynamic process models using computational and simulation tools.

2.	**Course Outcomes**
CO1	Develop mathematical models for basic chemical and bioprocess systems
CO2	Perform steady-state simulations of unit operations
CO3	Use numerical and simulation tools to solve process models
CO4	Analyze and interpret simulation results for process performance
CO5	Document modelling and simulation results in a structured manner

3.	**Detailed Description of the Course**		
Experiments / Exercises		**CO(s) Addressed**	
Introduction to process modelling and simulation environment		CO1	
Modelling and simulation of material balance problems		CO1, CO2	
Steady-state simulation of reactors (CSTR / PFR)		CO2, CO3	
Simulation of heat exchangers		CO2, CO3	
Simulation of separation processes		CO2, CO3	
Sensitivity analysis and parametric studies		CO4	
Mini exercise on modelling and simulation of an integrated process		CO4, CO5	

4.	**Text books**

i. Luyben, W. L., *Process Modeling, Simulation and Control for Chemical Engineers*, 2nd Edition, McGraw-Hill, 1990, ISBN: 9780070391598.

ii. Marlin, T. E., *Process Control: Designing Processes and Control Systems for Dynamic Performance*, 2nd Edition, McGraw-Hill, 2000, ISBN: 9780070393622.

5. Reference Book(s) and Other Required Material

i. Finlayson, B. A., *Introduction to Chemical Engineering Computing*, Wiley.
ii. User manuals and tutorials of Aspen Plus / Aspen HYSYS / DWSIM.

6. Evaluation Details:

- Continuous Evaluation (Lab Performance / Records): **50%**
- End-Semester Practical Examination: **50%**

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	2	–	–	2	–	–	–	–	–	–	1	3	2	1
CO 2	3	3	2	2	2	–	–	–	–	–	–	2	3	3	1
CO 3	2	3	2	3	2	–	–	–	–	–	–	2	3	3	1
CO 4	2	2	2	2	2	2	2	–	–	–	–	2	2	2	2
CO 5	1	1	1	1	1	–	–	–	–	–	–	1	2	2	2

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Included under Section 3 (Detailed Description of the Course)

Course Code & Course Title:	CMP303 & **Process Control and Instrumentation Laboratory**		
Course Type:	**DC**		
Name of the programme(s):	**Chemical Engineering**		
L – T – P	0-0-2	**No. of Credits**	**2**
Pre-requisites: Course Code(s) & Name(s)	**CML303 Process Control and Instrumentation**		
Course Equivalence: Course Code(s) & Name(s)	**NA**		

1. Course Objective:

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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Students will be able to apply the knowledge of control theory for understanding the various processes, carried out in the Chemical process industry.
CO2	Students demonstrate their ability of understanding the process control and its application by virtue of experimentation.
CO3	Students will be able to learn due care and precautions in handling measuring instruments.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
1.	**Interacting System**	ALL COs	1
2.	**Non-Interacting System**		1
3.	**Flapper Nozzle Trainer**		1
4.	**Response Of U-Tube Manometer**		1
5.	**Control Valve Characteristics**		1
6.	**Water Temperature Control System Trainer**		1
7.	**Level Measurement By Air Purge Method**		1
8.	**Determination of Time Constant of Thermometer And Thermocouple**		1
9.	**Study of Temperature Measurement Using Sensor RTD**		1
10.	**Study of Multi Process (Cascade) Control System**		1

4. Text books

i) Donald R. Coughanowr and L.B. Koppel, Process Systems Analysis and Control, 1st Edition, McGraw-Hill Book Company, 1965, ISBN 0-07-013210-0.

ii) George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall, New Jersey, 1984, ISBN 0131288480.

iii) R.P. Vyas, An Introduction to Process Dynamics & Control, Central Publication, Nagpur, 2001.

5.	Reference Book(s) and Other Required Material

i) Thomas E. Marlin, Process Control, McGraw-Hill, 1995, ISBN 0070393620.

ii) W.L. Luyben, Process Modelling Simulation and Control for Chemical Engineers, 2nd Edition, McGraw-Hill, 1990, ISBN 0070393093.

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

NA

Course Code & Course Title:	**Project Phase I CMD 401**		
Course Type:	DC		
Name of the programme(s):	B. Tech		
L – T – P	---	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1	**Course Objective:** 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

2	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Able to identify and formulate research problem
CO2	Able to design and develop solution to the problem
CO3	Able to analyze and solve the complex problems
CO4	Able to plan, implement and execute the project
CO5	Able to write effective technical report and demonstrate through presentation

3	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**

4	**Text books**

5	**Reference Book(s) and Other Required Material**

6	**Evaluation Details:**

- Internal: 20%
- Mid-Semester: 30%
- End-Semester Exam: 50%

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	**CMPxxx Chemical Engineering Laboratory**		
Course Type:	**DM**		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	**0-0-1**	**No. of Credits**	**01 credits**
Pre-requisites: Course Code(s) & Name(s)	**CMLxxx (Heat, Mass and Momentum Transport);** **CMLxxx (Chemical Reaction Engineering)**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**
	To learn chemical engineering principles and their practical applications in the areas of fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Ability to plan experiments and present the experimental data meaningfully
CO2	Ability to apply theoretical concepts for data analysis and interpretation
CO3	Capability to visualize and understand chemical engineering unit operations related to heat and mass transfer, fluid mechanics and reaction engineering

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Friction in Pipeline (To determine the friction coefficient factor for different size as well as different material of pipes.)		CO1, CO2, CO3	1
Pressure Measurement (Pressure measurement in pipeline.)		CO1, CO2, CO3	1
Sedimentation (To carry out the batch sedimentation test and use the results to design a Thickener.)		CO1, CO2, CO3	1
Jaw crusher (To perform the sieve analysis of the product obtained from Jaw crusher and verify the power law.)		CO1, CO2, CO3	1
Heat transfer trough lagged pipe		CO1, CO2, CO3	1
Emissivity of a surface		CO1, CO2, CO3	1
Vapour-Liquid Equilibria Set up		CO1, CO2, CO3	1
Liquid-air Diffusion (To determine the diffusion co-efficient of an organic vapor in air.)		CO1, CO2, CO3	1
Study the kinetics of reaction for all the combination for given three CSTR in series		CO1, CO2, CO3	1
Study the kinetics of reaction for all the combination for given PFR and CSTR in series		CO1, CO2, CO3	1

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

4.	Text Book(s) and Reference Book(s)

i) J. P. Holman and Souvik Bhattacharyya, Heat Transfer, 10th Edition (Special Indian Edition), McGraw Hill, 2017, ISBN: 978-0071069670.

ii) Noel de Nevers and Geoffrey Damian Silcox, Fluid Mechanics for Chemical Engineers, 4th Edition, McGraw Hill, 2020, ISBN: 978-1260475524.

iii) R. Byron Bird, Warren E. Stewart, and Edwin N. Lightfoot, Transport Phenomena, 2nd Edition (Revised), John Wiley & Sons, 2007, ISBN: 978-0470115398.

iv) Robert E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2017 (Reissue), ISBN: 978-1259029158.

v) Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, Wiley India Pvt. Ltd., 2021, ISBN: 978-9354244605.

5.	Reference Book(s) and Other Required Material

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Continuous Evaluation – I: 30-35

Continuous Evaluation – II: 30-40

Continuous Evaluation – III: 25-40

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	2	2	2	3	2	1	1	1	2	2	1	2	2	3	3	2
CO 2	3	3	2	3	2	1	1	1	2	2	1	2	3	3	2	2
CO 3	3	3	2	2	2	1	1	1	2	2	1	2	3	2	2	2

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

1.

Course Code & Course Title:	**CMD 4xx Mini Project**		
Course Type:	**DC**		
Name of the programme(s):			
L – T – P	**(0-0-4)**	**No. of Credits**	**2**
Pre-requisites: Course Code(s) & Name(s)			
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:** 5. To identify and analyze chemical engineering problems requiring innovative solutions. 6. To conduct a comprehensive literature review to establish project scope. 7. To develop a feasible methodology for experimentation or theoretical work. 8. To enhance technical communication through presentations and written reports

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Identify and define a problem in chemical engineering.
CO2	Conduct a thorough literature review to establish a project framework.
CO3	Develop a feasible methodology for experimental or theoretical analysis.
CO4	Present a preliminary project report and communicate objectives effectively.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Unit 1: Introduction to Problem Formulation • Overview of project planning and research. • Techniques for problem identification and formulation			(4 Hours)
Unit 2: Literature Review and Project Scope • Conducting and documenting a comprehensive literature review. • Defining project objectives and scope.			(6 Hours)
Unit 3: Methodology Development • Designing experimental or computational frameworks. • Tools and techniques for data collection and analysis.			(6 Hours)
Unit 4: Report Preparation and Presentation • Structuring a technical report. • Delivering a clear and concise presentation.			(4 Hours)

4.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]
Component	**Weightage**
Literature Review	20%
Problem Formulation	20%
Proposed Methodology	30%
Presentation and Report	30%

5.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**
CO4	**-**	**2**	**-**	**3**	**-**	**-**	**-**	**2**	**3**	**3**	**-**	**-**
CO5	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3 = Strong correlation, 2 = Moderate correlation, 1 = Weak correlation, - = No correlation

Course Code & Course Title:	**CMLxxx Heat, Mass and Momentum Transport**		
Course Type:	**DM**		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	**3-0-0**	**No. of Credits**	**03 credits**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**
	Students will be able to develop and solve some of the important design problem in fluid mechanics, heat transfer and mass transfer.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand the basic principal and its application in fluid mechanics
CO2	Understand the basic principal and its application in heat transfer
CO3	Understand the basic principal and its application in mass transfer
CO4	Able to correlate similarities between fluid mechanics, heat transfer and mass transfer.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Hydrostatic pressure, Hydrostatic force, pressure measurement, pressure vessel, pipeline thickness, manometer like real life cases, flow through pipe, Bernoulli's equation and its applications		CO1, CO4	2
Types of Pumps, working of pumps, trouble shooting, packed bed in Chemical Engineering application, agitating vessel for reaction		CO1, CO4	1–2
Basic modes of heat transfer, conduction, convection and radiation, heat conduction in plane, composite wall, cylinders, spheres, heat generation inside solids, critical thickness of insulation, extended surfaces, unsteady state heat conduction, free and forced convection, heat transfer in laminar flow and turbulent flow, radiation heat transfer, laws of radiation		CO2, CO4	2
Boiling and condensation, boiling curve and its characteristics, film condensation, drop wise condensing, heat exchangers, types of heat exchangers, analysis, LMTD, NTU, effectiveness, evaporators, classification		CO2, CO4	2
Diffusion: Fundamentals of diffusional mass transfer, steady state and unsteady state operations, concepts of mass transfer coefficient, application		CO3, CO4	1

