Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
(Deemed to be University)
Maduravoyal, Chennai - 600 095. Tamilnadu. India.
(An ISO 9001 : 2015 Certified Institution)

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FACULTY OF ENGINEERING AND TECHNOLOGY

OUTCOME BASED EDUCATION

Curriculum and Syllabus

M. TECH. CHEMICAL ENGINEERING
REGULATION – 2022 (Full Time)
(For students admitted from the Academic Year 2022-23)

DEPARTMENT VISION

Generating knowledge and developing technology through quality research in frontier areas of chemical and interdisciplinary field.

DEPARTMENT MISSION

- To provide high quality education experience that will prepare graduated to assure leadership position within chemical and associated industries.
- To attain global recognition in research and train students for meeting the challenging needs of chemical industries and the society.
- Fostering industry academic relationship for mutual benefits and growth.

QUALITY POLICY

We wish to foster a chemical engineering program coupled with research strength to acquire innovation and next generation techniques.

PROGRAM EDUCATIONAL OBJECTIVES

PEOs reflect the career and professional accomplishments of graduates. The PEOs of the M. Tech Chemical Engineering course follows:

PEO 1: Graduates pursue profession in chemical & allied Engineering

PEO 2: Graduates work in diversified team

PEO 3: Graduates will pursue higher education & research

Program Outcomes

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, andanengineeringspecializationtothesolutionofcomplexengineeringproblems
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the publichealthandsafety,andthecultural,societal,andenvironmentalconsiderations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques resources and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage independent and life-long learning in the broadest context of technological change.

LIST OF PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO-1: Graduates will apply knowledge in physics, chemistry and biology in the field of transfer processes for effective separation and purification of petrochemicals, pharmaceuticals and health care products.

PSO-2: Graduates will automate and control processes by applying mathematics, process control, instrumentation, simulation and processmodeling.**PSO-3:** Graduates will design equipment for modern science applications.

PEO WITH MISSION STATEMENT

	M1	M2	M3
PEO1	3	2	3
PEO2	3	3	3
PEO3	2	3	3

PEO-PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	3	3	2	3	3	2	3	2	2	-
PEO2	3	3	2	1	1	1	2	-	-	1	1	2
PEO3	3	3	3	3	1	1	3	2	3	2	3	3

PEO-PSO

	PSO1	PSO2	PSO3
PEO1	2	3	1
PEO2	3	2	1
PEO3	3	1	3

M.Tech – Chemical Engineering (Full Time)

Curriculum and Syllabus
2022 Regulation

I SEMESTER								
S.NO	**Sub Code**	**Title of Subject**	**Ty/Lb/ETL/IE**	**L**	**T/SLr**	**P/R**	**C**	**Category**
1.	EMMA22009	Statistical And Numerical Methods For Chemical Engineers	TY	3	1/0	0/0	4	BS
2.	EMCT22001	Advanced Separation Processes	TY	3	1/0	0/0	4	PC
3.	EMCT22EXX	Programme Elective I	TY	3	0/0	0/0	3	PE
4.	EMCT22EXX	Programme Elective II	TY	3	0/0	0/0	3	PE
5.	EMCC22001	Research Methodology and IPR	TY	3	0/0	0/0	3	ID
6.	EMCC22IXX	Audit course – I	IE	2	0/0	0/0	0	ID
7.	EMCT22L01	Advanced separation processes Lab	LB	0	0/0	0/4	2	PC
8.	EMCT22L02	Process Modeling and Simulation Lab	LB	0	0/0	0/4	2	PC
		TOTAL		**17**	**2**	**8**	**21**	

II SEMESTER								
S.NO	**Sub.Code**	**Title of Subject**	**Ty/Lb/ETL/IE**	**L**	**T**	**P**	**C**	**Category**
1.	EMCT22002	Advanced Transport phenomena	TY	3	1/0	0/0	4	PC
2.	EMCT22003	Advanced Reaction Engineering	TY	3	0/0	0/0	3	PC
3.	EMCT22EXX	Programme Elective III	TY	3	0/0	0/0	3	PE
4.	EMCT22EXX	Programme Elective IV	TY	3	0/0	0/0	3	PE
5.	EMCC22IXX	Audit Course-II	IE	2	0/0	0/0	0	ID
6.	EMCT22L03	Advanced Chemical Reaction Engineering Lab	LB	0	0/0	0/4	2	PC
7.	EMCT22L04	Advanced Chemical Engineering Lab	LB	0	0/0	0/4	2	PC
8.	EMCT22I01	Term paper	IE	0	0/0	0/4	2	PC
		TOTAL		**14**	**1**	**12**	**19**	

	III SEMESTER							
S.NO	**Sub.Code**	**Title of Subject**	**Ty/Lb/ETL/IE**	**L**	**T**	**P**	**C**	**Category**
1.	EMCT22004	Transport in porous Media	TY	3	0/0	0/0	3	PC
2.	EMCT22EXX	Programme Elective V	TY	3	0/0	0/0	3	PC
3.	EMOL22I01	Open Elective (NPTEL/SWAYAM/any MOOC, approved by AICTE/UGC)	IE	3	0/0	0/0	3	ID
4.	EMCT22I02	Summer Internship	IE	0	0/0	0/4	2	PC
5.	EMCT22L05	Dissertation Phase – I	LB	0	0/0	0/10	5	P
		Total		**09**	**0**	**14**	**16**	

IV SEMESTER								
S.NO	**Sub.Code**	**Title of Subject**	**Ty/Lb/ETL/IE**	**L**	**T**	**P**	**C**	**Category**
1.	EMCT22L06	Dissertation Phase – II	LB	0	0/0	10/10	10	P
2.	EMCT22I03	Research Publication	IE	0	0/0	2/2	02	PC
		Total		**0**	**0**	**24**	**12**	

CREDIT DISTRIBUTION

SEMESTER	**CREDITS**
I	21
II	19
III	16
IV	12
TOTAL	**68**

	PROGRAMME ELECTIVES (THEORY)					
S.NO	**Sub. Code**	**Title of Subjects**	**L**	**T**	**P**	**C**
		PROGRAMME ELECTIVE -I				
1	EMCT22E01	Chemical Reactor Analysis I	3	0/0	0/0	3
2	EMCT22E02	Process Design and Synthesis	3	0/0	0/0	3
3	EMCT22E03	Fluidization Engineering	3	0/0	0/0	3
		PROGRAMME ELECTIVE -II				
4	EMCT22E04	Industrial Pollution Control	3	0/0	0/0	3
5	EMCT22E05	Application of Nanotechnology in Chemical Engineering	3	0/0	0/0	3
6	EMCT22E06	Chemo informatics	3	0/0	0/0	3
		PROGRAMME ELECTIVE -III				
7	EMCT22E07	Modern concepts in Catalysis and Surface Phenomenon	3	0/0	0/0	3
8	EMCT22E08	Advanced Downstream Processes	3	0/0	0/0	3
9	EMCT22E09	Computational Fluid Dynamics	3	0/0	0/0	3
10	EMCT22E10	Bioprocess Engineering	3	0/0	0/0	3
		PROGRAMME ELECTIVE -IV				
11	EMCT22E11	Micro and Nano fluidics	3	0/0	0/0	3
12	EMCT22E12	Process Integration	3	0/0	0/0	3
13	EMCT22E13	Micro Flow Chemistry and Process Technology	3	0/0	0/0	3
		PROGRAMME ELECTIVE -V				
14	EMCT22E14	Design of Experiments and Parameter Estimation	3	0/0	0/0	3
15	EMCT22E15	Computer Aided Design	3	0/0	0/0	3
16	EMCT22E16	Cleaner Production	3	0/0	0/0	3

AUDIT COURSES						
S.No	**Sub. Code**	**Title of Subjects**	**L**	**T**	**P**	**C**
		AUDIT COURSE-I &II				
1.	EMCC22I01	English for Research paper writing	2	0/0	0/0	0
2.	EMCC22I02	Disaster Management	2	0/0	0/0	0
3.	EMCC22I03	Sanskrit For technical Knowledge	2	0/0	0/0	0
4.	EMCC22I04	Value Education	2	0/0	0/0	0
5.	EMCC22I05	Constitution of India	2	0/0	0/0	0
6.	EMCC22I06	Pedagogy studies	2	0/0	0/0	0
7.	EMCC22I07	Stress management by Yoga	2	0/0	0/0	0
8.	EMCC22I08	Personality Development through Life Enlightenment Skills.	2	0/0	0/0	0
9.	EMCC22I09	Research and Publication Ethics	2	0/0	0/0	0

Table 1:Credit Distribution Format(sample)

Components of Curriculum and Credit distribution for E&T Programmes

Course Component	Description	No. of Courses	Credits	Total	Credit Weight age (%)	Contact hours
Basic Science	Theory	1	4	4	5.8	60
	Lab					
	ETL					
Engineering Science	Theory					
	Lab					
	ETL					
Humanities and Social Science	Theory					
	Lab					
	ETL					
Program Core	Theory	4	14	22	32.4	330
	Lab	4	8			
	ETL					
Program Electives		5	15	15	22.1	225
Open Elective	Theory	1	3	3	4.4	45
Inter-disciplinary	Theory	6	7	7	10.3	80
	Lab					
	ETL					
Skill Component						
Internship/Project		4	17	17	25	30
Others if any						
	TOTAL	**7**	**68**	**68**	**100**	**770**

Table 2:

Revision/modification done in syllabus content:

S.No	Course(Subject) Code	Course (Subject) Name	Concept/ topic if any, removed in current curriculum	Concept/topic added in the new curriculum	% of Revision/ Modification done
1.	EMMA22009	Statistical And Numerical Methods For Chemical Engineers	Equation in process modeling / Problems using approximation theory	1&2 dimensional random variables/system in linear, non – linear equation	95%
2.	EMCT22004	Transport in porous Media	-	New program core subject added in the curriculum (III Semester)	100%
3.	EMCT22I01	Term paper	-	New paper added	100%

Table3:

List of New courses/ value added courses//life skills/Electives/interdisciplinary /courses focusing on employability/entrepreneurship/skill development.

S. No	New courses(Subjects)	Value added courses	Life skill	Electives	Inter Disciplinary	Focus on employability/entrepreneurship/skill development.
1	EMOL22I01/ Open Elective (NPTEL/SWAYAM/any MOOC, approved by AICTE/UGC)	-	-	Open Elective	-	Employability
2	EMCT22I02/ Summer Internship	Summer Internship	-	-	✓	Skill development
3	EMCT22I03/ Research Publication	-	✓	-	✓	Research

SEMESTER-I

Subject Code **EMMA22009**	Subject Name: **STATISTICAL AND NUMERICAL METHODS FOR CHEMICAL ENGINEERS**	**Ty/ Lb/ ETL**	**L**	**T/ S.Lr**	**P/R**	**C**
	Prerequisite: UG level statistics an d Numerical methods	TY	3	1/0	0/0	4

L : Lecture T : Tutorial S.Lr : Supervised Learning P : Project R : Research C: Credits
Ty/Lb/ETL : Theory/Lab/Embedded Theory and Lab

OBJECTIVES :

The student should be made to:

- To introduce the basic concepts of one dimensional and two dimensional Random Variables.
- Having problem solving ability-solving social issues and engineering problems.
- Having critical thinking and innovative skills

COURSE OUTCOMES (COs) :

CO1	To be able to understand Functions of a Random variable.
CO2	To Understand the problems and solve them with correlation and regression analysis
CO3	To be able to understand Estimation theory
CO4	To Derive and use the numerical techniques needed for the solution of a given engineering problems
CO5	To Understand and correlate the analytical and numerical methods

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	3	3
CO2	3	3	3	3
CO3	2	1	2	1
CO4	2	1	2	2
CO5	3	3	3	3

3/2/1 Indicates Strength Of Correlation, 3 – High, 2- Medium, 1- Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
	√											

Subject Code **EMMA22009**	Subject Name**:** **STATISTICAL AND NUMERICAL METHODS FOR CHEMICAL ENGINEERS**	**Ty/ Lb/ ETL**	**L**	**T/ S.Lr**	**P/R**	**C**
	Prerequisite: UG level statistics an d Numerical methods	TY	3	1/0	0/0	4

UNITI ONE DIMENSIONALRANDOMVARIABLES 12Hrs
Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Exponential, and normal distributions – Functions of a Random variable.

UNITII TWO DIMENSIONALRANDOMVARIABLES 12Hrs
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Correlation – Regression.

UNITIII ESTIMATIONTHEORY 12Hrs
Unbiased estimators – Method of moments –Maximum likelihood estimation – Curve fitting by Principle of least squares.

UNIT IV SYSTEM OFLINEAREQUATIONS 12Hrs
Gauss Elimination method – Gauss-Jordan method – Iterative methods – Gauss-Jacobi method – Gauss-Seidel method – Matrix Inversion by Gauss-Jordan method- Eigen value problem-Power method.

UNIT V NONLINEAREQUATIONS 12Hrs
Solution of Algebraic and Transcendental equations – Method of false position -Fixed point iteration method (single and multi variables)- Newton-Raphson method (single and multi variables).

Total no. of hrs: 60Hrs

REFERENCE BOOKS:

- Richard Johnson A., *Miller & Freund's Probability and statistics for Engineers (8th ed)*, Prentice Hall of India, (2209).
- Richard Johnson A., Wichern .D.W, *Applied Multivariate Statistical Analysis (6th ed)*, Prentice Hall of India, (2207).
- Gupta S.C., Kapoor V.K., *Fundamentals of Mathematical Statistics*, S.Chand & Co.,(2207).
- Veerarajan T., *Numerical Methods*, Tata McGraw Hill Publishing Co.,(2207).
- Sastry S.S., *Introductory Methods of Numerical Analysis*, Prentice Hall of India,(2212).
- Kandasamy P., Thilagavathy, Gunavathy K., *Numerical Methods (Vol.IV)*, S.Chand & Co.,(2208).

Subject Code: EMCT22001	Subject Name : Advanced Separation Processes	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Mass Transfer	Ty	3	1/0	0/0	4

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies.

