ERODE SENGUNTHAR ENGINEERING COLLEGE
(Autonomous)
(Approved by AICTE, New Delhi, Permanently Affiliated to Anna University – Chennai& Accredited by NAAC & National Board of Accreditation (NBA), New Delhi.)
PERUNDURAI, ERODE 638 057

DEPARTMENT OF CHEMICAL ENGINEERING

Curriculum and Syllabus

B.TECH.

CHEMICAL ENGINEERING

REGULATION - 2019

Choice Based Credit System (CBCS)

(Academic year 2020 – 21)

ERODE SENGUNTHAR ENGINEERING COLLEGE
(Autonomous)
(Approved by AICTE, New Delhi, Permanently Affiliated to Anna University – Chennai& Accredited by NAAC &National Board of Accreditation (NBA), New Delhi.)
PERUNDURAI, ERODE 638 057

INSTITUTION VISION & MISSION

VISION

Erode Sengunthar Engineering College strives with determination and commitment to provide and promote world-class Technical Education, in particular to the students of backward rural areas, transforming them into holistic personalities embedded with discipline, skill and responsibility that make them patriotic, successful, and self-developed professionals ready to accomplish any job in their career and life.

MISSION

- Provide an idyllic study atmosphere, fine infrastructure, qualified and dedicated faculty and standardized systems for a strong career foundation.
- Aid and motivate the students and faculty alike for maximum utilization of facilities, making them innovative and creative in thinking and research, in order to provide technical service to industry and society.
- Develop multi-skilled personalities to make ESEC, a world leader in Technical Education.

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

- To inculcate continuously and relentlessly to produce top notch Chemical Engineers for the industrial requirement.

MISSION

- To impart knowledge the students at all levels through vibrant, dynamic and state –of – the –art intellectual exercise.
- To synergize the efforts of the students and faculty to evolve the innovative practices and teaching methodologies.
- To generate in atmosphere of continuous learning and research promoting environment-conscious Chemical Engineers.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Program Educational Objectives (PEOs)

I. Preparing the students with strong fundamental knowledge in Mathematics, Science, English and Engineering Sciences so as to enable them to analyze the Chemical Engineering related problems. (Preparation)

II. To prepare the students to design Chemical Engineering equipment, process design by executing and evaluating the performance including socio-economic impacts to the region. (Core Competence and Professionalism)

III. To provide problem solving computational skills for process simulation, design and analysis by using appropriate software and also to give the students an exposure in word processing, spread sheet, ppt., and to make them use information on the world wide web.(Breadth)

IV. To train the students in communication techniques and to make them aware of job-related skills, emerging technologies in global issues. Giving information on safety aspects, professional ethics and to maintain harmony with society. (Learning Environment)

PROGRAM OUTCOMES (POs)

PO1:Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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 public health and safety, and the cultural, societal, and environmental considerations.

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.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

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 multidisciplinary environments.

PO12:Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Process Modeling & Simulation – Developing applied knowledge through Process Modeling & Simulation in Chemical Process Industries.

PSO2: Contemporary Skills – An ability to update knowledge on recent developments in Chemical Industries.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

CURRICULUM

ERODE SENGUNTHAR ENGINEERING COLLEGE, ERODE

DEPARTMENT OF CHEMICAL ENGINEERING

REGULATION – 2019

CHOICE BASED CREDIT SYSTEM

I TO VIII SEMESTERS CURRICULAM

Induction Program (Mandatory)	3 weeks duration
Induction program for students to be offered right at the start of the first year	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lecturer by Eminent People • Visits to local Areas • Familiarization to Dept. / Branch &Innovations