Drying: Concepts of drying, constant rate and falling rate periods, equilibrium moisture contents, drying equipment's, applications	CO3, CO4	1
Crystallization: theory of Crystallization, saturation, supersaturation, nucleation and various equipment for crystallization, applications	CO3, CO4	1
Adsorption: Adsorption isotherms, adsorption agents, equipment for adsorption, applications.	CO3, CO4	1
Humidification and dehumidification: basics of humidification, introduction to humidifiers and dehumidifiers, applications.	CO3, CO4	1
Distillation: Raoult's law, Vapour – liquid equilibria, X-Y and H-X-Y diagrams, introduction to various types of distillation viz. differential distillation, equilibrium distillation, distillation with rectification in binary distillation, concept of plate and packed columns, methods for estimation of number of stages required in distillation column, minimum reflux ratio, optimum reflux ratio, overall plate efficiency. Concept of packings, HETP, HTU, NTU, applications.	CO3, CO4	2
Absorption: Equilibrium relationships, concept of driving force, selection of solvent for absorption and desorption, applications.	CO3, CO4	1
Leaching: Fundamentals of leaching, single stage, multistage concurrent and counter current operation, equilibrium relationship, Solvent selection, applications.	CO3, CO4	1
Liquid–Liquid Extraction: fundamentals of extraction, Single stage, multistage operations, equipment, applications.	CO3, CO4	1
Similarity between heat, momentum and mass transport and mass transport Molecular and Convective Transport, Definition of Transport Properties, Viscosity, Thermal Conductivity, Diffusivity, Newton's Law of Viscosity, Fourier's Law of Heat Conduction, Fick's First Law of Diffusion, Dimensionless Numbers in Molecular Transport, Convective transport and total flux.	CO1, CO2, CO3, CO4	1
Inter-phase Transport and Transport Coefficients, Physical Interpretation of Friction Factor, Heat Transfer Coefficient, Mass Transfer Coefficient, Dimensionless Numbers in inter-phase Transport. Various Transport Analogies, The Reynolds Analogy, The Chilton-Colburn Analogy	CO1, CO2, CO3, CO4	1
Evaluation of transport properties like Viscosity, Thermal Conductivity, Diffusivity and transfer coefficient: Engineering Correlations	CO1, CO2, CO3, CO4	1
Computation of exit streams in flash drum, bubble point and dew point temperature of hydrocarbon mixture, T-xy and P-xy diagrams of a binary mixture; Simulation of a Rstoic and RCSTR model, binary distillation - DSTWU model, multicomponent distillation - RadFrac model, etc. using DWSIM or suitable open source software.	CO1, CO2, CO3, CO4	1–2

4.	**Text books**

i) J. P. Holman and Souvik Bhattacharyya, Heat Transfer, 10th Edition (Special Indian Edition), McGraw Hill, 2017, ISBN: 978-0071069670.

ii) Noel de Nevers and Geoffrey Damian Silcox, Fluid Mechanics for Chemical Engineers, 4th Edition, McGraw Hill, 2020, ISBN: 978-1260475524.

iii) R. Byron Bird, Warren E. Stewart, and Edwin N. Lightfoot, Transport Phenomena, 2nd Edition (Revised), John Wiley & Sons, 2007, ISBN: 978-0470115398.

iv) Robert E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2017 (Reissue), ISBN: 978-1259029158.

5. Reference Book(s) and Other Required Material

i) Ann Marie Flynn, Toshihiro Akashige, and Louis Theodore, Kern's Process Heat Transfer, 2nd Edition, Wiley-Scrivener, 2019, ISBN: 978-1119363644.

ii) Binay K. Dutta, Heat Transfer: Principles and Applications, 2nd Edition, PHI Learning Pvt. Ltd., 2023, ISBN: 978-8196378912.

iii) C. O. Bennett and J. E. Myers, Momentum, Heat, and Mass Transfer, 3rd Edition, McGraw Hill, 1982, ISBN: 978-0070046719.

iv) Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt, Fundamentals of Heat and Mass Transfer, 9th Edition (Global Edition), John Wiley & Sons, 2023, ISBN: 978-1119820437.

v) Warren L. McCabe, Julian C. Smith, and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill, 2017 (Indian Edition), ISBN: 978-9339213237.

vi) Yunus A. Cengel and Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 6th Edition, McGraw Hill, 2020, ISBN: 978-0073398198.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 20-30

Teacher Defined Assessment : 20

End Semester Exam : 50-60

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	1	3	2	1	1	1	1	1	1	2	3	3	1	3
CO 2	3	3	1	3	2	1	1	1	1	1	1	2	3	3	1	3
CO 3	3	3	1	3	2	1	1	1	1	1	1	2	3	3	1	3
CO 4	3	3	1	3	2	1	1	1	1	1	1	2	3	3	1	3

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

B. Tech Chemical Engineering Semester VII#

Code	Course Name	Type	L-T-P	Credits	Pre-requisites
CMD402	Project Phase-II	DC	--	3	None
				Core Credits=3	
ELECTIVE					
CMLxxx	Elective - 9 / MOOC*	DE	3-0-0	3	None
CMLxxx	Elective – 10 / MOOC*	DE	3-0-0	3	None
CMLxxx	Elective - 11	DE	3-0-0	3	None
CMLxxx	Elective – 12	DE	3-0-0	3	None
				Elective Credits=12	
				DC+DE=15 Credits	

* Maximum four MOOC/NPTEL/SWAYAM courses are allowed in a complete program and maximum two in a semester only for students going to internship.

VII and VIII semester will be interchanged if student opt for internship in VII semester.

Course Code & Course Title:	**Project Phase II CMD 402**		
Course Type:	DC		
Name of the programme(s):	B. Tech		
L – T – P	---	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1.	**Course Objective:** 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

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Able to identify and formulate research problem
CO2	Able to design and develop solution to the problem
CO3	Able to analyze and solve the complex problems
CO4	Able to plan, implement and execute the project
CO5	Able to write effective technical report and demonstrate through presentation

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**

4.	**Text books**

5.	**Reference Book(s) and Other Required Material**

6. Evaluation Details:

- Internal: 20%
- Mid-Semester: 30%
- End-Semester Exam: 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

B. Tech Chemical Engineering Semester VIII# Ω

Code	Course Name	Type	L-T-P	Credits
ELECTIVE (two)				
CMLxxx	Elective - 13 / MOOC*	DE	3-0-0	3
CMLxxx	Elective – 14 / MOOC*	DE	3-0-0	3
CMPxxx	Internship	DE	6-0-0	6
				Elective Credits=6
				DC+DE=6 Credits

* Maximum four MOOC/NPTEL/SWAYAM courses are allowed in a complete program and maximum two in a semester only for students going to internship.

VII and VIII semester will be interchanged if student opt for internship in VII semester.

Ω Students must select an appropriate combination of credit points to fulfill the total requirement of 160 credits for degree conferral.

List of Electives

Course Code & Course Title:	CML 428 – CFD for Chemical Engineers		
Course Type:	**DE**		
Name of the programme(s):	B. Tech.		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1.	**Course Objective:** Students shall be able to apply CFD techniques for simulation of practical problems in fluid flow and heat transfer.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Able to apply basic principles used in CFD.
CO2	Able to formulate the problem and apply discretisation techniques.
CO3	Design and solve heat transfer problems using CFD techniques.
CO4	Design and solve fluid flow problems using CFD techniques.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	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.	CO1	1
	Formulation of problem; Physical and mathematical classification of problems; Types of governing differential equations; 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; Examples using Comsol Multiphysics Software on Dirichlet boundary condition, Neumann boundary condition, etc.	CO2	3
	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; Examples using Comsol Multiphysics Software on state heat transfer in one dimension, transient heat transfer in one dimension, heat transfer in two dimensions, heat conduction with a hole, etc.	CO3	5
	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	CO4	5

algorithm for solving complete Navier-Stokes equation-MAC method SIMPLE algorithm; Introduction to standard κ-ε model for turbulent incompressible flow; Project problem; Examples using Comsol Multiphysics Software on flow of newtonian fluid in a pipe, flow of non-newtonian fluid in a pipe, reaction and diffusion, turbulent flow in a pipe, determining arrhenius parametrs using parameter estimation, etc.		

4. Text books

i. P. S. Ghoshdastidar, Computer simulation of flow and heat transfer, Tata McGraw-Hill Publishing, 1st Edition, 1998.
ii. K. Muralidhar and T. Sundararajan, Computational fluid flow and heat transfer, Narosa Publications, 2nd Edition, 2003.

5. Reference Book(s) and Other Required Material

i. H. K. Versteeg and W. Malalasekera, An introduction to CFD, Longman Scientific and Technical, 1st Edition, 1995.
ii. E. S. Oran and J. P. Boris, Numerical simulation of reactive flow, Cambridge University Press, 2nd Edition, 2001.
iii. J. H. Ferriger, M. Peric, Springer, Computational methods for fluid dynamics, 1st Edition, 1996.
iv. S. V. Patankar, Numerical heat transfer and fluid flow, Mc Graw-Hill Book Company, 1st Edition, 1980.
v. W. Rodi, Turbulence models and their applications – a state of the art review, IAHR – AIRH Monograph series, 3rd Edition, 1993.
vi. Finlayson, B A, Introduction to Chemical Engineering Computing, Wiley, 2nd Edition, 2014.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam: 20-30 Marks
Teacher Defined Assessment: 20 Marks
End Semester Exam: 50-60 Marks

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	**(CML424) Petroleum Refinery Engineering**		
Course Type:	**DE**		
Name of the programme(s):	**6th Semester B.Tech. Chemical Engineering**		
L – T – P	**3-0-0**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**Mass Transfer I**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	The student will understand the fundamentals and advances in refinery sector.
CO2	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.
CO3	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.
CO4	
CO5	

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	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.		

4.	**Text books**

i. **Bhaskara Rao, B. K.,** *Modern Petroleum Refining Processes*, 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

ii. **Gary, J. H. and Handwerk, G. E.,** *Petroleum Refining Technology and Economics*, 3rd Edition, Marcel Dekker, Inc., New York.

iii. **Hobson, G. D. and Rohl, W.,***Modern Petroleum Technology*, 4th Edition, Applied Science Publication.

iv. **Nelson, W. L.,** *Petroleum Refining Engineering*, 4th Edition, Tata McGraw Hill Publication Co. Ltd. (1985).

v. **Noel, H. M.,***Petroleum Refining Manual*, Reinhdd Pub. Corp., New York.