COURSE OUTCOMES (COs) : (3- 5)

CO1	List situations where liquid–liquid extraction might be preferred to distillation, make a preliminary selection of a solvent using group-interaction rule, Size simple extraction equipment
CO2	Ability to analyze and design pervaporation, chromatography and dialysis based separation processes
CO3	Differentiate between chemisorptions and physical adsorption, List steps involved in adsorption of absolute, Which steps may control the rate of adsorption, explain the concept of breakthrough in fixed-bed adsorption
CO4	Explain how crystals grow, Explain the importance of super saturation in crystallization. Describe effects of mixing on super saturation, mass transfer, growth, and scale-up of crystallization.
CO5	Explain membrane processes in terms of the membrane, feed, sweep, retentate, permeate, and solute membrane interactions. Distinguish among microfiltration, ultra filtration, nanofiltration, virus filtration, sterile filtration, filter-aid filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-
CO2	2	3	-	1
CO3	3	1	-	1
CO4	2	2	-	1
CO5	2	3	1	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√								

Subject Code: EMCT22001	Subject Name : Advanced Separation Processes	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Mass Transfer	Ty	3	1/0	0/0	4

UNITI INTRODUCTION 12Hrs

Conventional separation processes - Absorption, Adsorption, Conventional separation processes - Distillation, Drying, Conventional separation processes - Extraction, Diffusion, Conventional separation processes - Leaching, Crystalisation, Advances in separation techniques based on size, Advances in separation techniques based on surface properties, Advances in separation techniques based on ionic properties, Cross flow filtration, Electro filtration, Dual functional filter, Surface based solid-liquid separations involving a second liquid, Sirofloc filter

UNITII BUBBLE ANDFOAMFRACTIONATION 12Hrs

Nature of bubbles and foams, stability of foams, foam fractionation techniques, batch, continuous, single stageand multistage columns. Types and choice of membranes, Plate and frame, spiral wound membranes, Tubular and hollow fibre membrane reactors, Membrane Permeates: Dialysis, Reverse osmosis, Nanofiltration, ultra filtration, microfiltration, Donnan dialysis, Ceramic membranes

UNITIII MEMBRANESEPARATION 12Hrs

Characteristics of organic and inorganic membranes, basis of membrane selection, osmotic pressure, partition coefficient and permeability, concentration polarization, electrolyte diffusion and facilitated transport, macro-filtration, ultra-filtration, reverse osmosis, electro-dialysis. Industrial applications.

UNITIV SPECIALPROCESSES 12Hrs

Liquid membrane separation, super-criticalextraction, adsorptive separation-pressure, vacuum and thermal swing,pervaporation and permeation, nano-separation.

UNITV CHROMATOGRAPHIC METHODSOFSEPARATION 12Hrs

Gel, solvent, ion and high performance liquid chromatography.

Total no. of hrs: 60Hrs

REFERENCES

- King C.J., “Separation Processes”, Tata McGraw Hill.1982.
- Nakagawal, O. V., “Membrane Science and Technology”, Marcel Dekker,1992.
- Humphrey, J and G. Keller, Separation Process Technology, McGraw-Hill, 1997 Khoury F.M., “Multistage Separation Processes”, 3rd Ed., CRC Press.2204.
- Wankat P.C., “Separation Process Engineering”, 2nd Ed., Prentice Hall.2206. Seader J.D. and Henley E.J., “Separation Process Principles”, 2ndEd.,Wiley.2206
- Basmadjian D., “Mass Transfer and Separation Processes: Principlesand Applications”, 2nd Ed., CRC Press.2207.
- Phillip C. Wankat , Separation Process Engineering (2nd Edition),PrinticeHall,2207
- Rousseau, R. W., “Handbook of Separation Process Technology”, John Wiley, New York,2209.

Subject Code: EMCC22001	Subject Name : Research Methodology and IPR	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Basic Science	Ty	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Design and formulation of research problem.
- Analyze research related information and statistical methods in research.
- Carry out research problem individually in a perfect scientific method
- Understand the filing patent applications processes, Patent search, and various tools of IPR, Copyright, and Trademarks.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Design and Formulation of research problem.
CO2	Analyze research related information and statistical methods in research.
CO3	Carry out research problem individually in a perfect scientific method
CO4	Understand Patent Filing application Process.
CO5	Patent Search and various tools used.

Mapping of Course Outcomes with Program Outcomes (POs)

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

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project	Other		
										√		

Subject Code:	Subject Name : Research Methodology and IPR	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCC22001	Prerequisite: Basic Science	Ty	3	0/0	0/0	3

Course objective:

- Learn the meaning of interpretation, techniques of interpretation, precautions is to be taken in interpretation for research process,
- Application of statistical methods in research.
- Learn intellectual property rights and its constituents.

Unit 1

Introduction to research, Definitions and characteristics of research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Quantitative vs. Qualitative Approach, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs. Theoretical Research, Importance of reasoning in research.

Unit 2

Problem Formulation, Understanding Modeling & Simulation, Literature Review, Referencing, Information Sources, Information Retrieval, Indexing and abstracting services, Citation indexes, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Interpretation of Results.

Unit 3

Statistics: Probability & Sampling distribution, Estimation, Measures of central Tendency, Arithmetic mean, Median, Mode, Standard deviation, Co efficient of variation (Discrete serious and continuous serious), Hypothesis testing & application, Correlation & regression analysis, Orthogonal array, ANOVA, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One way and two way classified data, ‘F’ test.

Unit 4

Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents.

Unit 5

Intellectual property rights (IPR) patents copyrights Trademarks Industrial design geographical indication. Ethics of Research Scientific Misconduct Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science.

Text Book:

1. K. S. Bordens, and B. B.Abbott, , “Research Design and Methods – A Process Approach”, 8th Edition, McGraw Hill, 2011.
2. C. R. Kothari, “Research Methodology – Methods and Techniques”, 2nd Edition, New AgeInternational Publishers

Subject Code:	**Subject Name : Advanced separation processes Lab**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22L01	**Prerequisite: Technical Analysis**	**LB**	**0**	**0/0**	**0/4**	**2**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies

COURSE OUTCOMES (COs) : (3- 5)

CO1	Knowledge of mass transfer operations and mechanical operations
CO2	Students should be able to know the synthesis of materials and applications in separation processes.
CO3	Students will be able to provide applicable solutions to separation processes
CO4	Students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
CO5	Students introduce them to new trends used in the separation technologies

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**2**	**-**	**1**
CO2	**2**	**1**	**2**	**-**
CO3	**3**	**-**	**-**	**-**
CO4	**2**	**-**	**-**	**-**
CO5	**3**	**-**	**-**	**-**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EMCT22L01	Subject Name : Advanced separation processes Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Technical Analysis	LB	0	0/0	0/4	2

LIST OF EXPERIMENTS:

1. Separation of fluoride and arsenic using cellulose acetate asymmetric membrane separation process
2. Adsorption of dyes from waste water using nano adsorbents.
3. Supercritical extraction of the fragrance.
4. Study the effect of pressure on permeate flux and solution rejection in ROsystem.
5. Mass transfer studies and study the effect of parameters in separation system using liquid emulsion membrane.
6. Laboratory experiments on ion exchange membranes: effect of process parameters on fluxetc.
7. Study the reaction with mass transfer: e.g. Synthesis of calcium carbonate.
8. Study the reactive distillation system considering batch and continuous mode

Subject Code: EMCT22L02	Subject Name : Process Modeling and Simulation Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Computer Application Lab	**LB**	**0**	**0/0**	**0/4**	**2**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To learn Process Modeling and Simulation of Chemical operations and processes.
- To understand Dynamic Behavior of processes.
- To understand Close loop control of processes.
- To learn Dynamic simulation of chemical processes

COURSE OUTCOMES (COs) : (3- 5)

CO1	Carry out thermodynamic property estimations using property estimation and property analysis inAspen.
CO2	Simulate Mixer, splitter, heat exchangers, reactors, distillation columns.
CO3	Apply sensitivity, design specification and case study tools in Aspen.
CO4	Solve linear and non-linear programming problems
CO5	Understand the important physical phenomena from the problem statement

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2
CO2	2	3	1	2
CO3	3	1	2	2
CO4	3	2	-	-
CO5	1	2	1	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code:	Subject Name : Process Modeling and Simulation Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22L02	Prerequisite: Computer Application Lab	LB	0	0/0	0/4	2

LIST OF EXPERIMENTS:

Simulation laboratory practical

1. ThermodynamicpropertyestimationsusingpropertyestimationandpropertyanalysisinAspen.
2. Simulate Mixer, splitter, heat exchangers, and reactive distillationcolumn.
3. Apply sensitivity, design specification and case study tools inAspen
4. Solve linear and non-linear programmingproblems.
5. Controller tuning by Ziegler- Nichol's & Cohen- Coonmethods
6. Stability analysis using Bode diagrams for controlsystems.
7. Simulation of Ideal Binary DistillationColumn
8. Simulation of Heat/Mass Transfer coefficient in 3 phase fluidized bed column
9. Simulation studies of various unit operations usingCHEMCAD.
10. Modeling and Simulation of cycloneseparator

Note: Simulation can be done using C/C++ / MATLAB/ ASPEN PLUS/ CHEMCAD

SEMESTER-II

Subject Code: EMCT22002	Subject Name : Advanced Transport Phenomena	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Transport Phenomena	**TY**	**3**	**1/0**	**0/0**	**4**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To familiarize the student with basic concepts of transport phenomena and brief review of mathematics.
- To enable students to understand the equations of change for isothermal flow and for non- iso thermal flow.
- To introduce them details of equations of change for multi component systems.
- To give them insight into properties of two-dimensional flows and aspects of dimensional analysis

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the mechanism of momentum, heat and mass transport for steady and unsteady flow
CO2	Perform momentum, energy and mass balances for a given system at macroscopic and microscopic scale.
CO3	Solve the governing equations to obtain velocity, temperature and concentration profiles
CO4	Model the momentum, heat and mass transport under turbulent conditions.
CO5	Develop analogies among momentum, energy and mass transport

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-
CO2	2	-	2	-
CO3	2	1	-	-
CO4	3	-	2	-
CO5	3	-	1	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
				√					

Subject Code: EMCT22002	Subject Name : Advanced Transport Phenomena	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Transport Phenomena	TY	3	1/0	0/0	4

UNITI EQUATIONS OF CHANGE FORISOTHERMALSYSTEMS 12Hrs

Equation of Continuity, Equation of Motion, Equation of Mechanical Energy, Equations of Change in terms of the Substantial Derivative, Use of the Equations to solve Flow Problems, Dimensional Analysis of the Equations of Change. Velocity Distributions with more than one Independent Variable: Time Dependent Flow of Newtonian Fluids. Velocity Distributions in Turbulent Flow -Comparisons of Laminar and Turbulent Flows, Time Smoothed Equations of Change for Incompressible Fluids, Time Smoothed Velocity Profile near a wall, Empirical Expressions for the Turbulent Momentum Flux, Turbulent Flow in Ducts, Turbulent Flow in Jets.

UNITII MACROSCOPIC BALANCES FORISOTHERMALSYSTEMS 12Hrs

The Macroscopic Mass Balance, The Macroscopic Momentum Balance, The Macroscopic Mechanical Energy Balance, Estimation of the Viscous loss, Use of the Macroscopic Balances for Steady-State Problems, Derivation of the Macroscopic Mechanical Energy Balance. Equations of Change for Non-Isothermal Systems: The Energy Equation, Special forms of the Energy Equation, The Boussine sq Equation of Motion for Forced and Free Convection, Use of the Equations of change to Solve Steady-State Problems, Dimensional Analysis of the Equations of Change for Non-Isothermal Systems.

UNITIII TEMPERATURE DISTRIBUTIONS IN SOLIDS AND INLAMINARFLOW 12Hrs

Heat Conduction with an Electrical Heat Source, Heat Conduction with a Viscous Heat Source. Temperature Distributions with more than One Independent Variable - Unsteady Heat Conduction in Solids, Steady Heat Conduction in Laminar, Incompressible Flow. Temperature Distributions in Turbulent Flow - Time-Smoothed Equations of Change for Incompressible Non-Isothermal Flow, Time-Smoothed Temperature Profile near a Wall, Empirical Expressions for the Turbulent Heat Flux Temperature Distribution for Turbulent Flow in Tubes.

UNITIV MACROSCOPIC BALANCES FORNON-ISOTHERMALSYSTEMS 12Hrs

Macroscopic Energy Balance, Macroscopic Mechanical Energy Balance, Use Of The Macroscopic Balances To Solve Steady State Problems With Flat Velocity Profiles, Concentration Distributions in Solids and in Laminar Flow: Shell Mass Balances Boundary Conditions, Diffusion through a Stagnant Gas Film, Diffusion with a Heterogeneous Chemical Reaction. Concentration Distributions with more than One Independent Variable: Time-Dependent Diffusion, Steady-State Transport in Binary Boundary Layers, Concentration Distributions in Turbulent Flow - Concentration Fluctuations and the Time-Smoothed Concentration, Time-Smoothing of the Equation of Continuity of A, Semi-Empirical Expressions for the Turbulent Mass Flux, Enhancement of Mass Transfer by a First-Order Reaction in Turbulent Flow.

UNIT V INTERPHASE TRANSPORT INMULTI-COMPONENTSYSTEMS 12Hrs

Definition of Transfer Coefficients in One Phase, Analytical Expressions for Mass Transfer Coefficients, Correlation of Binary Transfer Coefficients in One Phase, Definition of Transfer Coefficients in Two Phases, Mass Transfer and Chemical Reactions. Macroscopic Balances For Multi-Component Systems: Macroscopic Mass Balances, Macroscopic Momentum, Use of the Macroscopic Balances to solve Steady-State Problems.

Total no. of hrs: 60Hrs

REFERENCES

- *Thomson W. J., Transport Phenomena, Pearson education, Asia,2201.*
- *Geankopolis C. J., Transport Processes and Unit Operations, 4th Ed., Prentice Hall (India) Pvt. Ltd., New Delhi.2204.*
- *Bird R. B., Stewart W. E. and Light Foot E. N., Transport Phenomena, Revised 2nd Edition, John Wiley & Sons, 2207.*

Subject Code: EMCT22003	Subject Name : Advanced Reaction Engineering	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engg	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- This Subject is essential for Design of Reactor especially heterogeneous reactors.
- Students will get insight of importance of population balance of particles.
- Role of Reaction Engineering in mitigation of Global warming will also addressed.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Evaluate heterogeneous reactor performance considering mass transfer limitations
CO2	Perform the energy balance and obtain concentration profiles in multiphase reactors
CO3	Estimate the performance of multiphase reactors under non-isothermal conditions.
CO4	Understand modern reactor technologies for mitigation of global warming
CO5	Students will learn the energy balance, temperature and concentration profiles in different reactors, advance design aspects of multiple reactors

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-
CO2	2	1	-	1
CO3	2	-	2	1
CO4	2	3	3	-
CO5	2	1	1	3

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
Category				√					

Subject Code: EMCT22003	Subject Name : Advanced Reaction Engineering	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engg	TY	3	0/0	0/0	3

UNITI NON-ELEMENTARYKINETICSIMPORTANCE 9Hrs

Approximations for formulations of Rate laws, Formulations of Kinetic model. Effect of flow on conversions in Reactors: Semi batch Reactors : Importance and examples of applications , Material Balance on Semi batch Reactor, Multiple reaction in Semibatch Reactors, Conversion Vs Rate in Reactors, Use of POLYMATHS to solve the equations and understanding the profiles.Non-Isothermal reaction modeling in CSTR & Semi-Batch reactor: Energy Balance equations for CSTR, PFR and Batch reactors, Adiabatic operations Temperature conversion profiles in PFR, CSTR, Steady state tubular reactor with heatexchange.