B.TECH. CHEMICALENGINEERING
Minimum credits to be earned :165

SEMESTER I

THEORY

Code No	Course	Objectives & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS101	Calculus and its Applications	I, II	1,2,3,4,12	-	3	1	0	4	40	60	100	BS
19BS102	Engineering Physics	I, II	1,2,4,5,6,8, 9	1,2	2	0	2	3	40	60	100	BS
19BS103	Engineering Chemistry	I, II	1,2,3,4,5,7, 12	-	3	0	0	3	40	60	100	BS
19HS101	Communicative English	III	2,3,6,9,10, 12	3	3	0	0	3	40	60	100	HS
19ES101	Python Programming	I, IV	1,2,3,4,12	2	3	0	0	3	40	60	100	ES
19TPS01	Soft Skill - I	III	8,9,10,12	3	1	0	1	1.5	40	60	100	EEC
PRACTICAL												
19ES104	Python Programming Laboratory	II	1,2,3,4,5,1 2	2	0	0	2	1	60	40	100	ES
19ES106	Engineering Graphics	I, II	1,2,3,5,10, 12	2	0	0	4	2	60	40	100	ES

Chairman - BoS
Dept. of Chemical Engg. - ESEC

19ES107	Workshop Practices	II	1,3,9,12	-	0	0	2	1	60	40	100	ES
			TOTAL		15	1	11	21.5	420	480	900	-

SEMESTER II

THEORY

Code No	Course	Objectives & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS201	Vector Calculus and Complex Variables	I,II	1,2,3,4,12	-	3	1	0	4	40	60	100	BS
19BS207	Physics of Materials	I, II	1,2,4,5,7	2	3	0	0	3	40	60	100	BS
19MC202	Environmental Science and Ecology	I,II	1,2,3,4,5,6, 7, 8,12	-	3	0	0	0	40	60	100	MC
	Language Elective	III	-	-	3	0	0	3	40	60	100	HS
19ES204	Principles of Electrical and Electronics Engineering	III	1,2,3,4	1,2	3	0	0	3	40	60	100	ES
19ES211	Introduction to Chemical Engineering	I, II	1,2,3,4	2	3	0	0	3	40	60	100	ES
19TPS02	Soft Skill - II	III	8,9,10,12	2	1	0	1	1.5	40	60	100	EEC
PRACTICAL												
19BS208	Engineering Chemistry Laboratory	I, II, III	1,2,3,4,5,12	1, 2	0	0	4	2	60	40	100	BS
19ES222	Chemical Analysis Laboratory	I, II	1,2,3,4,8,9	2	0	0	2	1	60	40	100	ES
			TOTAL		19	1	7	20.5	400	500	900	-

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER III													
THEORY													
Code No	**Course**	**Objectives & Outcomes**			**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**	**PSOs**					**CA**	**ES**	**Total**	
19BS302	Probability and Statistics	I, II	1,2,3,4	2	3	1	0	4	40	60	100	BS
19CH301	Organic Chemistry for Chemical Engineers	III	1,2,3,4	2	3	0	0	3	40	60	100	PC
19ES303	Engineering Thermodynamics	I, II	1,2,3,4,5	2	3	0	0	3	40	60	100	ES
19CH302	Fluid Mechanics for Chemical Engineers	I, II	1,2,3,4,5	2	3	0	0	3	40	60	100	PC
19CH303	Chemical Process Calculations	I, II	1,2,3,4,5,8	2	3	0	0	3	40	60	100	PC
19MC301	Indian Constitution	IV	1,2,6,8,10, 11,12	-	2	0	0	0	40	60	100	MC
19TPS03	Quantitative Aptitude and Logical Reasoning - I	III, IV	1,2,9,10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19CH304	Fluid Mechanics Laboratory	I, II	1,2,3,4,5	2	0	0	4	2	60	40	100	PC
19ES306	Electrical Engineering Laboratory for Chemical Engineers	I, II	1,2,3,4,9	2	0	0	4	2	60	40	100	ES
19HS301	Communication Skills	III	1,2,3,6,8, 9,10,12	2	0	0	4	2	100	-	100	EEC
			TOTAL		19	1	12	22	500	500	1000	-