5.	**Reference Book(s) and Other Required Material**

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	√	√	√				√	√							
CO2	√	√	√		√	√	√	√	√						
CO3	√	√	√	√	√	√	√	√	√						
CO4	√	√	√	√	√	√		√							
CO5					√	√	√	√	√						

High - 3; Medium – 2; Low – 1;

9.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	**(CML 342) Safety and Risk Analysis**		
Course Type:	**DE**		
Name of the programme(s):	**8th Semester B.Tech. Chemical Engineering**		
L – T – P	**3-0-0**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

1) To give students the knowledge on safety programs, engineering ethics, plant safety measures, safety warning symbols, handling of hazardous chemicals, fire andexplosion hazards and different methods of hazard identification and its analysisin qualitative and quantitative scales.
2) To gain knowledge on different mathematic models used to predict the rate of leakage of fuels from various unit operations.
3) To gain knowledge on the design to prevent fires and explosion, risk assessment and case study problems.
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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Basic procedures to be followed to ensure safety in chemical process industries
CO2	Fire-flammability characteristics of vapors and liquids
CO3	Designs to prevent fires and explosions
CO4	Mathematical models to understand the rate of discharge of materials
CO5	Risk assessment of various chemical process plants

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit-I: Introduction to process plant safety, handling of hazardous chemicals, 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.		
	Unit-II: 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. Resources for combating fires, dry chemical powders, fire fighting foam, fixed and portable fire extinguishers, FMEA.		
Unit-III: Designs to Prevent Fires and Explosions- Vacuum Purging, Pressure Purging, Combined Pressure-Vacuum Purging, Vacuum and Pressure Purging with Impure Nitrogen, Advantages and Disadvantages of the Various Pressure and Vacuum inerting procedures, Sweep-Through Purging, Siphon Purging.		
Unit-IV: Introduction to Source Models, Flow of Liquid through a Hole, Flow of Liquid through a Hole in a Tank, Flow of Vapor through Holes, Flashing Liquids, Flow of Gases through Pipes- Adiabatic Flows and isothermal flows, Liquid Pool Evaporation or Boiling.		
Unit-V: Safely audit of chemical process plants, HAZOP studies, RiskAssesment- fault tree and event tree analysis. Risk analysis of chemical processes, risk management, risk identification, personnel training, risk to environment.		

4. Text books

i. **Crowl, Daniel A. and Louvar, Joseph F.**, *Chemical Process Safety: Fundamentals with Applications*, 2nd Edition, Prentice Hall International Series.
ii. **Dekkar Marcel**, *Safety Management and Practices for Hazardous Units*, McGraw Hill Book Co., New York, 1995.
iii. **Greene, R.**, *Safe and Efficient Plant Operation and Maintenance*, McGraw Hill Book Co., New York.

5. Reference Book(s) and Other Required Material

i. **Saxena,** *Safety and Good House Keeping*, 3rd Edition, National Productivity Council, New Delhi (1976).
ii. **Wells, G. L.,** *Safety in Process Plant Design*, George Godwin Ltd., (1980).

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H					M		H		L		H			
CO2	H	H	M									H			
CO3	H	L	H									H			
CO4	M	M	L		H							H			
CO5	M	H			M				H	M		H			

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	**CML233 Environmental Engineering**		
Course Type:	DE		
Name of the program(s):	B.Tech. Chemical Engg.		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1	**Course Objective:**

Course Objective 1. To identify the sources of pollutants and its hazards on human and environment

Course Objective 2. To learn the nutrient cycle, ecosystem and ways to restore the ecosystem and cycles

Course Objective 3. To learn the methods for prevention and control / treatment of various pollutants

Course Objective 4. To understand the life cycle and the sustainability concept related to environment

Course Objective 5. To learn the basic environmental legislation

2	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand key current environmental problems.
CO2	Be able to analyse an industrial activity and identify the environmental problems
CO3	Be able to plan strategies to control, reduce and monitor pollution
CO4	Be able to select the most appropriate technique to purify and/or control the emission of pollutants
CO5	Be conversant with basic environmental legislation.

3	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Man and environment, biogeochemical cycles, Biosphere and ecosystem, Forest Nutrient cycles and the parameters responsible for the disturbance of these cycles.		CO1	1
Mobile and stationary sources of air pollutants, air pollution, behaviour of pollutants and atmospheric chemical reactions, Atmospheric dispersion of pollutants, models for dispersion, limitations of models, effective stack height concept, gas sampling and analysis. 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.		CO2	3
Air pollution control processes, Unit operations such as screening, coagulation, flocculation, filtration, clarification, solvent extraction. measurement of levels of pollution such as DO, BOD, COD,		CO2, CO3,CO4	5

TOC,ThOD, soluble and suspended volatile solids, Water quality and discharge standards		
Chemical treatment of waste material, oxidation, chlorination, Ozonation, incineration etc. Biological treatment, biochemical kinetics, microbial kinetics, microbial growth. 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.).	CO2, CO3,CO4	5
Measuring environmental impacts, life cycle analysis, legislation controlling discharges, optimal degree of abatement, and policies for regulation of environmental impacts.	CO2, CO5	2

4 Text books

i) Mahajan S.P. Pollution Control in Process Industries, Tata McGraw Hill Book Co., 2017

ii) Pandey G.N. and Camey G.C.; Environmental Engineering, Tata – McGraw Hill Book Co., New Delhi (1989)

iii) Rao C.S.; Environmental Pollution Control Engineering, New Age International Publishers, 3rd Edition, 2018

5 Reference Book(s) and Other Required Material

i) Sincero A., Environmental Engineering, A Design Approach. , Prentice – Hall of India, New Delhi (1996).

6 Evaluation Details:

i) Assignment – 20%
ii) Mid Sem Evaluation – 30%
iii) End Sem Evaluation -50%

7 Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2			3	3			2	3	3	2	2	
CO2	3	3	3	3			3	3					3	3	2	
CO3	3	3	3	3	1	2	3	3				3	3	3	3	
CO4	3	3	3	3	1	2	3	3	1				2	2	2	
CO5				3			3	3			3	3	1			

High - 3; Medium – 2; Low – 1;

8	List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	CML427 Advanced Separation Processes		
Course Type:	DE		
Name of the program(s):	B.Tech. Chemical Engg.		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1	Course Objective:

Course Objective 1: To explore the principles, design, and application of membrane-based separation techniques such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

Course Objective 2: To examine a wide range of advanced separation methods, such as, Surfactant based separation methods, ATPS, chromatography, isoelectric focusing, salting out etc and its applications

Course Objective 3: To focus on the specific applications of advanced separation methods in biotechnology, bioprocessing, and chemical engineering, including cell harvesting, protein purification, and product isolation.

Course Objective 4: To investigate emerging separation techniques

2	Course Outcomes (Min. 3 & Max. 5):
CO1	Ability to understand the governing mechanism and driving force of various advanced separation processes
CO2	Ability to perform process and design calculations on membrane separation processes Ability to understand process and design consideration on chromatography, aqueous two phase separations, bio separations
CO3	Ability to understand process and design consideration on hybrid and reactive separations
CO4	Ability to select/choose the suitable separation method for a particular product

3	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Overview of Separation Processes: Introduction / Revision of various Conventional Separation Processes and their applications, advantages, and disadvantages, Need of advance Separation processes, types.		CO1	1
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.		CO2, CO4	3

Bio-separation Processes: Introduction, overview of bioseparations, cell disruption/ pretreatment methods, filtration, centrifugation, adsorption, extraction / aqueous two phase systems, membrane separation, precipitation, chromatographic separation, Applications. Isoelectric focusing, Various case studies	CO2, CO4	4
Chromatographic Separation: Introduction, Principles, Classifications, High performance liquid chromatography, ion exchange chromatography, affinity chromatography, reversed phase chromatography, gas chromatography, application.	CO2,CO4	2
Hybrid Separations: Introduction, Concept of hybrid separations, types of hybrid separations, networking or combination of various separation processes, applications, design aspects, scope for future.	CO3, CO4	2
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.	CO3, CO4	2

4 Text books

i) Richardson J. F., Harker J. H., Chemical Engineering Vol. 2, Elsevier, 5th Edition, 2002.
ii) Mukhopadhyay M., Natural Extract using Supercritical CO_2, CRC Press, 1st Edition, 2000.
iii) Nath K., Membrane Separation Processes, Prentice Hall of India, 1st Edition, 2008.
iv) Sivasankar B., Bio-separations: Principles and Techniques, Prentice Hall of India, 1st Edition, 2005.

5 Reference Book(s) and Other Required Material

(i) Seader J. D., Henley E. J., Separation Process Principles, Wiley, 2nd Edition, 2001

6 Evaluation Details:

i) Assignment – 20%
ii) Mid Sem Evaluation – 30%
iii) End Sem Evaluation -50%

7 Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3								1	3			
CO2	3	3	3	1		2	2						3	3	3	3
CO3	3	3	3	2	3	3	3	3			2	2		3	3	2
CO4	3	3	3	3	3	3	3	3	2			3	3	3	3	3

High - 3; Medium – 2; Low – 1;

8	List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	CML 389 Chemical Informatics		
Course Type:	DE		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**
1.	To introduce cheminformatics concepts for handling the molecular data and prediction of properties.
2.	To make use of cheminformatics tools for the discovery, design and development of novel chemicals, drugs and materials.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To learn and utilize cheminformatics tools for pharmaceutical drug design and development.
CO2	To learn and utilize cheminformatics tools for the design and development of novel materials and chemicals
CO3	To learn chemical structure representation and ways to handle it on computers

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in hours**
Cheminformatics Introduction • Introduction to cheminformatics, History and evolution of cheminformatics • Use of cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation		CO1, CO2	6
Representation of Molecules and Chemical Reactions • Nomenclature; Different types of notations; SMILES coding; Matrix representations; Structure of Molfiles and Sdfiles; Libraries and tookits; Different electronics effects; reaction classification • Representing 2D and 3D structures, Kinds of 2D structures representation; atom lookup and connection tables; graph theory; SMILES; SD files; representation nuances; descriptors		CO3	6
Database screening by Similarity Search • Database screening by similarity search: Database concepts, Design of chemical databases • Structure search, Pharmacophore search, Fingerprints.		CO3	4

Molecular Mechanics • Calculation of physical and chemical data, molecular mechanics • Descriptors for chemical compounds, Artificial intelligence systems in chemical engineering • Methods for data analysis, Chemical markup language (CML)	CO2, CO3	6
Prediction of Physical and Chemical Properties • Prediction of physical and chemical properties, Structure–Activity correlations, Regression methods • Chemical reactions and synthesis design, Elements of bioinformatics and genomics, Docking	CO1, CO2	8
Drug Design • Drug design • Absorption-Distribution-Metabolism-Excretion (ADME) Pharmacokinetics • Drug delivery	CO1	6

4.	**Text books**
i)	Leach A. R. and Gillet V. J., An Introduction to Cheminformatics, Revised edition, Springer, 2007, ISBN 978-1-4020-6291-9.
ii)	Karthikeyan M., Vyas R., Practical Cheminformatics, Springer, 2014, ISBN 978-81-322-1779-4.