UNITII NEED FOR MULTI-STAGING CSTR WITHMULTIPLESTAGES 9Hrs

Exothermic and Endothermic Reaction with examples, CSTR with heat effects, Multiple reactions in CSTR and PFR with heat effects, Semi batch Reactors with heat exchange. Design of PFR and Packed Bed Tubular Reactors: Radial and Axial mixing in Tubular reactors, unsteady state in non-isothermal energy balance, STR, Energy balance in Batch Reactors, Volume of reactors calculations for non-isothermal reactors. Optimal Design of Reactors for Reversible exothermic reactions: Unsteady state non-isothermal reactor design, adiabatic operation in batch, Heat effects in semi batch unsteady state operation. Auto thermal Plug flow reactors and packed tubular reactors.PFR with inter stage cooling. Shift of Energy and material balance lines for reversible reactions in CSTR, Examples of optimal design of PFR and Semi batch and CSTR Exothermic Reactions.

UNITIII CATALYTIC REACTIONS THEORYANDMODELING 9Hrs

Global rate of reaction, Types of Heterogeneous reactions Catalysis, Different steps in catalytic reactions, Theories of heterogeneous catalysis . Steady State approximation, formulations of rate law Rate laws derived from the PSSH, Rate controlling steps, Eiley-Rideal model, Reforming catalyst example :Finding mechanism consistent with experimental observations Evaluation of rate law parameters, packed beds : Transport and Reactions, Gradients in the reactors : temperature. Porous media reactors: Mass transfer coefficients, Flow effects on spheres tube and cylinders, External Mass Transfer pore diffusion, structure and concentration gradients Internal Effectiveness Factor Catalytic wall reactor: limiting steps reactions and mass transfer limiting Porous catalyst on tube wall reactors Design of packed bed porous catalytic reactors: Mass transfer limited reactions in Packedbed.

UNITIV FLUIDIZED BEDREACTORMODELING 9Hrs

Geld art Classification of powders, fixed bed Vs fluidized bed why fluidized bed, important parameters pressure drop in fixed bed, Class I model Arbitrary Two Region Flow Models, Class II Chemical Reactor: Plug Flow or Mixed Flow Model. Class III Modeling the Bubbling Fluidized Bed Reactor, BFB, The Kunii-Levenspiel bubbling bed model, Gas Flow Around and Within a Rising Gas Bubble in a Fine particle BFB, Reactor performance ofBFB.

UNITV APPLICATION OF POPULATION BALANCE EQUATIONS FOR EACTORMODELING 9Hrs

Particle size distribution, Distribution Functions in Particle Measuring Techniques, Particle distribution model in colloidal particle synthesis in batch reactor, Moments of Distribution, Nucleation rate based on volumetric holdup versus crystal growth rate. Reaction engineering and mitigation of Global warming: CO2 absorption in high pressure water, different techniques of mitigation of CO2, methods of separations. Recent advancements, automotive monolith catalytic converter example, removal and utilization of CO2 for thermal power plants.

Total no. of hrs: 45Hrs

REFERENCES

- K.G. Denbigh : Chemical Reactor Theory, Cambridge University Press, Second Edition,1971.
- J.M. Smith : Chemical Engineering Kinetics, Mcgraw Hill, Third Edition, 1981. Levenspiel O., Chemical Reaction Engineering, Wiley,1998.

Subject Code: EMCT22L03	Subject Name : Advanced Chemical Reaction Engineering lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Chemical Reaction Engg Lab	Lb	0	0/0	0/4	2

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To provide through understanding of ReactionEngineering.
- To design reactor and identity type of reactor by suiting chemical kinetics and using information from thermodynamics, heat and mass transfereconomics.
- Characteristics of a fluidized bedreactor
- Understanding of corrosion reaction and monolithic catalyticreactors.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students will able to know the solid-liquid, liquid –liquid reactions.
CO2	Students will be able to know the micro reactor based process intensification.
CO3	Students will be able to know the monolithic catalytic reactors applications.
CO4	Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
CO5	Understand the experimental techniques related to chemical reaction engineering

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-
CO2	3	1	2	1
CO3	2	1	2	1
CO4	3	2	1	-
CO5	1	2	1	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code:	Subject Name : Advanced Chemical Reaction Engineering lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22L03	Prerequisite: Chemical Reaction Engg Lab	Lb	0	0/0	0/4	2

LIST OF LABORATORY EXPERIMENTS:

1. Analyze the characteristics of a fluidized bed reactor
2. Kinetics of a (solid-liquid) Esterification reaction in a batch reactor
3. Evaluate the performance of a process intensified Batch Reactive Distillation in catalytic reactions
4. Evaluate the performance of a process intensified micro reactor in catalytic reactions
5. Interfacial (Liquid-Liquid)Nitration
6. Gas-solid catalytic reactor analysis: Understanding of gas-solid catalytic reactor theory and dynamics analysis.
7. Gas-liquid-solid three-phase catalytic reactor analysis: Understanding gas-liquid-solid three-phase catalytic reactor theory and dynamics analysis.
8. Reactor analysis: Understanding the principle and diffusion analysis of batch and flow reactors.
9. Corrosion reaction characteristics of a metal in a given electrolyte.
10. Reactions on Monolithic Catalytic Reactors

Subject Code: EMCT22L04	Subject Name : Advanced Chemical Engineering Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite: Mass and Heat Transfer Lab	Lb	0	0/0	0/4	2

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Analyze characteristics of a fluidized bed dryer
- Estimate efficiency of compact heat exchangers
- Evaluate the performance of a process intensification in catalytic reactions, ultrasound assisted reactions, reactive distillation column, micro reactor and advanced flow reactor
- Design controller for a given process

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students will able to know the solid-liquid, liquid –liquid reactions.
CO2	Students will be able to know the micro reactor based process intensification.
CO3	Students will be able to know the monolithic catalytic reactors applications.
CO4	Ability to understand, explain and select instrumental techniques for analysis
CO5	Ability to plan experiments and operate several specific instruments

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-
CO2	3	1	2	1
CO3	2	1	2	1
CO4	1	2	3	2
CO5	2	1	2	1

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EMCT22L04	Subject Name : Advanced Chemical Engineering Lab	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	
	Prerequisite: Mass and Heat Transfer Lab	Lb	0	0/0	0/4	

DETAILED SYLLABUS

1. Characteristics of a Fluidized beddryer
2. Helical Coil heatexchanger
3. Determination of Effective thermal conductivity (ETC) in granularmaterial
4. Plate Type HeatExchanger
5. Kinetics for solid catalyzed esterification reaction in a batchreactor
6. Reactive distillation in PackedColumn
7. Ultrasonic cavitation basedreactions
8. Micro-reactor
9. Advanced FlowReactor
10. Membrane Separation for waterpurification
11. Corrosion characteristics of a metal in a givenelectrolyte
12. Control of liquid level in non-interactingsystems.
13. Identification and control of a three tanksystem.
14. pH control in aprocess.

Subject Code: EMCT22I01	Subject Name : Term Paper	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	IE	0	0/0	0/4	2

A term paper is an elaborate research-based work on a particular topic in the domain of study. The student must choose a topic of his interest from the domain of study for a term paper. The term paper can be an original research article or review article. In case of review article, the student must refer atleast 50 research/review articles and critically review other researcher's work. The term paper may be 10 -20 pages in length. The general guidelines for writing the term paper as follows:

1. Abstract
2. Introduction to explain about the broad and general statement on the topic chosen.
3. Aim /Objective of the term paper.
4. Description of methodology, concepts and arguments.
5. Identify the research gap and suggest possible future works.
6. Conclusion

Three reviews will be conducted to monitor the progress of the work. At the end of the semester, presentation must be made by the student and Viva-Voce examination will be conducted by the internal Examiner duly appointed by the Head of the department and the students will be evaluated.

SEMESTER-III

Subject Code:	**Subject Name : Transport in Porous Media**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22004	**Prerequisite: Engineering Chemistry**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Introduce the physics and governing mechanisms controlling flow and transport processes in porous media.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students will understand the mechanisms involved in transport processes in porous media and will be able to work with the equations that govern the fate and transport of gas, water and solutes in porous media
CO2	Grasp general principles governing the coupling among reactions, flow, and transport processes
CO3	Appreciate the importance of different processes under different conditions
CO4	Develop computational skills to simulate coupled flow, transport, and reactions using a reactive transport modeling code.
CO5	Ability to acquire and use new engineering techniques, skills, and tools for research and development in mechanical engineering, and to develop new methods and discover new knowledge

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**2**	**1**	**1**
CO2	**2**	**1**	**-**	**1**
CO3	**2**	**2**	**1**	**-**
CO4	**2**	**1**	**-**	**1**
CO5	**2**	**1**	**2**	**-**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : Transport in Porous Media	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22004	Prerequisite: Engineering Chemistry	TY	3	0/0	0/0	3

UNITI FUNDAMENTALS **9Hrs**
Mass, momentum and energy transport, Darcy and Non-Darcy equations, equilibrium and non-equilibrium conditions, species transport, radioactive decay.

UNITII EFFECTIVEMEDIUMAPPROXIMATION **9Hrs**
Equivalent thermal conductivity, viscosity, dispersion.

UNITIII EXACTSOLUTIONS **9Hrs**
Flow over a flat plate, flow past a cylinder, boundary-layers, reservoir problems.

UNITIV SPECIALTOPICS **9Hrs**
Field scale and stochastic modeling, Turbulent flow, compressible flow, multiphase flow, numerical techniques, hierarchical porous media, nanoscale porous media, multiscale modeling.

UNITV ENGINEERINGAPPLICATIONS **9Hrs**
Groundwater, waste disposal, oil and gas recovery, regenerators, energy storage systems.
Experimental techniques: Flow visualization, quantitative methods, inverse parameter estimation.

Total no. of hrs: 45Hrs

REFERENCES:

❖ Principles of Heat Transfer in Porous Media, by M. Kaviany, Springer New York(1995).
❖ Transport Phenomena in Porous Media, Volumes I-III, edited by D. R. Ingham and I. Pop, Elsevier, New York(1998-2205).
❖ Dynamics of Fluids in Porous Media, J. Bear, Dover(1988).
❖ Introduction to Modeling of Transport Phenomena inPorous Media, J. Bear and Y. Bachmat, Kluwer Academic Publishers, London(1990).
❖ Enhanced Oil Recovery, L.W. Lake, Gulf Publishing Co. Texas(1989).
❖ The Mathematics of Reservoir Simulation, R.E. Ewing, SIAM Philadelphia(1983).
❖ Stochastic Methods for Flow in Porous Media: Coping with Uncertainties, Zhang, D., Academic Press, California(2202).
❖ The Method of Volume Averaging, S. Whitaker, Springer, New York(1999).

Subject Code: **EMOL22I01**	**Subject Name : Open Elective (NPTEL/SWAYAM/any MOOC, approved by AICTE/UGC)**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
	Prerequisite:	**IE**	**3**	**0/0**	**0/0**	**3**

Students should register for the online course with a minimum course duration of 8 weeks through the online portals such as NPTEL/SWAYAM/Any MOOC in the beginning of the semester. The course can be core/interdisciplinary in such a way that the same course is not repeated during the course of his study.
Students are expected to attend the online classes regularly and submit the weeklyassignments before the due dates. Students should appear for the online examination andsubmit the certificate at the end of the semester.Internal examination will be conducted bythe examiners duly appointed by the head of the department.

Subject Code:	**Subject Name : Dissertation Phase– I**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22L05	**Prerequisite:**	**Lb**	**0**	**0/0**	**0/10**	**5**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
- Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify theirdesign.
- Presenting the work in International/ National conference or reputed journals.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Apply the knowledge and skills acquired in the course of study addressing a specific problem or issue.
CO2	To encourage students to think critically and creatively about societal issues and develop user friendly and reachable solutions.
CO3	To refine research skills and demonstrate their proficiency in communication skills
CO4	To take on the challenges of teamwork, prepare a presentation and demonstrate the innate talents.
CO5	lity to present the findings of their technical solution in a written report.

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**2**
CO3	**3**	**2**	**1**	**3**
CO4	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**2**	**2**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code: EMCT22L05	Subject Name : Dissertation Phase– I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	Lb	0	0/0	0/10	5

Students are expected to do the Project in a group of 3 to 4 students. Theyshould identify the area/topic of the Project and should collect the literatures related to the project. Students intending to do Industrial projects will approach the industries with the support of the university, identify the industrial problem and finalize the project. In case of Industrial projects apart from Industry guide, a guide has to be appointed by the department. At the end of the Semester the students should submit their Project Phase - I report to the Department and Viva -Voce examination will be conducted by the examiners duly appointed by the Head of the department.

Subject Code: EMCT22I02	Subject Name : Summer Internship	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	IE	0	0/0	4/0	2

The student will be sent to do their projects in the chemical and interdisciplinary filed to relevant industry/ companies to peruse there internship.

SEMESTER-IV

Subject Code:	Subject Name : Dissertation Phase – II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22L06	**Prerequisite:**	**Lb**	**0**	**0/0**	**10/10**	**10**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
- Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
- Ability to present the findings of their technical solution in a written report.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Apply the knowledge and skills acquired in the course of study addressing a specific problem or issue.
CO2	To encourage students to think critically and creatively about societal issues and develop user friendly and reachable solutions.
CO3	To refine research skills and demonstrate their proficiency in communication skills
CO4	To take on the challenges of teamwork, prepare a presentation and demonstrate the innate talents.
CO5	Presenting the work in International/ National conference or reputed journals.

Mapping of Course Outcomes with Program Outcomes (POs)

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

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
				√					√			

Subject Code:	Subject Name : Dissertation Phase – II	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22L06	Prerequisite:	LB	0	0/0	10/10	10

To make the students to make use of the knowledge and skill developed during their four years of study and to apply them for making an innovative product/process for the development of society and industries.