SEMESTER IV												
THEORY												
Code No	**Course**	**Objectives & Outcomes**			**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**	**PSOs**					**CA**	**ES**	**Total**	
19BS402	Numerical Methods	I, II	1,2,3,4	2	3	1	0	4	40	60	100	BS

Chairman BOS
Dept. of Chemical Engg. - PSEC

19CH401	Physical Chemistry	I, II	1,2,3,4	2	3	0	0	3	40	60	100	PC
19CH402	Chemical Engineering Thermodynamics	I, II	1,2,3,4,5,7	2	3	0	0	3	40	60	100	PC
19CH403	Mechanical Operations	I, II	1,2,3,4,7	2	3	0	0	3	40	60	100	PC
19CH404	Internet of Things for Chemical Engineers	I, II	1,2,3,4,5,10	2	2	0	2	3	40	60	100	PC
19HS402	Universal Human Values 2 : Understanding Harmony	I, II	6,7,8,9,10,12	2	2	1	0	3	40	60	100	MC
19TPS04	Quantitative Aptitude and Logical Reasoning - II	IV	1,2,9,10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19CH406	Organic Chemistry Laboratory	I, II	1,2,3,4	2	0	0	4	2	60	40	100	PC
19CH407	Mechanical Operations Laboratory	I, II	1,2,3,4,7	2	0	0	4	2	60	40	100	PC
			TOTAL	-	18	2	10	23	400	500	900	-

SEMESTER V

THEORY

Code No	Course	Objectives & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CH501	Chemical Reaction Engineering - I	I, II	1,2,3,4, 5,8	2	3	0	0	3	40	60	100	PC
19CH502	Material Science and Technology	I, II	1,2,3,4, 7,11	2	3	0	0	3	40	60	100	PC
19CH503	Mass Transfer Operations – I	I, II	1,2,3,4, 5,8,9	2	3	0	0	3	40	60	100	PC
19CH504	Heat Transfer Operations	I, II	1,2,3,4, 5,8,9	2	3	0	0	3	40	60	100	PC
19CH505	Instrumental	I, II	1,2,3,4,5,	2	3	0	0	3	40	60	100	PC

Chairman - BoS
Dept. of Chemical Engg. - ESEC

	Methods of Analysis		8,9									
	Professional Elective – I				3	0	0	3	40	60	100	PE
19TPS05	Quantitative Aptitude and Logical Reasoning - III	II, IV	1,2,9, 10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19CH505	Heat Transfer Laboratory	I, II	1,2,3,4,5, 8,9	2	0	0	4	2	60	40	100	PC
19CH506	Computational Engineering Practices Laboratory	I, II, III	1,2,3,4, 5,6,9	1, 2	1	0	2	2	60	40	100	PC
19HS501	Career Skills	III	1,2,3,6, 8,9,10, 12	2	0	0	2	0	100	-	100	EEC
19CH507	Internship/ Industrial visit	I, II, III, IV	1,2,3,4, 5,6,7,8,9, 10,11,12	1, 2	0	0	2	1	100	-	100	EEC
			Total	-	21	0	10	23	500	500	1000	-

SEMESTER VI

THEORY

Code No	Course	Objectives & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CH601	Mass Transfer Operations – II	I, II	1,2,3,4,5, 8,9	2	3	0	0	3	40	60	100	PC
19CH602	Chemical Reaction Engineering – II	I, II	1,2,3,4,5, 8,9	2	3	0	0	3	40	60	100	PC
19CH603	Process Dynamics and Control	I, II	1,2,3,4,5, 6,10	2	3	0	0	3	40	60	100	PC
19CH604	Chemical Process Industries	I, II	1,2,3,4,5,7,8, 9,11,12	2	3	0	0	3	40	60	100	PC
	Professional Elective –II				3	0	0	3	40	60	100	PE
	Professional Elective – III				3	0	0	3	40	60	100	PE