5.	**Reference Book(s) and Other Required Material**
i) .	Andrew Bender, Jonathan M Goodman, Cheminformatics, Oxford University Press-2007
ii) .	Gasteiger J. and Engel T., Chemoinformatics, A Text Book, Wiley VCH, 20023, ISBN 978-3-527-30681-7.
iii) .	Stuart Schreiber, Tarun M. Kapoor, Chemical Biology: From Small Molecules to Systems Biology and Drug Design Chemical Release 2001.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Class Tests and Assignments: 20%
	Mid-Semester Exam (1.5 Hours): 25%
	End-Semester Exam (3 Hours): 55%

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	1	2	-	-	-	2	2	-	1	2	2	3	1
CO2	2	2	3	1	2	-	1	-	2	2	-	1	2	2	3	1
CO3	1	1	1	-	2	-	-	-	-	-	-		1	1	1	-

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CML 402 Molecular Simulation and Informatics		
Course Type:	DE		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**
1.	To model and simulate the molecular interactions of various chemical systems.
2.	To analyze the molecular information of various chemical systems for designing new molecules.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To build and apply molecular force field to chemical structures.
CO2	To understand and utilize molecular modeling, molecular simulation and data analysis tools to understand molecular level interactions
CO3	To understand and utilize molecular informatics tools for designing small molecular systems.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in hours**
Introduction • Introduction and background of molecular computations • Introduction to Windows and Linux based freeware molecular modeling, simulation and informatics tools		CO1, CO2	6
Chemical File Formats • Chemical structure representation and manipulation • SMILES specification rules and coding • Various chemical file formats and their interconversion		CO1, CO3	4
Molecular Modeling and Simulation • Applications of molecular computations in material design and development • Molecular modeling, Molecular force field • Fundamentals of molecular simulations		CO2	8
Molecular Simulations Concepts • Molecular dynamics simulations • Integrating algorithms, Periodic box and Minimum image		CO2	8

convention • Long range forces and Non-bonded interactions • Monte Carlo simulations and other advanced topics		
Simulation Data Analysis • Energy minimization, System relaxation • Radial distribution function, • Gromacs, Ambertools, Visual molecular dynamics • Trajectory analysis	CO2	6
Virtual Screening Techniques • Virtual screening • Ligand-based drug design: Quantitative structure activity relationship (QSAR) modeling • Molecular descriptors, Lipinski's rule of five • Structure-based drug design: Molecular docking, Search algorithms, Scoring functions	CO3	4

4.	**Text books**
i) .	Allen M. P. and Tildesley D.J., Computer Simulation of Liquids, 2nd Edition, Oxford University Press, 2017, ISBN 978-0-19-880320-1.
ii) .	Frenkel D. and Smith B., Understanding Molecular Simulation: From Algorithms to Applications, 2nd Edition, Academic Press, San Diego, California, 2001, ISBN 978-0-12-267351-1.

5.	**Reference Book(s) and Other Required Material**
i).	Haile J. M., Molecular Dynamics Simulation: Elementary Methods, Wiley-Interscience, 1997.
ii).	Leach A. R., Molecular Modeling: Principles and Applications, Pearson, 2001, 2nd Edition.
iii).	Leach A. R. and Gillet V. J., An Introduction to Cheminformatics, Revised edition, Springer, 2007.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Class Tests and Assignments: 20%
	Mid-Semester Exam (1.5 Hours): 25%
	End-Semester Exam (3 Hours): 55%

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO1	2	-	-	-	3	-	-	-	-	-	-	-	2	-	-	-
CO2	3	2	3	2	3	-	-	-	2	1	1	-	3	2	3	2
CO3	2	2	3	2	3	-	-	-	2	1	-	1	2	2	3	2

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML XXX Space Technology for Chemical Engineers		
Course Type:	DE		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**
1.	To introduce chemical engineering principles to space technology
2.	To identify innovative materials and solutions for space exploration challenges.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To understand chemical engineering principles related to space technology
CO2	To develop innovative solutions for space exploration challenges
CO3	To identify and design newer chemicals and materials for space applications

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in hours**
Introduction to Space Technology • History of space exploration, Space organizations, Space missions and applications, • Relevance to chemical engineering		CO1	6
Propulsion systems • Propellants (fuel and oxidizer) • Chemical propulsion, Electric propulsion, Nuclear propulsion • Solar sails		CO2, CO3	6
Material Science • Nanomaterials for space applications, Materials selection for spacecraft design • Thermal protection systems, Smart materials		CO3	6
Energy generation and storage Concepts • Spacecraft power systems • Solar power generation, Nuclear power generation • Fuel cells and battery systems		CO2, CO3	6
Life support systems • Oxygen generation, Carbon dioxide removal • Water recycling and purification, Food production and processing,		CO1, CO2, CO3	6

• Waste management		
Space exploration • Space exploration • Planetary resource extraction and utilization • Use of artificial intelligence and robotics • Space policies and regulation	CO2	6

4.	**Text books**
i) .	Space Technology: A short introduction, Springer, 2023, ISBN 978-3-031-34817-4.
ii) .	Future Spacecraft Propulsion Systems: Enabling Technologies for Space Exploration, Paul A. Czysz and Claudio Bruno, Springer, 2006, ISBN 978-3-540-23161-5.

5.		**Reference Book(s) and Other Required Material**
i)	1.	Solid Rocket Propulsion Technology, A. Davenas, Pergamon Press, 1993.
ii)	2.	Space Material Sciences, A I Feonychev, 2011.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**
	Class Tests and Assignments: 20%
	Mid-Semester Exam (1.5 Hours): 25%
	End-Semester Exam (3 Hours): 55%

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	-	-	-	-	-	-	-	3	3	1	-
CO2	3	3	2	2	-	2	2	2	1	2	-	1	3	3	2	2
CO3	3	1	3	3	1	-	2	2	1	2	-	1	3	1	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML 232 & Introduction to computing softwares for chemical engineers		
Course Type:	**DE**		
Name of the programme(s):	Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**-**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective: This course will provide basic knowledge of Computing softwares and knowledge of simulation in the learned softwares**

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understanding the basic of software useful for Chemical Engineering
CO2	Abled to write the programs for Chemical Engineering Equation
CO3	System Modeling and Simulation of Chemical Engineering problems
CO4	Control and optimization problem using learned software's

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Introduction to Software's- Documentation; Development Environment; Desktop Tools, Other development environment tools.		CO1	2 weeks
Manipulating Matrices-Matrices and Magic squares, Expressions, Working with Matrices, more about Matrices and Arrays, controlling command 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.		CO2	5 weeks
Examples of Chemical engineering solved problems using MATLAB-Equations of state, Vapour liquid equilibrium		CO3	3 weeks
Chemical reaction equilibria, Reaction-kinetic system, Transport processes, etc		CO4	2 weeks

4.	Text books

i) W. Fred Ramirez, Computational Methods in Process Simulation, Elsevier Science & Technology Books
ii) S. Toan, H. Adidharma, B. Nojabei, Introduction to Matlab for Chemical and Petroleum Engineering, CreateSpace Independent Publishing Platform
iii) P, Rudra, Fetting started with MATLAB, OUP, USA

5.	Reference Book(s) and Other Required Material

6.	Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam: 25 %
Assignments/Presentation/Simulation: 20 %
End Semester Exam: 55 %

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CML5XX&Biorefinery Engineering		
Course Type:	**ES**		
Name of the programme(s):	Sachin A Mandavgane		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	Basic understanding of Unit Operations and Unit Process		
Course Equivalence: Course Code(s)& Name(s)	None		

1.	**Course Objective:** The primary aim of this course is to teach valorisation of different bio feedstocks, their conversion technologies and separation processes. **1)** To introduce students to concept of bio refinery engineering, waste valorisation and circular economy **2)** To introduce students newer sources of Carbon and Hydrogen for development of platform chemicals **3)** To teach students conversion techniques and separation processes involved in bio refinery with suitable case studies

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Student will learn to categories the feed stock based on origin
CO2	Students will understand concept of bio refinery
CO3	Students will learn bio based plateform chemicals, bio fuels and other bio based products
CO4	Students will be able to apply knowledge of unit operations and process to bio based processes

3.	**Detailed Description of the Course**		
Introduction to Biorefinery : Definition, Necessity of biorefinery, Overview of Biorefining,Role of biorefinery in bio-economy and circular economy **Biomass Characterization:** Biomass as a resource, Biomass properties, Classification of biomass (Energy crops; Agricultural residues and waste; Forestry waste and residues; Industrial and municipal waste), Chemistry of biomass (Triglycerides feedstock; Sugar and starchy feedstock; Lignocellulosic feedstock; Algae as a biomass)		**CO1**	

Biorefinery: Triglyceride biorefinery, Sugar and starchy biorefinery, Lignocellulosic biorefinery, Oil biorefinery, Microalgae biorefinery	**CO2**	
Platform Chemicals : C-3 Platform Chemicals, (Glycerol; 3-Hydroxypropionic Acid), C-4 Platform Chemicals (Succinic Acid; Fumaric Acid; Malic Acid; Aspartic Acid), C-5 Platform Chemicals (Levulinic Acid; Glutamic Acid; Itaconic Acid; Xylitol), C-6 Platform Chemicals (Sorbitol; Glucaric Acid; 2,5-Furan Dicarboxylic Acid)	**CO3**	
Conversion Technologies: Thermochemical conversion processes (Gasification; Fast pyrolysis), Chemical conversion processes (Transesterification; Microalgal biorefinery), Biochemical conversion processes (Pre-treatment; Hydrolysis; Fermentation; Products separation; Clean fractionation) **Biorefinery vs Refineries** : Availability and cost of bio-refinery, Feedstock diversity, Edible vs non-edible feedstock, Availability of biomass, Economics of biorefinery **Case Studies:** Waste orange bio refinery, paddy straw bio refinery, potato bio refinery etc	**CO4**	

4.	**Text books**

i) Jhuma Sandhukhan, Kok Siew Ng, Elias Martinez Hernandez, Biorefineries and Chemical Processes: Design, Integration and Sustainability Analysis,1st Edition,John Wiley and Sons, , 2014https://onlinelibrary.wiley.com/doi/book/10.1002/9781118698129

ii) Juan-Rodrigo Bastidas-Oyanedel, Jens Ejbye Schmidt,Biorefinery , Springer, 1st Edition. 2019

5.	**Reference Book(s) and Other Required Material**

i) Thallada Bhaskar, Ashok Pandey, S.Venkata Mohan, Waste Biorefinery: Potential and Perspectives,1stEdition, Elsevier, 2018

ii) Michele Aresta, Angela Dibenedetto, Franck Dumeignil; Biorefineries: An Introduction, 1stEdition ,De Gruyter, 2015

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML431 Entrepreneurship Development		
Course Type:	DE		
Name of the program(s):	B.Tech. Chemical Engg.		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	None		

1	Course Objective:

Course Objective 1. Explore the characteristics of successful entrepreneurs, the entrepreneurial mindset, and the impact of entrepreneurship on the economy and society.