Students are expected to do a Project work either in an Industry or at the University in the field of relevant Engineering /inter-disciplinary /multi-disciplinary area in a group of 3 or 4 students. The work to be carried out in Phase II should be continuation of Phase I. Each group will be allotted a guide based on the area of Project work. In case of industrial Project external guide has to be allotted from Industry. Inter disciplinary/multi-disciplinary project can be done with students of different disciplines as a group. Monthly reviews will be conducted during the semester to monitor the progress of the project by the project review committee. Students have to submit the Project thesis at the end of the semester and appear for the Project Viva-Voce examination conducted by the examiners duly appointed by the Controller of Examination. In case of industrial project certificate in proof has to be included in the report along with the bonofide certificate.

Subject Code:	Subject Name : Research Publication	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22I03	Prerequisite:	IE	0	0/0	2/2	2

Students are supposed to prepare and publish the article based on either his term paper or area of research in peer reviewed referred journal. Code of research publication ethics should be followed. After publishing the article students should present a seminar in presence of department faculties and PG students. At the end of semester viva examination will be conducted by the examiners appointed by the Head of the department.

PROGRAMME ELECTIVE-I

Subject Code:	Subject Name : Chemical Reactor Analysis I	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E01	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To learn the heterogeneous catalyzed reactions and the models involved in reactor design

COURSE OUTCOMES (COs) : (3- 5)

CO1	Evaluate heterogeneous reactor performance considering mass transfer limitations
CO2	Perform the energy balance and obtain concentration profiles in multiphase reactors.
CO3	Estimate the performance of multiphase reactors under non-isothermal conditions
CO4	The importance of both external and internal transport effects in gas
CO5	Student study mass and heat transfer mechanisms in the different reactors

Mapping of Course Outcomes with Program Outcomes (POs)

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

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	**Subject Name : Chemical Reactor Analysis I**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E01	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

UNITI CHEMICAL FACTOR AFFECTING THE CHOICE OFTHEREACTOR 9Hrs

Fundamental mass, energy and momentum balance, Model for a semi-batch reactor, optimum operation policies and control strategies, optimal batch operation time, optimal temperature policies, stability of operation and transient behavior for mixed flow reactor. Transient CSTR analysis, Hot spot equation; Optimization using Lagrange multiplier, Poyntrgins maximum principle.

UNITII FIXED BEDCATALYTICREACTOR 9Hrs

The importance and scale of fixed bed catalytic processes, factors in preliminary design, modeling of fixed bed reactor. Pseudo-homogeneous model, the multi- bed adiabatic reactor, auto-thermal operation, non-steady-state model with axial mixing, two dimensional pseudo-homogeneous models, heterogeneous models, global and intrinsic rates, Mechanism of catalytic reactions, Engineering properties of catalysts - BET surface area, pore volume, pore size, pore size distribution, one dimensional and two dimensional modelequation.

UNITIII MULTIPHASEFLOWREACTOR 9Hrs

Types of multiphase flow reactors, packed columns, plate columns, empty columns, stirred vessel reactors.Development of rate equations for solid catalyzed fluid phase reactions; Estimation of kinetic parameters. External mass and heat transfer in catalyst particles. Stability and selectivity, Packed bed reactor, slurry reactor; Trickle bed reactor and fluidized bed reactor. Intra-particle heat and mass transfer - Wheelers parallel pore model, random pore model of Wakao and Smith. deactivation of catalyst, Ideal and non-ideal flow in reactors.

UNITIV DESIGN MODEL FOR MULTIPHASEFLOWREACTORS 9Hrs

Gas and liquid phase in completely mixed and plug flow, gas phase in plug flow and liquid phase in completely mixed flow, effective diffusion model, two zone model, specific design aspects, packed absorber, two-phase fixed bed reactor, plate column, spray tower, bubble reactor, stirred vessel reactor.Computer - aided reactordesign.

UNITV TEMPERATURE EFFECTSINREACTOR 9Hrs

Introduction, well mixed system with steady feed, the stability and start-up of CSTR, limit cycles and oscillatory reactions, the plug flow reactors, tubular reactor, diffusion control, prorogation of reaction zone.

Total no. of hrs: 45Hrs

REFERENCE:

❖ *Froment G. F. and K.B.Bischoff, " Chemical Reactor Analysis and Design", John Wiley &Sons*
❖ *Denbigh K. G. and J.C. Turner, " Chemical Reactor and Theory – an Introduction", 3rd edition Cambridge UniversityPress.*
❖ *Bruce Nauman, " Chemical Reactor Design", John Wiley &Sons*
❖ *Elements of Chemical Reaction Engineering by H. Scott Fogler*
❖ *Chemical Engineering Kinetics by J. M.Smith.*

Subject Code:	Subject Name : Process Design and Synthesis	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E02	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand the systematic approaches for the development of conceptual chemical process designs
- To learn the advances in problem formulation and software capabilities which offer the promise of a new generation of practical process synthesis techniques based directly on structural optimization.
- Product design and development procedure and Process life cycle assessment

COURSE OUTCOMES (COs) : (3- 5)

CO1	Analyze alternative processes and equipment
CO2	Synthesize a chemical process flow sheet that would approximate the real process
CO3	Design best process flow sheet for a given product
CO4	Perform economic analysis related to process design and evaluate project profitability
CO5	Student learning chemical process synthesis, analysis, and optimization principles

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PMSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	-	1	-
CO2	2	1	1	-
CO3	3	-	2	-
CO4	3	-	1	-
CO5	2	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
					✓				

Subject Code:	Subject Name : Process Design and Synthesis	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E02	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Introduction to fundamental concepts and principles of process synthesis and design and use of flow sheet simulators to assist process design. Process Flow sheet Models: An Introduction to Design, Chemical process synthesis, analysis and optimization. Introduction to commercial process design software such as HYSYS, Aspen plus etc., Chemical Process (reactor, heat exchanger, distillation etc) analysis using commercialsoftware

UNITII PRODUCTDESIGNANDDEVELOPMENTS 9Hrs

Process engineering economics and project evaluation Life Cycle Assessments of process: From design to product development, Engineering Economic Analysis of Chemical Processes, Project costing and performance analysis, Environmental concerns, Green engineering, Engineering ethics, Health and safety.

UNITIII REACTORNETWORKS 9Hrs

Geometry of mixing and basic reactor types, The Attainable Region (AR) approach, AR in higher dimensions & for other processes, Reactive Separation processes, Fundamental behavior and problems, Separation through reactions. Reactive Residue Curve Maps

UNITIV SYNTHESIS OFSEPARATIONTRAINS 9Hrs

Criteria for selection of separation methods, select ion of equipment**:** Absorption, Liquid-liquid extraction Membrane separation, adsorption, leaching, drying, crystallization, Ideal distillation - Column and sequence fundamentals, Sharp splits & sequencing Phase diagrams for 2, 3 and 4 components, Feasibility and vapor ow rates for single columns, Residue curve basics, Non-ideal Distillation **-** Azeotropic systems; detecting binary azeotropes, Residue curve maps for azeotropic systems, Topological analysis, Feasibility for single azeotropic columns ,Binary VLLE and pressure- swing separation, Non-ideal distillation synthesis. Equipment sequencing: VLE + VLLE, Detailed Residue Curve Maps, Residue curve maps: Interiorstructure

UNITV HEAT EXCHANGERNETWORKSYNTHESIS 9Hrs

Minimum heating and cooling requirements, Minimum Energy Heat Exchanger Network, Loops and Paths, Reducing Number of Exchangers, HENS basics & graphics, The pinch point approach, Stream Splitting, Performance targets, trade-off & utilities, Heat & power integration, HENS as mathematical programming

Total no. of hrs: 45Hrs

REFERENCES:

- *Douglas, J. "Conceptual Design of Chemical Processes",New York, NY: McGraw-Hill Science/Engineering/Math, 1988. ISBN:0070177627.*
- *Seider, W. D., J. D. Seader, and D. R. Lewin. "Product and Process Design Principles: Synthesis, Analysis, and Evaluation",. 2nd ed. New York, NY: Wiley, 2204. ISBN:0471216631.*
- *Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz., "Analysis, Synthesis, and Design of Chemical Processes", 2nd Edition, 2202, Prentice Hall ISBN-10: 0-13-064792-6*
- *Biegler L.T., Grossmann I.E. and Westerberg A.W., "Systematic Methods of Chemical Process Design", Prentice Hall,1997.*

Subject Code:	**Subject Name : Fluidization Engineering**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E03	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To study the phenomenon of fluidization with industrial processingobjective
- To study the various regimes of fluidization and theirmapping.
- To study the design of equipments based on fluidizationtechnique

COURSE OUTCOMES (COs) : (3- 5)

CO1	Performing and understanding the behavior fluidization in fluidizedbed
CO2	Evaluate the characterization of particles and power consumption in fluidizationregimes
CO3	Understanding the applicability of the fluidized beds in chemicalindustries
CO4	Ability to estimate pressure drop, bubble size, TDH, voidage, heat and mass transfer rates for the fluidized beds
CO5	Ability to write model equations for fluidized beds

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**2**	**1**	**1**
CO2	**2**	**1**	**3**	**2**
CO3	**3**	**2**	**2**	**1**
CO4	**3**	**2**	**1**	**3**
CO5	**3**	**2**	**2**	**2**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EMCT22E03	Subject Name : Fluidization Engineering	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION TO FLUIDIZATIONANDAPPLICATIONS 9Hrs

Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Beds for Industrial applications, coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons.

UNITII MAPPING OFFLUIDIZATIONREGIMES 9Hrs

characterization of particles, mechanics of flow around single particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distributor, power consumption.

UNITIII BUBBLINGFLUIDIZEDBEDS 9Hrs

Davidson model for bubble in a fluidized bed, and its implications, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model.

UNITIV SOLIDS MOVEMENT ANDGASDISPERSION 9Hrs

Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds, Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models.

UNITV FLUIDIZEDBEDREACTORS 9Hrs

Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds.Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts,Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size.

Total no. of hrs: 45Hrs

REFERENCES:

- Levenspiel O. and Kunnii D., “Fluidization Engineering”, John Wiley, 1972
- Liang-Shih Fan, “Gas-Liquid-Solid Fluidization Engineering”, Butterworths,1989

PROGRAMME ELECTIVE-II

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Subject Code: EMCT22E04	Subject Name : Industrial Pollution Control	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand the importance of industrial pollution and its abatement
- To study the underlying principles of industrial pollution control
- To acquaint the students with cases studies

COURSE OUTCOMES (COs) : (3- 5)

CO1	Recognize the causes and effects of environmental pollution
CO2	Analyze the mechanism of proliferation of pollution
CO3	Develop methods for pollution abatement and waste minimization
CO4	Student should be able to design complete treatment system
CO5	Design treatment methods for gas, liquid and solid wastes

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	**2**	**1**	**-**	**-**
CO2	**3**	**2**	**-**	**-**
CO3	**2**	**1**	**2**	**-**
CO4	**1**	**2**	**3**	**-**
CO5	**2**	**-**	**-**	**-**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
					√				

Subject Code:	Subject Name : Industrial Pollution Control	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E04	Prerequisite:	TY	3	0/0	0/0	3

UNITI INDUSTRIES&ENVIRONMENT 9Hrs

Industrial scenario in India - Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests.

UNITII INDUSTRIALNOISEPOLLUTION 9Hrs

Sources of noise pollution, characterization of noise pollution prevention& control of noise pollution, Factories Act 1948 for regulatory aspects of noise pollution.

UNITIII AIRPOLLUTANTABATEMENT 9Hrs

Air pollutants scales of concentration, lapse rate and stability, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models.Air pollution control methods, Source correction methods, Design concepts for pollution abatement systems for particulates and gases. Such as gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes.

UNITIV WASTE WATERTREATMENTPROCESSES 9Hrs

Design concepts for primary treatment, grid chambers and primary sedimentation basins, selection of treatment process flow diagram, elements of conceptual process design, design of thickner, biological treatment Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process. Design, trickling filter design considerations, advanced treatment processes, Study of environment pollution from process industries and their abatement: Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents.

UNITV SOLID WASTE AND HAZARDOUSWASTEMANAGEMENT 9Hrs

Sources and classification, properties, public helth aspects, Sanitary land fill design, Hazardous waste classification and rules, management strategies, Nuclear waste disposal Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods, Latest Trends in solid waste management.

Total no. of hrs: 45Hrs

REFERENCES:

- Rao C.S., “Environmental Pollution Control Engineering”, 2ndedition
- Mahajan S.P., “Pollution Control in ProcessIndustries”.
- Nemerow N.L., “Liquid waste of industry- theories, Practices and Treatment”, Addison Wesley, New York, 1971
- Weber W.J., “Physico-Chemical Processes for water quality control”, Wiley Interscience New York,1969
- Strauss W., “Industrial Gas Cleaning”, Pergamon, London,1975
- Stern A.C., “Air pollution”, Volumes I to VI, academic Press, New York,1968
- Peterson and Gross .E Jr., “Hand Book of Noise Measurement”, 7th Edn,2203.
- Antony Milne, “Noise Pollution: Impact and Counter Measures”, David & Charles PLC,2209.

Subject Code:	**Subject Name : Application of Nanotechnology in Chemical Engineering**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E05	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understanding the different top down and bottom up approaches fornanoparticles
CO2	Get to know the different applications of nanoparticles in chemical engineering field.
CO3	Learning the characterization techniques fornanoparticles.
CO4	Students give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials
CO5	Students gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**2**	**3**	**-**	**-**
CO2	**2**	**1**	**-**	**-**
CO3	**3**	**2**	**-**	**-**
CO4	**2**	**3**	**-**	**-**
CO5	**2**	**1**	**2**	**-**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : Application of Nanotechnology in Chemical Engineering	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E05	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Introduction to nanotechnology, Feynman's Vision-There's plenty of room at the bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

UNITII APPROACHES TO SYNTHESIS OF NANOSCALE MATERIALS AND CHARACTERIZATION 9Hrs

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self- assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods. Size, shape, crystallinity, topology, chemistry analysis usingX-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

UNITIII SEMICONDUCTORS ANDQUANTUMDOTS 9Hrs

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

UNITIV POLYMER-BASED ANDPOLYMER-FILLEDNANOCOMPOSITES 9Hrs

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In- Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nano composites.

UNITV APPLICATIONS TO SAFETY, ENVIRONMENTANDOTHERS 9Hrs

Chemical and Biosensors- Classification and Main Parameters of Chemical and Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nanobiotechnology, Drug Delivery, Nanocoatings, Self cleaning Materials, Hydrophobic Nanoparticles, Photocatalysts, Biological nanomaterials, Nanoelectronics, Nanomachines & nanodevices, Societal, Health and Environmental Impacts.

Total no. of hrs: 45Hrs

REFERENCES

- Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", (CRC Press of Taylor and Francis Group LLC), May 2208, 856pp, ISBN-13:978142204805
- Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", Edited by WILEY-VCH Verlag GmbH Co. KGaA, Weinheim ISBN: 3-527-30359-6,2203.
- Kelsall Robert W., Hamley Ian W., GeogheganMark, "Nanoscale Science and Technology",John Wiley & Sons, Ltd, 2206.
- MKal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", McGraw- Hill Companies, Inc. ISBN: 978-0-07-162609-5,2210.

Subject Code:	Subject Name : Chemo Informatics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E06	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To give students a concept of Chemo-informatics related to chemical structure databases and database search methods

COURSE OUTCOMES (COs) : (3- 5)

CO1	The course will introduce the students preparing for professional work in chemistry must learn how to retrieve specific information from the enormous and rapidly expanding chemicalliterature.
CO2	The course will provide a broad overview of the computer technology to chemistry in all of itsmanifestations.
CO3	The course will expose the student to current and relevant applications in QSAR and DrugDesign.
CO4	Students understand the quantum methods and models involved in drug discovery and targeted drugdelivery
CO5	Students study the application of Chemical Libraries, Virtual Screening, Prediction of PharmacologicalProperties

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	-
CO2	1	-	2	-
CO3	2	-	1	2
CO4	1	-	2	-
CO5	2	-	1	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
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Subject Code:	**Subject Name : Chemo Informatics**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E06	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

UNITI CHEMO-INFORMATICS 9Hrs

Introduction, scope and application, Basics of Chemo-informatics, Current Chemo-informatics resources for synthetic polymers, pigments. Primary, secondary and tertiary sources of chemical information, Databases: Chemical Structure Databases (PubChem, Binding database, Drugbank), Database search methods:chemical indexing, proximity searching, 2D and 3D structure and substructure searching. Drawing the Chemical Structure: 2D & 3D drawing tools (ACD Chemsketch) Structureoptimization.

UNITII INTRODUCTION TOQUANTUMMETHODS 9Hrs

Combinatorial chemistry (library design, synthesis and deconvolution), spectroscopic methods and analytical techniques,Representation of Molecules and Chemical Reactions:Different types of Notations, SMILES Coding, Structure of Mol files and Sd files (Molecular converter, SMILES Translator).

UNITIII ANALYSIS AND USE OF CHEMICALREACTIONINFORMATION 9Hrs

Chemical property information, spectroscopic information, analytical chemistry information, chemical safety information, Drug Designing: Prediction of Properties of Compounds, QSAR Data Analysis, Structure-Activity Relationships, Electronic properties, Lead Identification, Molecular Descriptor Analysis.

UNITIV TARGETIDENTIFICATION 9Hrs

Molecular Modeling and Structure Elucidation: Homology Modelling (Modeller 9v7, PROCHECK), Visualization and validation of the Molecule (Rasmol, Pymol Discovery studio), Applications of Chemoinformatics in Drug Research - Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties.

UNITV DRUGDISCOVERY 9Hrs

Structure based drug designing, Docking Studies (Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds, Library docking), Pharmacophore - Based Drug Design, Pharmacophore Modeling (Identification of pharmacophore features, Building 2D/3D pharmacophore hypothesis), Toxicity Analysis-Pharmacological Properties (Absorption, Distribution and Toxicity), Global Properties (Oral Bioavailability and Drug-Likeness) (ADME, OSIRIS, and MOLINSPIRATION)

Total no. of hrs: 45Hrs

REFERENCES:

- Bajorath J (2204), “Chemoinformatics: Concepts, Methods and Tools for Drug Discovery” HumanaPress Leach A, Gillet V, “An Introduction to Chemoinformatics” Revised edition,Springer
- Gasteiger J. Engel T. “A textbook of Chemoinformatics” Wiley- VCH GmbH & Co.KGaA
- Bunin B. Siesel B. Guillermo M. “Chemoinformatics: Theory, Practice & Products”,Springer
- Lavine B. (2205), “Chemometrics and Chemoinformatics”, American ChemicalSociety
- Casteiger J. and Engel T (2203) “Chemoinformatics”Wiley-VCH
- Bunin Barry A. Siesel Brian, MoralesGuillermo,Bajorath Jürgen.Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer.2206.
- Leach Andrew R., Valerie J. Gillet, “An introduction to Chemoinformatics”, Publisher: Kluwer academic, 2203. ISBN:1402213477

PROGRAMME ELECTIVE-III

Subject Code: **EMCT22E07**	**Subject Name : Modern concepts in Catalysis and Surface Phenomenon**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
	Prerequisite:	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To give the students insight into advances in catalytic reactionengineering
- To understand the mechanisms involved in catalytic reactions
- To study the catalyst characterizationtechniques
- To study the advanced industrial applications incatalysis

COURSE OUTCOMES (COs) : (3- 5)

CO1	To understand the concepts of homogenous and heterogeneous catalysis, with specificexamples.
CO2	To study reaction mechanisms and kinetics of homogenous and heterogeneous catalyticreactions.
CO3	To familiarize with the characterization ofcatalysts
CO4	To understand the application and mechanisms of several types of catalysts in chemicalindustry.
CO5	To understand the principles behind catalyst deactivation and study theirmodels

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**2**	**1**	**-**
CO2	**1**	**2**	**3**	**-**
CO3	**2**	**3**	**1**	**-**
CO4	**2**	**2**	**1**	**2**
CO5	**2**	**3**	**1**	**1**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : Modern concepts in Catalysis and Surface Phenomenon	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E07	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTIONTOCATALYSIS 9Hrs

Definition of Catalytic activity, Magnitude of Turnover Frequencies and Active Site Concentrations, Evolution of Important Concepts and Techniques in Heterogeneous Catalysis, Classification of Catalysts – Homogeneous, Heterogeneous, Biocatalysts, Dual Functional Catalysts, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active Ingredients, Supportive materials, Catalysts Activation, CatalystDeactivation.

UNITII ADSORPTIONINCATALYSIS 9Hrs

Adsorption and its importance in Catalysis, Adsorption and potential energy curves, Surface Reconstruction, Adsorption Isotherms and Isobars, Dynamical Considerations, Types of Adsorption Isotherms and their Derivation from Kinetic Principles, Mobility at Surfaces, Kinetics of surface Reactions, Photochemistry on oxide and metallic surfaces, Characterization of the adsorbed molecules

UNITIII CATALYSTCHARACTERIZATION 9Hrs

Catalyst Characterization Methods – Their Working Principle and Applications – XRF, XRD, IR Spectroscopy, XPS, UPS, ESR, NMR; Infrared, Raman, NMR, Mossbauer and X-Ray Absorption spectroscopy, Surface Acidity and Toxicity, Activity, Life time, Bulk density, Thermal stability Crystal Defects, Peroviskites, Spinels, Clays, Pillared Clays, Zeolites.

UNITIV SIGNIFICANCE OF PORE STRUCTURE ANDSURFACEAREA 9Hrs

Importance of Surface Area and Pore Structure, Experimental Methods for Estimating Surface Area – Volumetric, Gravimetric, Dynamic Methods, Experimental Methods for Estimating Pore Volume and Diameter Gas Adsorption and Mercury Porosimeter Method, Models of the Pore Structure – Hysteresis Loops, Geometric Models, Wheeler’s Model, Dusty Gas Model, Random Pore Model, Diffusion in Porous Catalysts – Effective Diffusivity, Knudsen Diffusion, Effect of Intraparticle Diffusion, Non-isothermal Reactions in Pores, DiffusionControl.

UNITV INDUSTRIAL APPLICATIONS–CASESTUDIES 9Hrs

Industrial processes involving heterogeneous solid catalyst: Synthesis of Methanol, Fiscer-Tropsch Catalysis, Synthesis of Ammonia, Automobile Exhaust Catalysts and Catalyst Monolith, Photocatalytic Breakdown of Water and the Harnessing of Solar Energy.Contribution of homogeneous catalytic process in chemical industry:Oxidations of Alkenes such as production of acetaldehyde, propylene oxide etc., Polymerization such as production of polyethylene, polypropylene or polyesterproduction

Total no. of hrs: 45Hrs

REFERENCES:

- Emmett, P.H. - “Catalysis Vol. I and II, Reinhold Corp.", New York,1954
- Smith, J.M. - “Chemical Engineering Kinetics ", McGraw Hill,1971
- Thomas and Thomas - “Introduction to Heterogeneous Catalysts ", Academic Press, London1967
- Piet W.N.M. van Leeuwen, Homogeneous catalysis: Understanding the Art, Springer,2204
- Piet W.N.M. van Leeuwen, and John C. Chadwick, Homogeneous catalysis: Activity-stability–deactivation, Wiley, VCH,2211.

Subject Code:	**Subject Name : Advanced Downstream Processes**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E08	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand the unit processes involved in downstream processing.
- To study advanced treatment methods.

COURSE OUTCOMES (COs) : (3- 5)

CO1	To learn effective strategies of downstream processing in chemical industry.
CO2	To study the energy conservation in different separation processes
CO3	To understand the underlying design principles
CO4	Understand the role of downstream processing.
CO5	Analyze reactors, upstream and downstream processes in production

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	2	1	3
CO2	3	2	1	-
CO3	1	2	-	1
CO4	3	2	1	1
CO5	1	1	1	2

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : Advanced Downstream Processes	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E08	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Introduction to Downstream processes theory, applications in chemical separation for Gas-Liquid system, Gas- Solid system. Super critical fluids extraction in food, pharmaceutical, environmental and petroleum applications, water treatment, desalination, Bio separation, dialysis, industrialdialysis.

UNITII DOWNSTREAM PROCESSES INPETROCHEMICALINDUSTRY 9Hrs

Cryogenic distillation for refinery, petrochemical off gases, natural gases, gas recovery-Olefin, Helium, Nitrogen, Desulfurization - coal, fluegases

UNITIII ADVANCEDDISTILLATIONPROCESSES 9Hrs

Azeotropic & extractive distillation - residue curve maps, homogeneous azeotropic distillation, pressure swing distillation, Column sequences, heterogeneous azeotropic distillation.

UNITIV ENERGY CONSERVATION INSEPARATIONPROCESSES 9Hrs

Energy balance, molecular sieves - zeolights, adsorption, catalytic properties, manufacturing processes, hydrogel process, application, New trends.

UNITV NON-IDEAL MIXTURES ANDIONEXCHANGE 9Hrs

Separations process synthesis for nonazeotropic mixtures, non ideal liquid mixtures, separation synthesis algorithm, Ion exchange - manufacture of resins, physical & chemical properties, capacity, selectivity, application, regeneration, equipment, catalysis use.

Total no. of hrs: 45Hrs

REFERENCES:

- Perry’s “Chemical Engg. Handbook”: McGraw HillPub.
- Douglas J.M., “Conceptual Design of Chemical Processes”, McGrawHill
- Liu Y.A., “Recent Developments in Chemical Process & Plant Design”, John Wiley & SonsInc.
- Timmerhaus K.D., “Cryogenic Process Engg.”, PlenumPress
- Othmer Kirk “Encyclopedia of Separation Technology, Vol I & II”, WileyInterscience

Subject Code:	Subject Name : Computational Fluid Dynamics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E09	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation

OBJECTIVE :

- To make students understand the governing equations of fluid dynamics and their derivation from laws of conservation
- To develop a good understanding in computational skills, including discretisation, accuracy and stability.
- To acquaint the students with a process of developing a mathematical and geometrical model of flow, applying appropriate boundary conditions and solving system of equations.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the basic principles of mathematics and numerical concepts of fluid dynamics.
CO2	Develop governing equations for a given fluid flow system.
CO3	Adapt finite difference techniques for fluid flow models.
CO4	Apply finite difference method for heat transfer problems.
CO5	Solve computational fluid flow problems using finite volume techniques.

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	3
CO2	3	2	1	-
CO3	1	2	-	1
CO4	3	2	-	-
CO5	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code:	Subject Name : Computational Fluid Dynamics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E09	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION TOFLUIDDYNAMICS 9Hrs

Concepts of Fluid Flow, Pressure distribution in fluids, Reynolds transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies. Philosophy of CFD, Governing equations of fluid dynamics and there physical meaning, Mathematical behavior of governing equations and the impact on CFD simulations, Simple CFD techniques and CFL condition. Numerical Methods in CFD:Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutions

UNITII GRID GENERATION 9Hrs

Basic theory of structured grid generation, Surface grid generation, Mono block, multi block, hierarchical multi block, Moving and sliding multiblock, Grid clustering and grid enhancement. Basic theory of unstructured grid generation, advancing front, Delaunay triangulation and various point insertion methods, Unstructured quad and hex generation, grid based methods, various elements in unstructured grids, Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination

UNITIII TURBULENCE ANDITS MODELLING 9Hrs

Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model,The k-e model, Reynolds stress equation models, Algebraic stress equation models.

UNITIV CHEMICAL FLUIDMIXINGSIMULATION 9Hrs

Stirred tank modeling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examples

UNITV POST-PROCESSING OF CFDRESULTS 9Hrs

Contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.

Total no. of hrs: 45Hrs

REFERENCES

- Anderson John D., “Computational Fluid Dynamics: The Basics with Applications”, Mc Graw Hill, 1995
- Ranade V.V., “Computational Flow Modeling for Chemical Reactor Engineering”, Process Engineering Science, Volume 5,2201
- Knupp Patrick and Steinberg Stanly, “Fundamentals of Grid Generation”, CRC Press,1994
- Wilcox D.C., “Turbulence Modelling for CFD”,1993
- Wesseling Pieter, “An Introduction to Multigrid Methods”, John Wiley & Sons,1992
- Thompson J.F., Warsi Z.U.A. and Mastin C.W., “Numerical Grid Generation: Foundations and Applications”, North Holland,1985
- Patankar S.V., “Numerical Heat Transfer and Fluid Flow”,McGraw-Hill,1981

Subject Code:	**Subject Name : Bioprocess Engineering**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E10	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To learn the principles of bio processing for traditional chemical engineering in the design and development of processes involving biocatalyst.
- To study engineering principles in the development of products based on living cells or subcomponents of such cells.
- To learn and develop quantitative models and approaches related to bioprocesses
- To learn mechanistic models for enzyme catalyzed reactions for large scale production of bio-products

COURSE OUTCOMES (COs) : (3- 5)

CO1	Understand the different cells and their use in biochemical processes.
CO2	Understand the role of enzymes in kinetic analysis of biochemical reaction.
CO3	Analyze bioreactors, upstream and downstream processes in production of bio-products
CO4	Demonstrate the fermentation process and its products for the latest industrial revolution
CO5	Understand the difference between bioprocesses and chemical processes

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**1**	**2**	**1**	**3**
CO2	**3**	**2**	**1**	**-**
CO3	**1**	**2**	**-**	**1**
CO4	**2**	**1**	**2**	**1**
CO5	**2**	**1**	**2**	**1**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project
					√				

Subject Code:	Subject Name : Bioprocess Engineering	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E10	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Biotechnology and bioprocessing. An overview of biological basics. Basics of enzyme and microbial kinetics. Operating considerations for bioreactors: cultivation method, modifying batch and continuous reactors, immobilized cell systems, solid state fermentations.