Course Objective 2. Learn how to identify business opportunities, develop innovative ideas, and assess their potential in the market.

Course Objective 3. Learn how to develop marketing strategies, create branding, and understand customer behaviour to attract and retain clients.

2	Course Outcomes (Min. 3 & Max. 5):
CO1	To understand the role of an entrepreneur.
CO2	To understand the factors influencing an entrepreneur.
CO3	To understand the steps involved in setting up a business.
CO4	Be able to select the most appropriate technique to purify and/or control the emission of pollutants
CO5	To understand the financial aspects of a business.

3	Detailed Description of the Course		
Topics		CO(s) Addressed	Duration in weeks
Traits of Entrepreneurs - Types of Entrepreneurs – Intrapreneur, Difference between Entrepreneur and Intrapreneur - Entrepreneurship in Economic Growth, Factors affecting Entrepreneurical Growth.		CO1	2
Major motives influencing Entrepreneur- Achivement Motivation Training, Self Rating, Business game, Thematic Apperception Test - Stress Management. Entrepreneurship Development Programs - Need, objectives		CO2	1
To understand the steps involved in setting up a 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		CO3	5
Marketing: Functions and strategies, Product protection: Patents , Trademarks and Copyrights.		CO3	2

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	CO4	2

4 Text books

i) Dr Sharma D. D., Total Quality Management, Sultan Chand and Sons, New 2017
ii) Gupta C. B. and Srinivasan P., Entrepreneurship Development, Sultan Chand and Sons, New Delhi
iii) Khanna S.S, Entrepreneurial Development, S.Chand & Co. Ltd NewDelhi, 1999.
iv) Philip Kotler, Marketing Management, Prentice Hall of India, New Delhi.
v) Rathore B.S. and Dr. Saini J. S, A Handbook of Entreprenuership, AapgaPublications, Panchkula (Haryana).

5 Reference Book(s) and Other Required Material

6 Evaluation Details:

i) Assignment – 20%
ii) Mid Sem Evaluation – 30%
iii) End Sem Evaluation -50%

7 Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	3	3	3	3	3	1	1	-	-	-	-
CO2	-	-	-	-	-	3	3	2	1	3	1	2	-	-	-	-
CO3	-	-	-	-	-	3	3	2	1	3	1	2	-	-	-	-
CO4	-	-	-	-	-	1	2	1	-	3	3	3	-	-	-	-
CO5	-	-	-	-	-	3	3	3	3	3	1	1	-	-	-	-

High - 3; Medium – 2; Low – 1;

8 List of Indicative Laboratory Experiment (if applicable):

Not Applicable

Course Code & Course Title:	CML 423: Optimization Techniques		
Course Type:	DE		
Name of the programme(s):	B. Tech in Chemical Engineering		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	Basic Maths		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**

The course aims to:

Introduce the fundamental principles of optimization and its significance in chemical engineering.

Develop mathematical modelling skills to solve optimization problems.

Equip students with classical optimization techniques and linear programming tools.

Enable students to apply optimization methods to practical problems in chemical engineering.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand the principles, scope, and applications of optimization in chemical engineering.
CO2	Formulate mathematical models for optimization problems.
CO3	Apply classical optimization techniques to solve unconstrained problems.
CO4	Use linear programming methods for decision-making in chemical process optimization.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Unit 1: Introduction to Optimization. Definition and scope of optimization. Importance and applications in chemical engineering. Structure of optimization problems: objective functions, constraints, and variables.		CO1, CO5	1
Unit 2: Fundamentals of Optimization. Mathematical concepts: continuity, unimodal and multimodal functions. Convex and concave functions, convex regions. Conditions for extrema: necessary and sufficient conditions.		CO1, CO2	2
Unit 3: Optimization of Unconstrained Functions.		CO3, CO3	3

One-dimensional search techniques: Newton's method, Secant method, and polynomial approximation. Multivariable optimization: gradient methods, random search, and simplex methods.		
Unit 4: Linear Programming. Introduction to linear programming. Graphical solutions for two-variable problems. Simplex method: concepts and applications in process optimization	CO2, CO4	2
Unit 5: Applications in Chemical Engineering. Optimization of chemical process equipment: heat exchangers, distillation columns, and reactors. Pipe diameter selection for cost minimization. Residence time optimization for batch and continuous reactors.	CO3, CO5	3
Unit 6: Introduction to Modern Optimization Techniques. Overview of genetic algorithms and their role in optimization (qualitative treatment). Applications of modern optimization tools in chemical process design.	CO1, CO5	1

4. Text books

i) Edgar, T.F., Himmelblau, D.M., and Lasdon, L.S., Optimization of Chemical Processes, 2nd Edition, McGraw-Hill International Edition, Singapore, 2001. ISBN: 9780070393592.

ii) Rao, S.S., Engineering Optimization: Theory and Practice, 5th Edition, Wiley & Sons, USA, 2019. ISBN: 9781119454717.

iii) Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, 2nd Edition, PHI Learning Private Limited, New Delhi, 2012. ISBN: 9788120346789.

5. Reference Book(s) and Other Required Material

i) Reklaitis, G.V., Ravindran, A., and Ragsdell, K.M., Engineering Optimization: Methods and Applications, 2nd Edition, John Wiley & Sons, New York, 2006. ISBN: 9780471558142.

ii) Fletcher, R., Practical Methods of Optimization, 2nd Edition, John Wiley & Sons, New York, 2000. ISBN: 9780471494638.

iii) Chong, E.K.P., and Żak, S.H., An Introduction to Optimization, 2nd Edition, John Wiley & Sons, New York, 2001. ISBN: 9780471395263.

iv) Nocedal, J., and Wright, S.J., Numerical Optimization, 2nd Edition, Springer, New York, 2006. ISBN: 9780387303031.

v) Gen, M., and Cheng, R., Genetic Algorithms and Engineering Optimization, 1st Edition, John Wiley & Sons, New York, 2000. ISBN: 9780471315315.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Class Tests and Assignments: 20%

Mid-Semester Exam (1.5 Hours): 30%

End-Semester Exam (3 Hours): 50%

7.	**Relationship of Course Outcomes to Program Outcomes:**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	1	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	3	2	-
CO3	2	3	3	-	-	-	-	-	-	-	-	-	2	3	3	1
CO4	1	2	3	2	3	-	-	-	-	-	-	-	2	3	3	2
CO5	1	2	1	2	2	-	-	-	-	-	-	2	2	3	3	1
CML423	2	3	2	1	1							1	3	3	3	1

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Nil

Course Code & Course Title:	CML 481: Instrumental Analytical Techniques		
Course Type:	DE		
Name of the programme(s):	B.Tech. in Chemical Engineering		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	CML202: Fluid Mechanics, CML221: Mass Transfer I, CML222: Heat Transfer		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	**Course Objective:**

The course aims to:

Introduce students to the basic principles and methodologies of instrumental techniques used in chemical analysis.

Provide an understanding of key analytical tools, such as chromatographic and spectroscopic techniques.

Develop skills to interpret analytical data and apply it to solve chemical engineering problems.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Describe the principles and functioning of common analytical instruments.
CO2	Apply chromatographic and spectroscopic methods for chemical analysis.
CO3	Process, analyze, and interpret data obtained from analytical instruments

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Unit 1: Introduction to Analytical Techniques Overview of analytical methods in chemical engineering. Sampling, sample preparation, and choice of methodology. Tools for quantitative chemical analysis and quality assurance.		CO1, CO3	1
Unit 2: Chromatographic Techniques Principles of gas chromatography (GC) and high-performance liquid chromatography (HPLC). Detectors and applications of chromatographic methods. Introduction to hyphenated techniques: GC-MS and LC-MS.		CO1, CO2, CO3	3
Unit 3: Spectroscopic Methods Fundamentals of UV-visible (UV-VIS) and infrared (IR) spectroscopy. Introduction to atomic absorption spectroscopy (AAS) and inductively		CO1, CO2, CO3	4

coupled plasma mass spectrometry (ICP-MS). Applications of spectroscopic techniques in chemical analysis.		
Unit 4: Data Processing and Statistical Analysis Error analysis and accuracy in chemical measurements. Statistical methods for data analysis and presentation. Introduction to chemometrics for analytical data interpretation.	CO3, CO1	2
Unit 5: Method Development and Validation QA/QC principles in analytical techniques. Method development, evaluation, and validation. Introduction to uncertainty analysis in chemical analysis.	CO2, CO3	2

4. Text books

i) McNair, H. M., Miller, J. M., & Snow, N. H., Basic Gas Chromatography, 3rd Ed., Wiley, 2019, ISBN: 9781119450757.
ii) Snyder, L. R., Kirkland, J. J., & Dolan, J. W., Introduction to Modern Liquid Chromatography, 3rd Ed., Wiley, 2010, ISBN: 9780470167540.
iii) Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R., Introduction to Spectroscopy, 5th Ed., Cengage Learning, 2015, ISBN: 9781285460123.

5. Reference Book(s) and Other Required Material

i) Harris, D. C., & Lucy, C. A., Quantitative Chemical Analysis, 11th Ed., Macmillan Learning, 2026, ISBN: 9781319490294
ii) Bruno, T. J., & Svoronos, P. D. N., CRC Handbook of Basic Tables for Chemical Analysis: Data-Driven Methods and Interpretation, 4th Ed., CRC Press, 2020, ISBN: 9780367517199.
iii) Skoog, D. A., Holler, F. J., & Crouch, S. R., Principles of Instrumental Analysis, 7th Ed., Cengage Learning (likely 2017), ISBN: 9781305577213

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Class Tests and Assignments: 20%
Mid-Semester Exam (1.5 Hours): 30%
End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	ε	3	-	-	-	-	-	-	-	-	-	-	3	3	1	1

CO2	3	3	2	-	3	-	-	-	-	-	-	-	3	3	3	2
CO3	2	2	3	3	2	2	-	-	-	-	-	2	2	3	3	3
CML 481	3	3	2	1	2	1						1	3	3	3	2

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Nil

Course Code & Course Title:	**Ore and Mineral Processing (CML 468)**		
Course Type:	DE		
Name of the programme(s):	B. Tech		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	None		
Course Equivalence: Course Code(s) & Name(s)	CML203 Mechanical Operations		

1.	**Course Objective:** 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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Knowledge of basics of mineral processing and their relevance
CO2	Calculate technical-economic conditions for winning of mineral resources
CO3	Describe and explain commonly occurring processes for mineral beneficiation
CO4	Analyze reasons for selection of processes based on raw material properties

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit-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.	**CO1**	1-2
	Unit-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.	**CO3**	1-2
	Unit-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,	**CO3 & CO4**	2

Hydrocyclones etc. Theory and practice of sedimentation and filtration. Working of Rotary vacuum filters.		
Unit-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 schelite.	**CO3 & CO4**	2-3
Unit-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.	**CO3 & CO4**	2
Unit-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.	**CO2, CO3 & CO4**	2

4. Text books

i) Elements of Mineral Dressing Author Gaudin A.M.; Publisher New York Edition 2nd Edition
ii) Mineral Processing Author Pryor E.J; Publisher Kluwar Academic Publishers Edition 3rd Edition
iii) Elements of Mineralogy Author Rutley F. Publisher Thomas Murray & Co., London
iv) A Text Book of Ore Dressing, Author Robert H. & Locke, Richards C.E; Publisher McGraw Hill Co.

5. Reference Book(s) and Other Required Material

i) Richard O. Burt, Chris Mills, 1984, Gravity Concentration Technology, Elsevier.
ii) Drzymala, J. (2007). Mineral processing. Foundations of theory and practice of minerallurgy.
iii) Gaudin, A. M., Flotation, McGraw-Hill Book Company, Incorporated, 1932.

6. Evaluation Details:

- Internal: 20%
- Mid-Semester Exam (1.5 Hours): 30%
- End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

CO3	3	3	3	3	2	2	3	-	1	2	-	3	3	3	3
CO4	3	3	3	2	2	2	3	-	1	2	-	2	3	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	**Advance Heat Transfer (CML 383)**		
Course Type:	DE		
Name of the programme(s):	B.Tech (BPT)		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	CML222 Heat Transfer		
Course Equivalence: Course Code(s)& Name(s)	**None**		

1.	**Course Objective:** To understand the fundamental theory, design processes 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.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Ability to understand the design approach and its application for various heat exchange equipment like heat exchangers, evaporators, jacketed vessels, etc.
CO2	Ability to identify, formulate, and solve engineering problems involving heat transfer equipments.
CO3	Ability to apply energy balances and rate equations to model and analyze thermal systems.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Unit-1 Classification of heat exchangers, recuperative, regenerative and direct contact type, double pipe heat exchangers, co-current counter, current flow arrangement, overall heat transfer coefficient.	**CO1**	1-2
	Unit-2 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.	**CO1**	1-2
	Unit-3 Plate heat exchangers, design procedure, advantages over shell and tube heat exchangers, spiral plate heat exchangers, helical coil heat exchangers.	**CO2 & CO3**	1-2

Unit-4 Heat Regenerators, fixed and fluidized bed, Evaporators types and their operational characteristics.	**CO2 & CO3**	2
Unit-5 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.	**CO2 & CO3**	2
Unit-6 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.	**CO2 & CO3**	2-3

4. Text books

i. Hollman J.P.; Heat Transfer, McGraw Hill, 1993

ii. Incropera F.P. Fundamentals of Heat and Mass Transfer 5th Edition Wiley India Pvt.Ltd Ltd., 2008

iii. Cengel Y.A. Heat Transfer: A Practical Approach McGraw-Hill; 2 edition, 2002

iv. Coulson J.M., Richardson J.R. Chemical Engineering, Vol. I 5th Edition, Butterworth Heinemann, New Delhi.

v. Dutta B.K. Heat Transfer; Principles and Applications PHI Pvt.Ltd New Delhi, 2006

5. Reference Book(s) and Other Required Material

i. Kern D.Q., Process Heat Transfer, Tata McGraw Hill Book Co., New Delhi, 1990.

6. Evaluation Details:

- Internals: 20%
- Mid-Semester Exam (1.5 Hours): 30%
- End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	-	-	-	-	1	-	3	3	3	2

CO2	3	3	3	3	2	2	1	1	-	-	-	3	3	3	3
CO3	3	3	3	3	1	-	-	-	-	-	-	2	3	3	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable): NA**

Course Code & Course Title:	CML422 Plant Utility		
Course Type:	**DE**		
Name of the programme(s):	B.Tech in Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)			

1.	**Course Objective:**

Understand **and explain** the role of various utility systems (steam, water, air, refrigeration, power, etc.) in chemical process plants. **Learn the principles of generation, distribution, and efficient use** of these utilities in industrial operations. **Develop competence in selecting utility equipment** based on process requirements and performance criteria. **Apply basic engineering calculations** related to steam generation, psychrometrics, cooling, and refrigeration systems. **Foster analytical reasoning** for troubleshooting utility system issues for safe, reliable plant operation.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	To understand the principals and working of different utilities like water treatment, generation of steam, compressor, and refrigeration cycles.
CO2	Describe the different equipment used to run the process plant with different utilities.
CO3	Acquire the knowledge for selection of different utility
CO4	Understand basic calculation (performance) involved in steam generation, compressor, psychometric operation and refrigeration

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
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.		CO1	01
Refrigeration: Refrigeration cycles 04, Different methods of refrigeration used in industry, Vapour compression, Vapour absorption: Lithium bromide (eco-Friendly) Different refrigerants like Monochlorodifluoro methane (R-22) Chlorofluorocarbons (CFC-Free). Secondary refrigerants: Brines Simple calculation of C.O.P. Refrigerating effects.		CO3	04
Steam and steam generation: Properties of steam, Problems based on enthalpy calculation for wet, steam, dry saturated steam, superheated		CO4	03

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.		
Psychrometry: Properties of Air-water vapours. Use of humidity chart, Equipment used for humidification, dehumidification, Evaporative cooling, spray ponds, cooling towers.	CO4	02
Air: Use of Compressed air, process air and instrument air, Process of getting instrument air.	CO4	01
Non steam heating system, Thermic fluid heater, Down- thermo heater, Temperature range.		01

4. Text books

i) R.S. Khurmi and J.K.Gupta, Thermal Engineering, S. Chand Technical Publication, 15th Edition ,2004, ISBN:81-219-1337-3

5. Reference Book(s) and Other Required Material

i) Mahesh m. Rathod , Thermal Engineering , Mc Graw hill, ISBN: 978-0-07-068113-2

ii) Narayan K.V., a text book of Chemical Engineering Thermodynamics, PHI, 2001.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

- Class Tests and Assignments: 20%
- Mid-Semester Exam (1.5 Hours): 30%
- End-Semester Exam (3 Hours): 50%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3				2	3	2	3	3	3	3	3	3	3
CO 2	3	3				2	3	2	3	3	3	3	3	3	3
CO 3	3	3				2	3	2	3	3	3	3	3	3	3
CO 4	3	3				2	3	2	3	3	3	3	3	3	3

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CML530 Process Intensification		
Course Type:	**DE**		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**03**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**
	Based on the concepts taught, student shall be able to apply the concepts and philosophy of process intensification to resolve the various issues in process industry such as cost, waste minimization, size etc.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Understand & apply the basic knowledge of philosophy and concepts of process intensification
CO2	Analyze and utilize the knowledge of various methods of process intensification for specific applications.
CO3	Analyze and utilize the knowledge of Various equipment of process intensification for specific applications.
CO4	Analyze and utilize the knowledge of application of process intensification.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Introduction to Process Intensification: History, definitions, and the philosophy		CO1	2
Methods of Process Intensification (Multifunctional reactors, alternative energy sources, hybrid separations)		CO2,CO3	4
Equipment used for Process Intensification (Reactors, Equipment for non-reactive operations)		CO2,CO3	4
Industrial Applications and Case Studies		CO1,CO2, CO3,CO4	4

4.	**Text books**

i) Stankiewicz, Andrzej and Moulijn, Jacob A., Re-engineering the Chemical Processing Plant: Process Intensification, 1st Edition, Marcel Dekker, Inc., 2004, ISBN 0-8247-4302-4.

5.	**Reference Book(s) and Other Required Material**

i) De Weerd, Cornelis, Process Intensification in Practice, 1st Edition, John Wiley & Sons, 2005, ISBN 978-0-470-02500-0.

6.	**Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]**

Assignment: 25 %

Mid Sem Exam: 25 %

End Sem Exam: 50 %

7.	**Relationship of Course Outcomes to Program Outcomes:**

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	3	3	1	1	3	-	2	3	-		3	3	1	2
CO 2	2	3	2	2	1	1	2		1	2		2	2	3	1	2
CO 3	2	3	2	2	1	1	2		1	2		2	2	3	1	2
CO 4	2	3	3	2	1	1	3		2	3	2	2	2	3	2	3
Avg	3	3	3	3	1	1	3		2	3	2	2	3	3	2	3

High - 3; Medium – 2; Low – 1;

8.	**List of Indicative Laboratory Experiment (if applicable):**

Course Code & Course Title:	CML - 426 Polymer Processing		
Course Type:	DE		
Name of the programme(s):	B. Tech		
L – T – P	L	No. of Credits	03
Pre-requisites: Course Code(s) & Name(s)	Nil		
Course Equivalence: Course Code(s) & Name(s)	Nil		

1.	Course Objective:

Based on the topics discussed in the class, Student shall be able to describe the principles of polymer processing techniques and evaluation of polymer properties as per standard.

2.	Course Outcomes:
CO1	Differentiate and describe the processing technique employed for manufacturing plastic products.
CO2	Describe the flow behavior of polymers.
CO3	Identify the polymer by which the given product is made.
CO4	Describe the testing method for evaluation of specified property of a polymer.
CO5	Illustrate the importance of plastic materials and describe the plastic waste management techniques.

3.	Detailed Description of the Course	
Topics	CO(s) Addressed	Duration in weeks
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. 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.	CO1	5
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.	CO2	2

Identification of plastics by simple test - Visual examination, Density, Melting point, Solubility test, Flame test, Chemical tests.	CO3	0.5
Basic concepts of testing,National & International standards, Test specimen preparation, Pre conditioning & Test atmosphere. 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.	CO4	4
Plastics waste and the associated problems, Integrated waste management - source reduction, recycling & sustainability correlation, energy recovering process. Environmental issues, policies and legislation in India.	CO5	1.5

4. Text books

i) Gruenwald G, Plastics - How Structure Determines Properties, Hanser Publishers, 1993, ISBN 3-446-16520-7.

ii) Vishu Shah, Hand Book of Plastics Testing Technology, 3rd edition, John Wiley & Sons Inc., New York, 2007, ISBN 13: 9780471182023.