UNITII ADVANCEENZYMEKINETICS 9Hrs

Models for complex enzyme kinetics, modeling of effect of pH and temperature, models for insoluble substrate, models for immobilized enzyme systems, diffusion limitations in immobilized enzyme system, electrostatic and steric effects.

UNITIII BIOREACTORS 9Hrs

Selection, scale-up, operation and control of bioreactors: Scale-up and its difficulties, bioreactor instrumentation and control, sterilization of process fluids.Modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized system, solid state fomenters.

UNITIV HOMOGENEOUS AND HETEROGENEOUS REACTIONSINBIOPROCESSES 9Hrs

Reaction thermodynamics, growth kinetics with Plasmid instability, The thiele modulus and effectiveness factor, diffusion and reaction in waste treatment lagoon. Reactors and choice of reactors.

UNITV RECOVERY AND PURIFICATIONOFPRODUCTS 9Hrs

Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products.

Total no. of hrs: 45Hrs

REFERENCES

- Bailey J.E. and Ollis D.F., “Biochemical Engineering Fundamentals”,McGraw-Hill
- Doran P.M., “Bioprocess Engineering Principles”, AcademicPress
- Shuler M.L., Kargi F., ”Bioprocess Engineering”, Prentice–Hall

PROGRAMME ELECTIVE-IV

Subject Code:	Subject Name : Micro and Nano fluidics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E11	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To introduce to the students, the various opportunities in the emerging field of micro and nanofluids.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Introduce students to the physical principles to analyze fluid flow in micro and nano-size devices. It unifies the thermal sciences with electrostatics, electro kinetics, colloid science; electrochemistry; and molecular biology.
CO2	To the make students familiar with the important concepts applicable to small micro and nano fluidic devices, their fabrication, characterization and application.
CO3	To get familiarize with the new concepts of real-time nano manipulation &assembly
CO4	Student understand major methods to fabricate micro/nanofluidic devices
CO5	Student understand major applications of micro/nanofluidics

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	-	1
CO3	2	1	-	-
CO4	2	1	-	1
CO5	2	1	-	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Inter Disciplinary	Skill Component	Practical /Project			
					√							

Subject Code: EMCT22E11	Subject Name : Micro and Nano fluidics	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Fundamentals of kinetic theory-molecular models, micro and macroscopic properties, binary collisions, distribution functions, Boltzmann equation and Maxwellian distribution functions-Wall slip effects and accommodation coefficients, flow and heat transfer analysis of microscale Couette flows, Pressure driven gas micro-flows with wall slip effects, heat transfer in micro-Poiseuille flows, effects of compressibility. Pressure Driven Liquid Microflow: apparent slip effects, physics of near-wall microscale liquid flows, capillary flows, electro-kinetically driven liquid micro - flows and electric double layer (EDL) effects, concepts of electroosmosis, electrophoresis anddielectro-phoresis.

UNITII LAMINARFLOW 9Hrs

Hagen-Poiseullie eqn, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps, Approaches toward combining living cells, microfluidics and 'the body' on a chip, Chemotaxis, cell motility. Case Studies in Microfluidic Devices. Ionic transport: Polymer transport – microtubule transport in nanotuble channels driven by Electric Fields and by Kinesin Biomolecular Motors - Electrophoresis of individual nanotubules in microfluidic channels.

UNITIII FABRICATIONTECHNIQUES 9Hrs

Nanofluidic channels – Biomolecules separation using Nanochannels - Biomolecules Concentration using Nanochannels – Confinement of Biomolecules using Nanochannels. Hydrodynamics: Particle moving in flow fields – Potential Functions in Low Renoylds Number Flow – Arrays of Obstacles and how particles Move in them: Puzzles and Paradoxes in Low Re Flow.

UNITIV MICROFLUIDICSANDLAB-ON-A-CHIP 9Hrs

Microfluidic Devices - Microchannels, Microfilters, Microvalves, Micropumps, Microneedles, Microreserviors, Micro-reaction chambers. Concepts and Advantages of Microfluidic Devices - Fluidic Transport - Stacking and Scaling – Materials for The Manufacture (Silicon, Glass, Polymers) - Fluidic Structures - Fabrication Methods - Surface Modifications - Spotting - Detection Mechanisms. Microcontact printing of ProteinsStrategies- printing types- methods and characterization- Cell nanostructure interactions- networks for neuronal cells. Applications in Automatic DNA sequencing, DNA and Protein microarrays.

UNITV BIOMEMS(MICRO-ELECTRO-MECHANICALSYSTEMS) 9Hrs

Introduction and Overview, Biosignal Transduction Mechanisms: Electromagnetic Transducers Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and Actuating mechanisms (for all types). Case Studies in Biomagnetic Sensors, Applications of optical and chemical transducers. Ultimate Limits of Fabrication and Measurement, Recent Developments in BioMEMS and BioNEMS - An alternative approach to traditionalsurgery,Specifictargetingoftumorsandotherorgansfordrugdelivery,Micro-visualizationand manipulation, Implantation of microsensors, microactuators and other components of a larger implanted device or external system (synthetic organs).

Total no. of hrs: 45Hrs

TEXT BOOKS:

- Joshua Edel "Nanofluidics" RCS publishing,2209.
- Patric Tabeling "Introduction to Microfluids" Oxford U. Press, New York2205.
- K. Sarit "Nano Fluids; Science and Technology", RCS Publishing,2207.

REFERENCES

- M. Madou, Fundamentals of Microfabrication, CRC Press,1997
- G. Kovacs, Micromachined Transducers, McGraw-Hill,1998
- Steven S Saliterman, Fundamentals of BioMEMS and Medical Microdevices,2206

Subject Code:	**Subject Name : Process Integration**	**Ty/Lb/ETL/IE**	**L**	**T / S.Lr**	**P/ R**	**C**
EMCT22E12	**Prerequisite:**	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To introduce to the students, the various opportunities in the process integration in chemical industries.
- To the make students familiar with the important concepts process integration for heat recovery/minimization.
- To get familiarize with the casestudies.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Maximum heat recovery for a given process (both new processes
CO2	Energy-intensive thermal separation operations (distillation
CO3	Evaluate the process integration measures with respect to energy efficiency
CO4	Understanding of heat and power integration
CO5	Ability to modify processes for minimization of waste water and raw water utilization

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**2**	**1**	**1**
CO2	**2**	**1**	**-**	**1**
CO3	**2**	**1**	**-**	**-**
CO4	**3**	**-**	**-**	**-**
CO5	**2**	**2**	**-**	**1**

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

Subject Code:	Subject Name : Process Integration	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E12	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION **9Hrs**
Introduction to process Intensification and Process Integration (PI). Areas of application and techniques available for PI, oniondiagram.

UNITII PINCHTECHNOLOGY-ANOVERVIEW **9Hrs**
Introduction, Basic concepts, How it is different from energy auditing, Roles of thermodynamic laws, problems addressed by Pinch Technology, Key steps of Pinch Technology: Concept of T_{min} , Data Extraction, Targeting, Designing, Optimization Super targeting, Basic Elements of Pinch Technology: Grid Diagram, Composite curve, Problem Table Algorithm, Grand CompositeCurve.

UNITIII HEATEXCHANGER **9Hrs**
Heat exchanger networks analysis, Maximum Energy Recovery (MER) networks for multiple utilities and multiple, Chemical Engineering Pre-requisites: Knowledge of basic process design of process equipment. Pinches, design of heat exchanger network.

UNITIV **9Hrs**
Heat integrated distillation columns, evaporators, dryers, and reactors.

UNITV **9Hrs**
Waste and waste water minimization, flue gas emission targeting, and heat and power integration. Casestudies.

Total no. of hrs: 45Hrs

REFERENCES:

- Shenoy U.V.;"Heat Exchanger Network Synthesis", Gulf Publishingcompany.
- Smith R.;"Chemical Process Design",McGraw-Hill.
- Linnhoff B., Townsend D. W.,Boland D, Hewitt G. F., Thomas B.E.A., Guy A. R., and Marsland R. H.;"A User Guide on Process Integration for the Efficient Uses of Energy", Inst. of Chemical Engineers.

Subject Code: EMCT22E13	Subject Name : Micro Flow Chemistry and Process Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	**TY**	**3**	**0/0**	**0/0**	**3**

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Introduce the students to micro flow chemistry and process technology

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students will understand the Micro mixers, Mixing Principles.
CO2	Students will understand the micro reactor based chemicals production
CO3	Students will understand the role of micro flow chemistry and process technology in chemical engineering.
CO4	The student is expected to obtain considerable insight into various types of microreactors.
CO5	Students will understanding some advanced fluid mechanics relevant to micro scale device

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	-	1
CO3	2	2	1	-
CO4	2	1	-	1
CO5	2	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				

Subject Code: EMCT22E13	Subject Name : Micro Flow Chemistry and Process Technology	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

UNITI **9Hrs**

State of the Art of Microreaction Technology, Structural Hierarchy of Microreactors, Functional Classification of Microreactors, Fundamental Advantages of Microreactors, Advantages of Microreactors Due to Decrease of Physical Size, Advantages of Microreactors Due to Increase of Number of Units, Potential Benefits of Microreactors

UNITII **9Hrs**

Modern Microfabrication Techniques for Microreactors, Evaluation of Suitability of a Technique, Anisotropic Wet Etching of Silicon, Dry Etching of Silicon, LIGA Process, Injection Molding, Wet Chemical Etching of Glass, Advanced Mechanical Techniques

UNITIII **9Hrs**

Micromixers, Mixing Principles and Classes of Macroscopic Mixing Equipment, Mixing Principles and Classes of Miniaturized Mixers, Mixing Tee-Type Configuration

UNITIV **9Hrs**

Microsystems for Gas Phase Reactions, Catalyst Supply for Microreactors , Types of Gas Phase Microreactors, Microchannel Catalyst Structures, H_2/O_2 Reaction, Selective Partial Hydrogenation of Benzene, Selective Oxidation of 1-Butene to Maleic Anhydride, Selective Oxidation of Ethylene to Ethylene Oxide, Oxidative Dehydrogenation of Alcohols, Synthesis of Methyl Isocyanate and Various Other Hazardous Gases, Synthesis of Ethylene Oxide, Oxidation of Ammonia

UNITV **9Hrs**

Microsystems for Energy Generation, Microdevices for Vaporization of Liquid Fuels, Microdevices for Conversion of Gaseous Fuels to Syngas by Means of Partial Oxidations, Hydrogen Generation by Partial Oxidations, Microdevices for Conversion of Gaseous Fuels to Syngas by Means of Steam Reforming

Total no. of hrs: 45Hrs

REFERENCES:

- Wolfgang Ehrfeld, Volker Hessel, Holger Löwe MicroreactorsNew Technology for Modern Chemistry © WILEY-VCH Verlag GmbH, D-69469 Weinheim (Federal Republic of Germany), 2200.
- S.V. Luis and E. Garcia-Verdugo, Chemical Reactions and Processes under Flow Conditions, University Jaume I/CSIC, Castello´n, Spain, The Royal Society of Chemistry2210
- Madhvanand N. Kashid, Albert Renken,and Lioubov Kiwi-Minsker, Microstructured Devices for Chemical Processing, Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr ©2215 12, 69469 Weinheim,Germany
- Hessel, V., Renken, A., Schouten, J.C., Yoshida, Micro Process Engineering" A Comprehensive Handbook 2209, ISBN978-3-527-31550-5

PROGRAMME ELECTIVE-V

Subject Code: EMCT22E14	Subject Name : Design of Experiments and Parameter Estimation	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- Use statistics in experimentation;
- Understand the important role of experimentation in new product design, manufacturing process development, and process improvement.

COURSE OUTCOMES (COs) : (3- 5)

CO1	Plan experiments for a critical comparison of outputs
CO2	Include statistical approach to propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization
CO5	Analyze the results from such investigations to obtain conclusions; become familiar methodologies that can be used in conjunction with experimental designs for robustness and optimization

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	-	1
CO3	2	2	1	-
CO4	2	1	-	1
CO5	2	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				

Subject Code: EMCT22E14	Subject Name : Design of Experiments and Parameter Estimation	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

UNITI **9Hrs**

Design of experiments. Basic concepts, Bias and confounding, controlling bias, causation, Examples. Random Variables: Introduction to discrete and continuous random variables, quantify spread and central tendencies of discrete and continuous random variables.

UNITII **9Hrs**

Exploratory Data Analysis Variable types, Displaying the distribution, mean variance and typical spread, quartiles and unusual spread, multivariate data: finding relations. Probability Definition of a random variable, expectation, percentiles, common distributions such as the binomial, Poisson and normal distributions.

UNITIII **9Hrs**

Point Estimation Estimators as random variables, sample mean and the central limit theorem, normal approximations, assessing normality. Interval Estimation Confidence intervals for the mean when the variance is known, confidence interval for the mean when the variance is unknown, confidence intervals for a single proportion, sample size, Student distribution. Hypothesis Testing Hypothesis testing for a mean or proportion, testing the equality of two means assuming equal variances, testing the equality of two means with unequal variances, comparison of two proportions.

UNITIV **9Hrs**

Linear regression analysis, the linear regression model, Parameter estimation, accuracy of the coefficient estimates, checking the model, multiple linear regression, confidence and prediction intervals, potential issues, high leverage points, outliers. Matrix approach to linear regression, Variance-Covariance matrix, ANOVA in regression analysis, quantifying regression fits of experimental data, Extra sum of squares approach, confidence intervals on regression coefficients, lack of fit analysis.