5. Reference Books

i) Anthony L. Andrady (Ed.), Plastics and the Environment, Wiley Interscience, New York, 2003, ISBN-13. 978-0471095200.

ii) Baird D. G. and Collias D. I., Polymer Processing Principles and Design, 2nd edition, Butterworth-Heinemann, 2014, ISBN 13: 978-0470930588.

iii) J.S.Anand, K.Ramamurthy, K.Palanivelu, How to identify Plastics by Simple Methods, 2nd edition, CIPET, Chennai, 1998.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Component	Duration	Weightage
Mid Term Exam	1 hour	30
Class Tests and Assignments	-	20
End Semester Exam	3 hours	50

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

Relationship of Course Outcomes to Program Outcomes (CML426 Polymer Processing)															
Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**

CO426.1	3	-	3	3	-	-	-	-	-	3	-	3	3	-	3	3
CO426.2	3	3	3	3	3	-	-	-	-	3	-	3	3	3	3	3
CO426.3	3	3	3	3	-	-	-	-	3	3	3	3	3	3	3	3
CO426.4	3	3	3	3	-	-	-	3	-	3	-	3	3	3	3	3
CO426.5	3	3	3	3	-	3	3	3	-	3	-	3	3	3	3	3
CML426	3	3	3	3	1	1	1	2	1	3	1	3	3	3	3	3

8.	**List of Indicative Laboratory Experiment (if applicable):**

Nil

Course Code & Course Title:	CML435 Computer Aided Design		
Course Type: DE	**BS/ES/HU/IC/DC/IE/DE/HM/OC**		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-0-0	**No. of Credits**	**1**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

The objective of this course is to introduce students to the principles and applications of computer-aided design in chemical engineering and to develop an understanding of how computational tools are used in the analysis and design of chemical processes. The course aims to enable students to formulate mass and energy balance equations, develop process flowsheets, and apply appropriate thermodynamic models using process simulation software. It also seeks to provide hands-on experience in the design and analysis of basic chemical engineering equipment and to train students in interpreting simulation results for process evaluation, improvement, and preliminary optimization.

2.	**Course Outcomes**
CO1	Understand the fundamentals of computer-aided process design
CO2	Develop process flowsheets using mass and energy balance principles
CO3	Apply thermodynamic models for property estimation and phase equilibrium
CO4	Design and analyze chemical engineering equipment using simulation tools
CO5	Interpret simulation results for process evaluation and improvement

3.	**Detailed Description of the Course (Theory)**		
Topics		**CO(s) Addressed**	**Duration in Weeks**
Introduction to computer-aided design, design hierarchy, design basis, degrees of freedom analysis		CO1	2
Process flow sheeting, mass and energy balances, recycle and purge systems		CO2	3
Thermodynamic models, equations of state, property estimation, phase equilibrium		CO3	3
Computer-aided design and simulation of reactors and heat exchangers		CO4	3
Simulation of separation processes and process analysis		CO4	2
Sensitivity analysis, parametric studies, case studies		CO5	1

4.	Text books

i) Turton, R., Bailie, R. C., Whiting, W. B., and Shaeiwitz, J. A., *Analysis, Synthesis, and Design of Chemical Processes*, 5th Edition, Prentice Hall, 2018, ISBN: 9780132618121.

ii) Ulrich, G. D., and Vasudevan, P. T., *Chemical Engineering Process Design and Economics*, 2nd Edition, Process Publishing, 2004, ISBN: 9780970876811.

5.	Reference Book(s) and Other Required Material

i) Douglas, J. M., *Conceptual Design of Chemical Processes*, McGraw-Hill, 1988, ISBN: 9780070177628.

ii) Towler, G., and Sinnott, R., *Chemical Engineering Design*, 2nd Edition, Elsevier, 2013, ISBN: 9780080966595.

iii) Aspen Plus / Aspen HYSYS / DWSIM User Manuals.

6.	Evaluation Details:

- Continuous Assessment (Assignments / Quizzes / Mid-Sem): **40%**
- End-Semester Examination: **60%**

Practical Evaluation:

- Continuous Evaluation: **50%**
- End-Semester Practical Examination: **50%**

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

- Introduction to process simulation software (Aspen Plus / Aspen HYSYS / DWSIM)
- Simulation of material and energy balance problems
- Simulation of chemical reactors (CSTR and PFR)
- Simulation of heat exchangers
- Simulation of separation processes (distillation / absorption)
- Sensitivity analysis and parametric studies
- Mini project on computer-aided design of a chemical process

Course Code & Course Title:	CML 429 – Nanotechnology		
Course Type: DE	**BS/ES/HU/IC/DC/IE/DE/HM/OC**		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

The objective of this course is to introduce the fundamental concepts of nanotechnology and nanomaterials, their unique physical and chemical properties arising due to nanoscale dimensions, methods of synthesis and characterization, and applications of nanotechnology in chemical engineering and related areas. The course also aims to provide awareness about environmental, health, and safety aspects of nanomaterials.

2.	**Course Outcomes**
CO1	Understand basic concepts, length scales, and classification of nanomaterials
CO2	Explain various synthesis techniques used for nanomaterials
CO3	Describe characterization techniques for nanomaterials
CO4	Understand applications of nanotechnology in chemical engineering and allied fields
CO5	Understand environmental, health, safety, and regulatory issues related to nanotechnology

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in Weeks**
Introduction to nanotechnology, nanoregime, historical development, size-dependent properties		CO1	2
Classification of nanomaterials and nanostructures (0D, 1D, 2D, 3D)		CO1	1
Synthesis of nanomaterials: top-down and bottom-up approaches, physical and chemical methods		CO2	3
Biological and green synthesis of nanoparticles		CO2	1
Characterization techniques: SEM, TEM, AFM, XRD, FTIR, UV–Vis spectroscopy		CO3	3
Applications of nanotechnology in catalysis, energy, environment, and chemical processes		CO4	3

4.	**Text books**

i) Bhushan, B., *Springer Handbook of Nanotechnology*, 4th Edition, Springer, 2017, ISBN: 9783642050559.

ii) Poole, C. P., and Owens, F. J., *Introduction to Nanotechnology*, 1st Edition, Wiley, 2003, ISBN: 9780471079359.

5.	Reference Book(s) and Other Required Material

i) Cao, G., and Wang, Y., *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, 2nd Edition, World Scientific, 2011, ISBN: 9789814322508.

ii) Ratner, M., and Ratner, D., *Nanotechnology: A Gentle Introduction to the Next Big Idea*, Pearson Education, 2003, ISBN: 9780131014008.

iii) Recent review articles from peer-reviewed journals on nanoscience and nanotechnology.

6.	Evaluation Details:

Class Tests and Assignments: **20%**
Mid-Semester Examination (1.5 Hours): **30%**
End-Semester Examination (3 Hours): **50%**

7.	Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8.	List of Indicative Laboratory Experiment (if applicable):

Not applicable (Theory course)

Course Code & Course Title:	**CML234 Industrial Waste Treatment**		
Course Type:	**DE**		
Name of the programme(s):	BTech Chemical Engineering		
L – T – P	**3-0-0**	**No. of Credits**	**03 credits**
Pre-requisites: Course Code(s) & Name(s)	**Nil**		
Course Equivalence: Course Code(s) & Name(s)	**Nil**		

1.	**Course Objective:**
	Our objective is to discuss engineering aspects of industrial Pollution Control Technologies so that student shall be able to apply different control strategies to protect the ecosystem.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Student will gain the knowledge of different pollutants and their effects on public health and on ecosystem.
CO2	Students will learn the different methods of sampling and measurement of air, water and solid pollutants.
CO3	Students will gain the knowledge of conventional methods as well as new methods to control the pollution.
CO4	Students will able to identify air, water, and solid waste management practices and technologies adapted by different industries.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
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.		CO1, CO2	2
Methods for Treating industrial waste gases or air discharges- physical method, chemical method, combined method, biological method.		CO2, CO3	3
Solid and Hazardous wastes: definitions, concepts. Incineration, recycling, composting, landfill, On-Site Monitoring and Analysis of Industrial Pollutants.		CO3, CO4	3
Waste water treatment-physical, chemical and biological method. Recent trends in Industrial waste treatment. Application of Biotechnology for Industrial Waste Treatment.		CO2, CO3, CO4	3-4

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.).	CO3, CO4	3

4. Text books

i) C. S. Rao, Environmental Pollution Control Engineering, 3rd Edition, New Age International, 2018, ISBN: 9789386649898.

ii) S. P. Mahajan, Pollution Control in Process Industries, 1st Edition, McGraw Hill, 2017, ISBN : 9780074517727.

5. Reference Book(s) and Other Required Material

i) F. Woodard, Industrial Waste Treatment Handbook, 1st Edition, Butterworth-Heinemann, 2001, ISBN: 9780750673174

ii) H. M. Freeman, Industrial Pollution Prevention Handbook, 1st Edition, McGraw Hill Education, 2017, ISBN: 9789339218089

iii) N. L. Nemerow, Industrial Waste Treatment: Contemporary Practice and Vision for the Future, 1st Edition, Butterworth-Heinemann, 2006, ISBN: 9780123724939

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Mid Semester Exam : 30

Teacher Defined Assessment : 20

End Semester Exam : 50

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2		2	3	2			1		3	2		
CO2	3	3		3	3	2				1			3	3		3
CO3	3	3	3	2	3	2	2			1			3	3	3	2
CO4	2	3	3	2	3	3	3	2	2		2	1	2	3	3	2
Avg.	3	3	3	2	3	2	3	2	2	1	2	1	3	3	3	2

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Not Applicable.

Course Code & Course Title:	**CML 392 Corrosion Engineering**		
Course Type:	**DC**		
Name of the programme(s):			
L – T – P	**3-0-0**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:** At the end of the course, the student will understand the reaction kinetics, types and thermodynamics of corrosion, its preventive methods and may able to devise novel equipment's from MOC point of view to prevent corrosion**.**

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Provide students with a basic understanding of corrosion phenomena, its types, reaction kinetics and thermodynamics.
CO2	Enhance their knowledge on industrially important corrosion types and forms, factors responsible for corrosion, its preventive methods and minimizing losses due to corrosion.
CO3	Mathematical analysis of corrosion engineering problems and development of problem solving ability.
CO4	Improve student's ability in handling on site industrial corrosion problems and devise novel equipment' from MOC point of view.

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Thermodynamics and Kinetics of Electrochemical Corrosion: Theory of corrosion; reaction mechanisms and reaction kinetics; thermodynamic aspects of corrosion; Nernst equation. Basic wet corrosion cell; electrode potential; potential-ph diagram; Butler-Volmer equation; polarization; mixed potential theory; passivity; immunity.	CO1, CO3	1.5 (6 Hours)
	Types of Corrosion – Recognition and Mechanisms and Theory: Uniform corrosion; galvanic corrosion; pitting; dealloying; crevice corrosion; intergranular corrosion; stress corrosion cracking (SCC); stray current corrosion; graphite corrosion; high temperature corrosion; flow-assisted corrosion; cavitation's corrosion; fretting corrosion cracking process.	CO2	2.0 (8 Hours)
	Corrosion Measurements: Methods of measurements of corrosion based on study of various ASTM standards for corrosion–electrochemical	CO2	1.5 (6 Hours)

and non-electrochemical methods-Weight, electrical, thickness, ultrasonic etc.		
Microbially Influenced Corrosion (MIC): Definitions, environment and microbiology; Electrochemical aspects and general mechanisms; Bacterial transport, attachment [16]and affected materials; Role of aerobic and anaerobic microorganisms; Mechanisms and models for SRB corrosion; MIC and biofilms; MIC-case studies and mechanisms.	CO3, CO4	1.5 (6 Hours)
Corrosion Protection and Surface Engineering: Principles of different methods of corrosion protection and surface treatment, chemical and electrochemical surface treatments of metals, protective coatings like plating, pvd, cvd, thermal spray, hot dip, applications of inhibitors, and electrochemical methods for corrosion protection.	CO4	1.5 (6 Hours)
Thermodynamics and Kinetics of Electrochemical Corrosion: Theory of corrosion; reaction mechanisms and reaction kinetics; thermodynamic aspects of corrosion; Nernst equation. Basic wet corrosion cell; electrode potential; potential-ph diagram; Butler-Volmer equation; polarization; mixed potential theory; passivity; immunity.	CO1, CO3	1.5 (6 Hours)

4. Text books

i) Rajagopalan, K.S., Corrosion and its Prevention, 1st Edition, Chemical Engineering Education Development Centre, I.I.T. Madras, 1975.

5. Reference Book(s) and Other Required Material

i) Butlar, G. and Ison, H.C.K., Corrosion and its Prevention in Waters, Leonard Hill - London, 1966.

ii) Uhlig, H.H., Corrosion and Corrosion Control, John Wiley and Sons, 1971.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

Assessment Component	**Weightage**
Class Tests and Assignments	20%
Mid-Semester Exam (1.5 Hours)	20%
End-Semester Exam (3 Hours)	60%
Total	**100%**

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	2		2											
CO2	3	2	3	2	2		2					1		1	
CO3	2	2	1	1	2		2			1		2	1		
CO4	3	3	2	2	2	2	2	3				1			1

8.	List of Indicative Laboratory Experiment (if applicable): None

Course Code & Course Title:	CML386 & Biotechnology & Biochemical Engineering		
Course Type:	**DE**		
Name of the programme(s):	B.Tech. Chemical Engineering		
L – T – P	3-0-0	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1.	**Course Objective:**

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 bio-separations. 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.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Student will get well acquainted with intervention of chemical engineering principles to biological process
CO2	Student will able to understand the concepts of enzyme technology, immobilization technology, cell growth kinetics.
CO3	Student will get knowledge of bioreactors, fermentation, sterilization techniques, and media preparation.
CO4	Student will get well acquainted with biological process specific reactor design aspects.
CO5	Student will get knowledge of downstream processing in fermentation industries. .

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
Types of microorganisms, structure and function of microbial cells, batch and continuous culture, microbial growth kinetics- kinetics of microbial growth, Sterilization techniques, media and air sterilization, death rate of microorganisms		CO1, CO2, CO3	3
enzymes from cells, their function and immobilized kinetics, Enzyme technology and kinetics, enzyme catalysis, Reactions catalyzed by enzymes, enzyme applications in industries and medicines, metabolism and bioenergetics, photosynthesis, synthesis and regulation of bimolecular fundamentals of microgenetics, role of DNA and RNA		CO2	3
types of reactors such as CFSTR, Plug flow, Introduction to fermentor, design, design of fermentors with modified organisms, Introduction to Bioreactor design		CO3, CO4	3

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	CO3, CO4	2
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	CO4, CO5	2

4. Text books

i) Shuler, M. L. & Kargi, F., Bioprocess Engineering: Basic Concepts, 2nd ed., PHI Learning, 2015, ISBN 9789332549371.

5. Reference Book(s) and Other Required Material

i. Bailey, J. E. & Ollis, D. F., Biochemical Engineering Fundamentals, 2nd ed., McGraw-Hill, 1986, ISBN 9780070032125.
ii. Inamdar, Syed Tanveer Ahmed, Biochemical Engineering: Principles & Concepts, 3rd ed., PHI Learning, 2012, ISBN 9788120345850.
iii. Rao, D. G., Introduction to Biochemical Engineering, 2nd ed., McGraw-Hill, 2008, ISBN 9780070151383.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Nil

Course Code and Name:	CML425: Membrane Technology		
Course Type:	DE		
Name of the programme(s):	B.Tech. (Chemical Engineering)		
L – T – P	3-0-0	No. of Credits	3
Pre-requisites: Course Code(s) & Name(s)	Mass Transfer		
Course Equivalence: Course Code(s)& Name(s)	NIL		

1.	**Course Objective:** **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)** Identifying, formulating, and solving engineering problems involving various membrane separation processes **3)** To designand analysis of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation etc. **4)** To introduce application of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration etc.

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	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
CO2	Identifying, formulating, and solving engineering problems involving various membrane separation processes
CO3	To designand analysis of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration, dialysis and electrodialysis, pervaporation etc.
CO4	To introduce application of various membrane separation processes such as microfiltration, reverse osmosis, ultrafiltration, nanofiltration etc.

3.	**Detailed Description of the Course**		
Topics		**CO(s) Addressed**	**Duration in weeks**
CO1: Principles, characteristic, and classification of membrane separation processes; Membrane materials, structures, and preparation techniques; Membrane modules; Plant configurations		**CO1**	2-3 Weeks
CO2: Membrane characterization: Pore size and pore distribution; Bubble point test; Challenge test; Factors affecting retentivity,		**CO2**	2-3 Weeks

concentration polarization, gel polarization, fouling, cleaning and regeneration of membranes		
CO3: 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	**CO3**	2-3 Weeks
CO4: 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	**CO4**	2-3 Weeks

4. Text books

i) Geankoplis, Transport Processes And Separation Process principles, Prentice-Hall of India Private Ltd , New Delhi.

ii) Nath K., Membrane Separation Process, Prentice-Hall of India Private Ltd , New Delhi 2008

5. Reference Book(s) and Other Required Material

i) Richardson J.F., Harker J.H., Chemical Engineering, Vol. II, Butterworth Heinemann, New Delhi.2006.

6. Evaluation Details:

- Class Tests and Assignments: 15%
- Mid-Semester Exam (1.5 Hours): 25%
- End-Semester Exam (3 Hours): 60%

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

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

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable): NA

Course Code & Course Title:	CML 393 & Innovative Design		
Course Type:	**DE**		
Name of the programme(s):	B.Tech. Chemical Engineering		
L – T – P	2-0-2	**No. of Credits**	3
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1. Course Objective:

1.To contribute to the understanding of human creativity

2.To orient students outward, toward the rest of society and to create a broader outlook to face the challenges of the real world effectively

3.To augment engineering education by adding the design component in thinking and doing

4.To impart product and system building knowledge and skills

5.To tackle real life problem by cross-functional and multi-disciplinary team approach

2.	Course Outcomes (Min. 3 & Max. 5):
CO1	1.will be able to identify and define a problem
CO2	2.Learn to frame the design challenge properly
CO3	3.Ideate and iterate solutions
CO4	4.Develop skills and attitudes such as experimentation, design thinking, teamwork, communication, societal context and business context
CO5	5.Learn to participate more fully in society

3. Detailed Description of the Course		
Topics	**CO(s) Addressed**	**Duration in weeks**
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 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.,)What, Why, How, for whom and Novelty (comparison with existing solutions)	**CO 1** **CO 2**	

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	**CO 3**	
Design thinking: Design thinking including socio-ecological design/empathetic design, traditional wisdom based/ ancient wisdom based	**CO 4**	
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	**CO 5**	

4. Text books

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i) Santiago Ramón Caja, Advice to Young Investigator, The MIT Press, Edition 1st

ii) Sir Peter Medawar, .Advice to Young Scientist, Alfred P. Sloan Foundation Series, Edition 1st

iii) Ulrich, Karl T. and Steven D. Eppinger, Product Design and Development, 5th edition , Irwin/McGraw-Hill, 2012

5. Reference Book(s) and Other Required Material

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1.	H	H		H		H	M		H						
CO2.		M		H		H	M		H						
CO3.		M	H	H		H									
CO4.				H	M	H	H	H	H						
CO5.				H		H	H								

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):

Course Code & Course Title:	CML 537 & Sustainable Engineering		
Course Type:	**DE**		
Name of the programme(s):	Dr. Shyam Kodape		
L – T – P	**3-0-0**	**No. of Credits**	**3**
Pre-requisites: Course Code(s) & Name(s)	**None**		
Course Equivalence: Course Code(s) & Name(s)	**None**		

1. Course Objective:

1) introduce students to engineering design and manufacturing process including societal and environmental factors

2)To develop a fundamental understanding of the environmental impact of engineering decision/ design/system/ process/ product/ technology and method to assess

3)To develop a fundamental understanding of the societal impact of engineering decision/ design/system/ process/ product/ technology and method to assess

2.	**Course Outcomes (Min. 3 & Max. 5):**
CO1	Students will become aware of sustainability concept and issues related to it
CO2	Students will be able to measure sustainability index of a process
CO3	Sustainable design thinking will be developed
CO4	Students will be able to carry elementary LCA of a process

3.	**Detailed Description of the Course**		
	Topics	**CO(s) Addressed**	**Duration in weeks**
	Introduction and definition: What is Sustainability Engineering?, various definitions of sustainability, Protocols regarding sustainable development, Basel convention, Cartagena protocol, Kyoto protocol, Stockholm convention, Measures of Sustainability	**CO1**	
	Tools for measuring Sustainibility Optimization: Classical Optimization Techniques, Case Studies for Optimization, Process Intensification: Methods of Process Intensification, Multi Criteria Analysis (MCA): Criteria for Selecting MCA Techniques, Multi Criteria Decision Analysis	**CO2**	
	Life Cycle Analysis:	**CO3**	

Why to Conduct a Life Cycle Assessment, definition and scope, Principles of life cycle analysis, Examples of LCA		
Application Examples and case studies Green chemistry/engineering, Energy: few case studies, Biorefineries	**CO4**	

4. Text books

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Mary Ann Curran, Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products, Wiley, 2012, 1st Edition.

ii) Leslie Jacquemin, Pierre Yves Pontalier, Caroline Sablayrolles *Life cycle assessment (LCA) applied to the process industry: a review* https://hal.archives-ouvertes.fr/hal-00741389

iii) Alessio Ishizaka, Philippe Nemery, *"Multi Criteria Decision Analysis: methods and Software"*, Wiley-Blackwell, 2009

5. Reference Book(s) and Other Required Material

Note: *Kindly arrange the textbooks/references in* ***alphabetical order.***

i) Bhaskar D Kulkarni and Sachin A Mandavgane, Introduction to Sustainable Engineering: A course module for undergraduates, a course book for internal circulation among students.

6. Evaluation Details: [Refer Table No. 5 of Academic Ordinances, Rules and Regulations]

7. Relationship of Course Outcomes to Program Outcomes:

Mapping with POs (Departmental Reference)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1							H		H						
CO2	H	M			H		H								
CO3	H	M		M	M	M	H								
CO4	H	H		H	M	H	H	H							
CO5															

High - 3; Medium – 2; Low – 1;

8. List of Indicative Laboratory Experiment (if applicable):