UNITV **9Hrs**

Response surface methodology, Method of steepest ascent, first and second order models, identification of optimal process conditions

Total no. of hrs: 45Hrs

REFERENCES:

- ❖ Hanneman, Robert A., Kposowa, Augustine J., Riddle, Mark D. (2212). Research Methods for the Social Sciences: Basic Statistics for Social Research. John Wiley &Sons.
- ❖ Saunders, Mark, Brown, Reva Berman (2207). Dealing with Statistics: What You Need to Know. McGraw-Hill Education.
- ❖ Cowles, Michael (2200). Statistics in Psychology: An Historical Perspective (2nd Edition).Lawrence Erlb

Subject Code:	Subject Name : Computer Aided Design	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E15	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand importance and applications of CAD in the field of chemical engineering
- To understand the basic structure and components of CAD software
- To understand flow charts, computer languages and numerical methods used for writing algorithms

COURSE OUTCOMES (COs) : (3- 5)

CO1	Students get the knowledge about computer Aided Flow Sheet Synthesis
CO2	Computer aided equipment design of Evaporators; Distillation columns; Reactors, adsorption columns.
CO3	Students will understand the underlying thermodynamic and physical principles To give insight into the approaches used in the simulation of flow sheets
CO4	Student will understand flow charts, computer languages and numerical methods used for writing algorithms
CO5	Student understand flow charts, computer languages and numerical methods used for writing algorithms

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	-	1
CO3	2	2	1	-
CO4	2	1	-	1
CO5	1	2	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

Subject Code:	Subject Name : Computer Aided Design	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E15	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION **9Hrs**

Introduction to CAD, Scope and applications in chemical Engineering, Mathematical methods used in flow sheeting and simulation, Introduction to solution methods for linear and non-linear algebraic equations, solving one equation one unknown, solution methods for linear and nonlinear equations, general approach for solving sets of differential equations, solving sets of sparse non-linearequations.

UNITII PROPERTIESESTIMATION **9Hrs**

Physical properties of compounds, Thermodynamic properties of gases and binary mixtures, Viscosity, Vapour pressure, Latent heat, Bubble point and drew point calculation, phase equilidria, Vapour-liquid equilibria, Liquid phase activity coefficients, K-values, Liquid phase activity coefficients, K-values, Liquid- Liquid equilidria, Gassolutions.

UNITIII EQUIPMENTDESIGN **9Hrs**

Computer aided Design of Equipment: Design of Shell and Tube Heat exchangers; Design of Evaporators; Design of Distillation columns; Design of Reactors, Design of adsorption columns. Distillation columns (specific attention to multi components systems. Heat exchangers)

UNITIV COMPUTER AIDED FLOWSHEETSYNTHESIS **9Hrs**

Computerized physical property systems – physical property calculations, degrees of freedom in process design, degrees of freedom for a unit, degrees of freedom in a flow sheet, steady state flow sheeting and process design, approach to flow sheeting systems, introduction to sequential modular approach, simultaneous modular approach and equation solving approach, sequential modular approach to flow sheeting, examples. Tear streams, convergence of tear streams, partitioning and tearing of a flow sheet, partitioning and precedence ordering, tearing a group of units. Flow sheeting by equation solving methods based ontearing.

UNITV DYNAMICSIMULATION **9Hrs**

Numerical recipes in CLinear and nonlinear equations, Ordinary and partial differential equations, Dynamic simulation of stirred tanks system with heating Multi component system, Reactors, Absorption and distillation columns, Application of orthogonal collocation and weighted residuals techniques in heat and mass transfer systems, Introduction to special software for steady and dynamic simulation of Chemical engineering systems. Introduction to various commercial design software and optimizers used in field of chemical engineering.

Total no. of hrs: 45Hrs

REFERENCES

- Douglas James M., “Conceptual design of Chemical Processes", McGraw -Hill Book Company, New York,1988
- Remirez, W.F. - " Computational methods for Process Simulations ", Butterworths, New York,1989
- Sinnott R.K. "Chemical Engineering”, Volume 6, Pergamon Press, New York,1989
- Westerberg A.W., et al, “Process Flow Sheeting”, Cambridge UniversityPress
- Biegler Lorenz T, et al, “Systematic method of Chemical Process Design”, PrenticeHall
- Crowe C.M., et al, “Chemical Plant Simulation-An Introduction to Computer Aided Steady State Analysis”, PrenticeHall
- Anil Kumar, “Chemical Process Synthesis and EngineeringDesign”,TMH,1981

Subject Code:	Subject Name : Cleaner Production	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
EMCT22E16	Prerequisite:	TY	3	0/0	0/0	3

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

OBJECTIVE :

- To understand importance and applications of CAD in the field of chemical engineering
- To understand the basic structure and components of CAD software
- To understand flow charts, computer languages and numerical methods used for writing algorithms

COURSE OUTCOMES (COs) : (3- 5)

CO1	Explain the concept and principles of cleaner production.
CO2	Suggest different unit operations in industrial production process to minimizepollutions.
CO3	Plan good housekeeping practices for Industry/other places with concern of safety, hygiene and waste reduction.
CO4	Suggest basic methods and techniques of pollution prevention duringproduction.
CO5	Suggest cleaner production methods for a given situation which will also lead to cost reduction in long run

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	2	1	-	1
CO3	2	2	1	-
CO4	2	1	-	1
CO5	3	1	2	-

H/M/L indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills			
					√							

Subject Code: EMCT22E16	Subject Name : Cleaner Production	Ty/Lb/ETL/IE	L	T / S.Lr	P/ R	C
	Prerequisite:	TY	3	0/0	0/0	3

UNITI INTRODUCTION 9Hrs

Cleaner production definition: Evaluation of cleaner production, Cleaner production network, Area covered by cleaner production (what is not cleaner production?).Difference between cleaner production and other methods, End of the pipe treatment to curb pollution, prerequisites of cleaner production.

UNITII CLEANERPRODUCTIONTECHNIQUE 9Hrs

Waste reduction at source, (a) Good housekeeping, (b) Process changes: change in raw material, batter process, control, equipment modification and technology changes, Recycling: on site recovery and reuse creation of useful byproducts, Productmodification.

UNITIII CLEANERPRODUCTIONMETHODOLOGY 9Hrs

Methods of environmental protection-preventive strategy, Methods of environmental protection -- preventive strategy, making team for cleaner production, Analyzing process steps, Generating C.P opportunities Selection of C.P solution, Implementing C.P solution

UNITIV CONCEPT OFCLEANERPRODUCTION 9Hrs

Overview of CP Assessment Steps and skills, Preparing for the site visit, Information Gathering, and process flow diagram, material balance, CP Option Generation Technical and Environmental feasibility analysis- Economic valuation of alternatives fuels, Total cost analysis-CP Financing- Establishing a program- Organizing a program preparing a program plan-Measuring progress- pollution prevention and cleaner production Awareness plan -Waste audit-Environmental Statement. Energy audit related tocleaner production, Energy audit's need and scope, Types of energy audit. Preliminary or walk through energy audit. Detailed energy audit, Methodology of energy audit, Energy balance and identifying the energy conservation opportunities.

UNITV FINANCIAL ANALYSIS OFCLEANERPRODUCTION 9Hrs

Gathering base line information, Determining the capital or investment cost, Establishing lifetime of equipment and annual depreciation, Determine revenue implication of the project. Estimating change in operating cost, Calculating incremental cash flow, Assessing project'sviability.

Total no. of hrs: 45Hrs

Case studies and Cleaner Production applications

Application (Industrial application of CP,LCA,EMS and Environmental Audits. C.P in chemical process industry, Practical ways & means to save material loss in loading/unloading and unit operations equipment like distillation column, drying and other equipments like heat exchanger, vacuum unit, conveying, etc. Practical ways & means for energy saving in industries. Case Studies of cleanerproduction.

REFERENCES

- "Cleaner Production Worldwide", 1993, United Nations Environment Programme, Industry and Environment, Paris, France,1993
- "Cleaner Production: Training Resource Package", UNEP IE, Paris,1996
- "Clean Technology for manufacture of Specialty Chemicals", Editor-W. Hoyle and M. Lancaster, Royal Society of Chemistry,U.K
- RandallPaulM,"EngineersGuidetoCleanerProductionTechnologies".
- AhluvaliaV.K.,"GreenChemistry:EnvironmentallyBenignReactions".Sanders R.E., "Chemical Process Safety: Learning from case Histories", Oxford Butter Worth Publication"Training Manual Package" byNCP

AUDIT COURSE-I &II

Subject Code: EMCC22I01	SubjectName: ENGLISHFORRESEARCH PAPERWRITING	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

Objectives

- Toknowtheartofwritingtheresearchpaperandthesistoe Ensurethegoodqualityofpaperatveryfirst-time submission.

COURSEOUTCOMES(COs) :At the end of this course the students would be able to

CO1	Understandthathowtoimprove yourwritingskillsandlevelofreadability
CO2	Learnaboutwhattowriteineach section
CO3	Understandtheskillsneededwhen writingaTitle

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3-High,2-Medium, 1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocialScien	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /TechnicalSkill	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I01	SubjectName: ENGLISHFORRESEARCH PAPERWRITING	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNIT-I: **4**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs andSentences,BeingConciseand RemovingRedundancy,AvoidingAmbiguityandVagueness

UNIT-II: **4**

ClarifyingWhoDidWhat,HighlightingYourFindings,HedgingandCriticising,ParaphrasingandPlagiarism,Sections ofa Paper,Abstracts.Introduction

UNIT-III: **4**

ReviewoftheLiterature, Methods,Results,Discussion,Conclusions,TheFinalCheck.

UNIT-IV: **4**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, keyskills are needed when writing an Introduction, skills needed when writing a Review of theLiterature

UNIT-V: **4**

Skills are needed when writing the Methods, skills needed when writing the Results, skills areneeded when writing the Discussion, skills are needed when writing the Conclusions. usefulphrases,howto ensurepaper isasgoodasit couldpossiblybethefirst-timesubmission.

REFERENCES:

1. *GoldbortR(2006)WritingforScience,YaleUniversityPress(availableonGoogleBooks)*
2. *DayR(2006)HowtoWriteand Publisha ScientificPaper, CambridgeUniversityPress*
3. *Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.Highman’sbook.*
4. *AdrianWallwork,EnglishforWritingResearchPapers,SpringerNewYorkDordrechtHeidelbergLondon,2011*

Subject Code EMCC22I02	Subject Name: DISASTERMANAGEMENT	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0	0	0

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

Objectives: Learnto demonstrate a critical understandingof keyconcepts indisasterriskreductionandhumanitarian response.

COURSEOUTCOMES(COs) : At the end of this course the students would be able to

CO1	Criticallyevaluatedisasterriskreductionandhumanitarianresponsepolicyandpracticefrom multipleperspectives.
CO2	Developanunderstandingofstandardsofhumanitarianresponseandpracticalrelevancein specifictypesof disastersandconflictsituations.
CO3	criticallyunderstandthestrengthsandweaknessesofdisastermanagementapproaches,planningandprogramm ingindifferentcountries,particularlytheir homecountryorthe countriestheyworkin

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3- High,2-Medium, 1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocial	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /Technical	SoftSkills	Auditcourse		
										✓		

Subject Code EMCC22I02	Subject Name: DISASTERMANAGEMENT	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0	0	0

UNIT-I: INTRODUCTION 4

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; NaturalandManmadeDisasters:Difference,Nature, TypesandMagnitude.

UNIT-II: REPERCUSSIONS OFDISASTERSAND HAZARDS 4

EconomicDamage,Loss ofHumanandAnimal Life,DestructionofEcosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines,Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents,OilSlicksAndSpills, OutbreaksOf DiseaseAndEpidemics,WarAndConflicts.

UNIT-III: DISASTER PRONE AREAS ININDIA 4

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; AreasProneToCyclonicandCoastalHazardswithSpecialReferencetoTsunami;Post-DisasterDiseasesand Epidemics

UNIT-IV: DISASTER PREPAREDNESSAND MANAGEMENT 4

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk:Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports:GovernmentalAndCommunityPreparedness.

UNIT-V: RISKASSESSMENT ANDDISASTER MITIGATION 8

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster RiskSituation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning,People'sParticipation inRisk Assessment.Strategies forSurvival.

Meaning,ConceptandStrategiesofDisasterMitigation,EmergingTrendsinMitigation.StructuralMitigationandNon-StructuralMitigation,ProgramsOfDisasterMitigationinIndia.

SUGGESTEDREADINGS:

1. R.Nishith,SinghAK,"DisasterManagementinIndia:Perspectives,issuesandstrategies"'New Royal bookCompany.
2. Sahni,PardeepEt.Al.(Eds.),"DisasterMitigationExperiencesAndReflections",PrenticeHall OfIndia, NewDelhi.
3. GoelS.L.,DisasterAdministrationAndManagementTextAndCaseStudies",Deep&Deep Publication Pvt.Ltd., NewDelhi.

Subject Code: EMCC22I03	Subject Name SANSKRITFORTECHNICALKNOWLEDGE	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

ObjectivesTo get a working knowledge in illustrious Sanskrit, the scientific language in the world Learning ofSanskrittoimprovebrainfunctioning,todevelopthelogicinmathematics,science&othersubjectsenhancingthe memorypower.The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge fromancientliterature.

COURSEOUTCOMES(COs):Attheendofthis coursethestudentswouldbeableto

CO1	UnderstandingbasicSanskritlanguage
CO2	AncientSanskritliteratureaboutscience&technologycanbeunderstood
CO3	Beingalogicallanguagewillhelptodeveloplogicinstudents

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3-High,2-Medium, 1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocial	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /Technical	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I03	Subject Name SANSKRITFORTECHNICALKNOWLEDGE	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNIT-I: **8**

- AlphabetsinSanskrit,
- Past/Present/FutureTense,
- SimpleSentences

UNIT-II: **8**

- Order
- Introductionofroots
- TechnicalinformationaboutSanskritLiterature

UNIT-III: **8**

- Technicalconceptsof Engineering-Electrical,Mechanical,Architecture,Mathematics.

SUGGESTEDREADING

1. "Abhyaspustakam"–Dr.Vishwas,Samskrita-BhartiPublication,NewDelhi
2. "TeachYourselfSanskrit"PrathamaDeeksha-VempatiKutumbshastri,RashtriyaSanskritSansthanam,New DelhiPublication
3. "India'sGloriousScientificTradition"Suresh Soni, Ocean books (P)Ltd.,NewDelhi.

Subject Code: EMCC22I04	SubjectNameVALUEEDUCATION	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

C : Credits L : Lecture T : Tutorial S.Lr : Supervised Learning P : Problem / Practical R : Research
T/L/ETP/IE : Theory/Lab/Embedded Theory and Practice/Internal evaluation.

Objectives .Understand value of education and self- development, Imbibe good values in students. Let them shouldknowabouttheimportanceof character

COURSEOUTCOMES(COs):Attheendofthiscoursethestudentswouldbeableto

CO1	Knowledgeofself-development
CO2	LearntheimportanceofHuman values
CO3	Developingtheoverallpersonality

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3-High,2-Medium,1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocialScien	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /TechnicalSkill	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I04	SubjectNameVALUEEDUCATION	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNIT-I: **4**

Valuesandself-development–Socialvaluesandindividualattitudes.Workethics,Indian vision of humanism.Moral and non- moral valuation.Standards and principles.Valuejudgments.

UNIT-II: **6**

Importanceofcultivationofvalues.Sense of duty. Devotion, Self-reliance.Confidence,Concentration.Truthfulness,Cleanliness.Honesty,Humanity.Powerof faith,NationalUnity.Patriotism.Lovefornature,Discipline.

UNIT-III: **6**

PersonalityandBehaviorDevelopment-SoulandScientificattitude.PositiveThinking.Integrityanddiscipline.Punctuality,LoveandKindness.AvoidfaultThinking. Free from anger, Dignity of labour. Universal brotherhood and religioustolerance.Truefriendship.HappinessVssuffering,love fortruth.Awareofself-destructivehabits.AssociationandCooperation.Doingbestforsavingnature

UNIT-IV: **6**

Character and Competence –Holy books Vs Blind faith.Self-management and Goodhealth.Scienceofreincarnation.Equality,Non-violence, Humility,RoleofWomen. Allreligionsandsamemessage.MindyourMind,Self-control.Honesty,studyingeffectively

SUGGESTEDREADING

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, OxfordUniversityPress, NewDelhi

Subject Code: EMCC22I05	SubjectName:CONSTITUTIONOFINDIA	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

L:LectureT:Tutorial P:ProjectR:ResearchC:CreditsT/L:Theory/Lab

Objectives Understand the premises informing the twin themes of liberty and freedom from a civil rightsperspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional roleand entitlement to civil and economic rights as well as the emergence of nationhood in the early years ofIndiannationalismToaddresstherole ofsocialismin IndiaafterthecommencementoftheBolshevikRevolutionin1917anditsimpactontheinitialdraftingoftheIndian Constitution.

COURSEOUTCOMES(COs):Attheendofthiscoursethestudentswouldbeabletoknow

CO1	Discussthe growthofthedemand forcivilrightsin IndiaforthebulkofIndiansbeforethe arrivalofGandhiinIndianpolitics.
CO2	Discusstheintellectualoriginsoftheframeworkofargumentthatinformedtheconce ptualizationofsocialreforms leadingto revolutionin India.
CO3	. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP]under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of directelectionsthroughadultsuffrage in the Indian Constitution.
CO4	Discussthe passageoftheHindu CodeBillof1956.

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1
CO4	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3-High,2-Medium, 1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocial	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /Technical	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I05	SubjectName: CONSTITUTIONOFINDIA	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNIT-I:HISTORYOF MAKINGOFTHE INDIANCONSTITUTION: 4
History,DraftingCommittee,(Composition&Working)

UNIT-II: PHILOSOPHY OFTHE INDIANCONSTITUTION: 4
Preamble,SalientFeatures

UNIT-III:CONTOURSOFCONSTITUTIONALRIGHTS&DUTIES:
FundamentalRights,RighttoEquality,RighttoFreedom,RightagainstExploitation,RighttoFreedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies,DirectivePrinciples of StatePolicy,FundamentalDuties.

UNIT-IV:ORGANSOFGOVERNANCE: 4
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions,Executive,President,Governor,CouncilofMinisters,Judiciary,AppointmentandTransfer ofJudges,Qualifications,Powers andFunctions

UNIT-V:LOCALADMINISTRATIONANDELECTIONCOMMISSION: 4
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor androle ofElected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction,PRI: ZilaPachayat.Electedofficialsandtheirroles,CEOZilaPachayat:Positionandrole. Block level: Organizational Hierarchy (Different departments), Village level: Role of ElectedandAppointedofficials,Importanceofgrassrootdemocracy.
ElectionCommission:RoleandFunctioning.ChiefElectionCommissionerandElectionCommissioners. State Election Commission: Role and Functioning. Institute and Bodies for thewelfareofSC/ST/OBC andwomen.

SUGGESTEDREADING

1. TheConstitutionofIndia,1950(Bare Act),GovernmentPublication.
2. Dr.S.N.Busi, Dr. B.R.Ambedkar framingof Indian Constitution, 1stEdition,2015.
3. M.P.Jain,IndianConstitutionLaw,7thEdn., LexisNexis,2014.
4. D.D.Basu, IntroductiontotheConstitutionofIndia,LexisNexis,2015.

Subject Code: EMCC22I06	SubjectName:PEDAGOGYSTUDIES	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

L :LectureT :TutorialP:ProjectR:ResearchC:CreditsT/L:Theory/Lab

ObjectivesStudentswillbeableto:4.Reviewexistingevidenceonthereviewtopictoinformprogramme designand policymakingundertakenbytheDfID,otheragenciesandresearchers.5.Identifycriticalevidencegapstoguidethedevelopment.

COURSEOUTCOMES(COs):Attheendofthiscoursethestudentswouldbeabletoknow

CO1	Whatpedagogicalpracticesarebeingused byteachersinformalandinformalclassroomsindevelopingcountries?
CO2	Whatistheevidenceontheeffectivenessofthesepedagogical practices,inwhatconditions, andwithwhatpopulation oflearners?
CO3	Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumand guidancematerialsbestsupporteffectivepedagogy?

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3- High,2-Medium, 1-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocial	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /Technical	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I06	SubjectName:PEDAGOGYSTUDIES	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNITI: **4**

Aims and rationale, Policy background, Conceptual framework and terminology, Theories oflearning, Curriculum, Teacher education.Conceptual framework, Research questions**.**OverviewofmethodologyandSearching.

UNITII: **2**

Thematic overview: Pedagogical practices are being used by teachers in formal and informalclassroomsin developingcountries.Curriculum, Teachereducation.

UNITIII: **4**

Evidence on the effectiveness of pedagogical practices. Methodology for the in depth stage:quality assessment of included studies. How can teacher education (curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy? Theory ofchange.Strengthandnatureofthebodyofevidenceforeffectivepedagogicalpractices.Pedagogic theory and pedagogical approaches.Teachers’ attitudes and beliefs and Pedagogicstrategies.

UNITIV: **4**

Professional development: alignment with classroom practices and follow- up support, Peersupport.Supportfromtheheadteacherandthecommunity.Curriculumandassessment,Barriersto learning: limitedresources and large classsizes.

UNITV: **2**

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Disseminationandresearchimpact.

Suggestedreading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare,31(2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal ofCurriculumStudies,36 (3):361-379.
3. AkyeampongK(2003)TeachertraininginGhana-doesitcount?Multi-siteteachereducationresearch project(MUSTER)countryreport1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning ofbasic maths and reading in Africa: Does teacher preparation count? International JournalEducationalDevelopment, 33 (3):272–282.

SubjectCode: **EMCC22I06**	**SubjectName: STRESS MANAGEMENT BY YOGA**	**Ty/Lb**	**L**	**T**	**P**	**C**
	Prerequisite:**BasicKnowledgeofYoga**	Ty	2	0/0	0/0	0

Objectives

- ToUnderstandtheBasic Conceptsof Yoga
- ToGainknowledgeonAshtangayoga
- ToAcquireknowledgeofTechniquesandPracticeofYogasanas
- Tounderstandstressandthecauses.ToAttaintheknowledgeaboutstressbustingthroughyoga

CO1	Understandthe BasicConceptsofYoga
CO2	GainknowledgeonAshtangayoga
CO3	ToUnderstandstressand thecauses
CO4	AcquireknowledgeofTechniquesandPracticeofYogasanas
CO5	Attaintheknowledge aboutstressbustingthroughyoga

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1
CO4	1	1	1	1	1	3	1	1	1	1	1	1
CO5	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation 3-High,2-Medium,1-Low

Category	BasicSciences	Engineerin gSciences	Humanities andSocial	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /Technical	SoftSkills	Auditcourse		
										✓		

SubjectCode: **EMCC22I06**	**SubjectName: STRESS MANAGEMENT BY YOGA**	**Ty/Lb**	**L**	**T**	**P**	**C**
	Prerequisite:**BasicKnowledgeofYoga**	Ty	2	0/0	0/0	0

UNITI: **8**

DefinitionsofEightpartsofyog.(Ashtanga)

UNITII: **8**

- YamandNiyam.Do`s andDon't'sinlife.

i) Ahinsa, satya, astheya, bramhacharya and aparigrahaShaucha,santosh,tapa,swadhyay,ishwarpranidhan

UNITIII: **8**

- AsanandPranayam

i) Variousyogposesandtheirbenefitsformind&body
ii) Regularizationofbreathingtechniquesanditseffects-Typesofpranayama

SUGGESTEDREADING

1. 'YogicAsanasforGroupTarining-Part-I":JanardanSwami YogabhyasiMandal,Nagpur

2. "RajayogaorconqueringtheInternalNature"bySwamiVivekananda,AdvaitaAshrama(Publication Department),Kolkata

Subject Code: EMCC22I08	Subject Name PERSONALITYDEVELOPMENTTHROUGHLIFEENLIGHTENMENTSKILLS	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

L:LectureT:Tutorial P:ProjectR:ResearchC:CreditsT/L:Theory/Lab

ObjectivesTolearntoachievethehighest goalhappily,Tobecome apersonwithstablemind,pleasing personalityanddetermination.To awaken wisdominstudent

COURSEOUTCOMES(COs):Attheendofthiscoursethestudentswouldbeabletoknow

CO1	StudyofShrimad-Bhagwad-Geetawillhelpthestudentindevelopinghispersonalityandachieve thehighest goal inlife
CO2	ThepersonwhohasstudiedGeeta willleadthenationand mankind topeaceandprosperity
CO3	StudyofNeetishatakamwillhelpin developingversatilepersonalityofstudents.

Mappingof CourseOutcomeswithProgramOutcomes(POs)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	1	1	1	1	1	1
CO2	1	1	1	1	1	3	1	1	1	1	1	1
CO3	1	1	1	1	1	3	1	1	1	1	1	1

H/M/LindicatesStrengthofCorrelation H-High,M-Medium,L-Low

Category	BasicSciences	Engineering Sciences	Humanities andSocialScien	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships /TechnicalSkill	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I08	Subject Name PERSONALITYDEVELOPMENTTHROUGHLIFEENLIGHTENMENTSKILLS	Ty/Lb	L	T	P	C
	Prerequisite:Nil	Ty	2	0/0	0/0	0

UNITI: **8**

Neetisatakam-Holisticdevelopmentofpersonality

- Verses-19,20,21,22(wisdom)
- Verses-29,31,32 (pride&heroism)
- Verses-26,28,63,65 (virtue)
- Verses-52,53,59(dont's)
- Verses-71,73,75,78(do's)

UNITII: **8**

- Approachto daytodayworkandduties.
- ShrimadBhagwadGeeta :Chapter2-Verses41,47,48,
- Chapter3-Verses13,21, 27,35,Chapter6-Verses 5,13,17,23,35,
- Chapter18-Verses45,46,48.

UNITIII: **8**

- Statementsofbasicknowledge.
- ShrimadBhagwadGeeta:Chapter2-Verses56,62,68
- Chapter12-Verses13, 14,15, 16,17,18
- Personality of Role model. ShrimadBhagwadGeeta: Chapter2-Verses 17,Chapter3-Verses36,37,42,
- Chapter4-Verses18,38,39
- Chapter18–Verses37,38,63

SUGGESTEDREADING

1. "SrimadBhagavadGita"bySwamiSwarupanandaAdvaitaAshram

(PublicationDepartment),Kolkata

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) byP.Gopinath,RashtriyaSanskritSansthanam, NewDelhi.

Subject Code: EMCC22I09	Subject Name : RESEARCH AND PUBLICATION ETHICS	T / L/ ETP/IE	L	T / S.Lr	P/ R	C
	Prerequisite: core subjects	T	2	0/0	0/0	0
T/L/ : Theory/Lab L : Lecture T : Tutorial P : Practical/Project R : Research C: Credits T/L Theory/Lab						

OBJECTIVE:

- To understand the philosophy of science and ethics, research integrity and publication ethics.
- To identify research misconduct and predatory publications.
- To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.).

COURSE OUTCOMES (COs) : By doing this course students will

CO1	Understand the ethical issues related to Research and Publication
CO2	Get to know about different types of plagiarism and ways for avoiding plagiarism
CO3	Know about best practices and guidelines in publication ethics and also learns to avoid Publication misconduct
CO4	Get to know about Violation of publication ethics, authorship and contributor ship and get to identify about Predatory publishers and journals.
CO5	Get to know about various open sources database and research metrics like indexing, citation etc.,

Mapping of Course Outcomes with Program Outcomes (POs)

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

COs / PSOs	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	2	3	3
CO3	2	3	3
CO4	2	3	3
CO5	2	3	3

1/2/3 indicates Strength of Correlation 3- High, 2- Medium, 1-Low

Category	BasicSciences	EngineeringSciences	Humanities andSocialSciences	ProgramCore	ProgramElectives	OpenElectives	Practical/Project	Internships	SoftSkills	Auditcourse		
										✓		

Subject Code: EMCC22I09	Subject Name : **RESEARCH AND PUBLICATION ETHICS**	T / L/ ETP/IE	L	T / S.Lr	P/ R	C
	Prerequisite: core subjects	T	2	0/0	0/0	0

Unit I: Introduction

Introduction to philosophy: Definition, nature and scope, concept, branches - Ethics: Definition, moral philosophy, nature of moral judgments and reactions – Ethics with respect to Science and Research Intellectual honesty and research integrity

Unit II: Scientific Conduct

Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)

Redundant Publications: Duplicate and over lapping publications, salami slicing – Selective reporting and misrepresentation of data

Unit III: Publication Ethics -I

Publication ethics: Definition, introduction and importance – Best practices/standards setting initiatives and guidelines: COPE, WAME etc. Publication misconduct: definition, Concept, problems that lead to unethical behavior and vice-versa, types.

Unit IV: Publication Ethics - II

Violation of publication ethics, authorship and contributor ship – Identification of publication misconduct, complaints and appeals – Predatory publishers and journals – Subject specific ethical issues, Complaints and appeals: examples and fraud from India and Abroad

Unit V: Data Bases and Research Metrics

Open Access publication and Initiatives – Indexing databases – Citation databases, Web of Science, Scopus, etc. – Impact factor of journals as per Journal Citation report .SNIP, SJR, IPP, Cite Score - Metrics: h-index,gindex,i10index,altmetrics – Conflict of interest.

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