Chairman - BoS
Dept. of Chemical Engg. - ESEC

19TPS06	Quantitative Aptitude and Logical Reasoning - IV	III, IV	1,2,9,10,12	3	2	0	0	0	40	60	100	EEC
PRACTICAL												
19CH605	Process Control Laboratory	I, II	1,2,3,4,5,6, 10	2	0	0	4	2	60	40	100	PC
19CH606	Mass Transfer Laboratory	I, II	1,2,3,4,5,8, 9	2	0	0	4	2	60	40	100	PC
19CH607	Chemical Reaction Engineering and Iron Sponge Laboratory	I, II	1,2,3,4,5,8, 9	2	0	0	4	2	60	40	100	PC
			TOTAL	-	20	0	12	24	460	540	1000	-

SEMESTER VII

THEORY

Code No	Course	Objectives & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CH701	Transport Phenomena	I, II	1,2,3,4,5, 7,12	2	3	0	0	3	40	60	100	PC
19CH702	Chemical Process Equipment Design and Drawing	I, II	1,2,3,4,5, 8,12	2	3	0	0	3	40	60	100	PC
19CH703	Process Engineering Economics	I, II, IV	1,2,3,4,9, 11	2	3	0	0	3	40	60	100	PC
	Professional Elective – IV				3	0	0	3	40	60	100	PE
	Open Elective – I				3	0	0	3	40	60	100	OE
19HS601	Research Methodology	I, II, III, IV	1,2,3,4,5, 6,7,8,9,10, 11,12	2	3	0	0	3	40	60	100	HS
PRACTICAL												

Chairman - BoS
Dept. of Chemical Engg. - ESEC

19CH704	Project Work Phase – I	I, II, III, IV	1,2,3,4,5, 6,7,8,9,10, 11,12	1, 2	0	0	2	1	60	40	100	EEC
19CH705	Comprehensive Review	II, IV	1,2,3,4,5,6, 7,8,9,10,11, 12	1,2	0	0	2	0	100	-	100	EEC
			TOTAL	-	18	0	4	19	400	400	800	-

SEMESTER VIII												
THEORY												
Code No	**Course**	**Objectives & Outcomes**			**L**	**T**	**P**	**C**	**Maximum Marks**			**Category**
		PEOs	**POs**	**PSOs**					**CA**	**ES**	**Total**	
	Professional Elective – V				3	0	0	3	40	60	100	PE
	Open Elective – II				3	0	0	3	40	60	100	OE
PRACTICAL												
19CH801	Project Work Phase – II	I, II, III, IV	1,2,3,4,5, 6,7,8,9,10, 11,12	1, 2	0	0	12	6	60	40	100	EEC
			TOTAL		6	0	12	12	140	160	300	-

Professional Electives							
Code No.	**Course**	**Objectives and Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
ELECTIVES – I							
19CHX01	Polymer Technology	I, II	1,2,3,4,7,11	3	0	0	3
19CHX02	Chemical Process Optimization	I, II	1,2,3,4,7,11	3	0	0	3
19CHX03	Corrosion Engineering	I, II	1,2,3,4,7	3	0	0	3
19CHX04	Energy Engineering	I, II	1,2,3,4,7,8	3	0	0	3
ELECTIVES – II							
19CHX05	Chemical Process Flow Sheeting	I, II	1,2,3,4,7,11	3	0	0	3
19CHX06	Enzyme Engineering	I, II	1,2,3,4,7	3	0	0	3
19CHX07	Food Technology	I, II	1,2,3,4,7	3	0	0	3

Chairman - BoS
Dept. of Chemical Engg. - ESEC

19CHX08	Plastics Engineering	I, II	1,2,3,4,7	3	0	0	3
ELECTIVES – III							
19CHX09	Fluidization Engineering	I, II	1,2,3,4,5	3	0	0	3
19CHX10	Modern Separation Techniques	I, II	1,2,3,4,5,7, 8,12	3	0	0	3
19CHX11	Industrial Safety	I, II	1,2,3,4,8,9,10,12	3	0	0	3
19CHX12	Renewable Energy Technologies	I, II	1,2,3,4,7,8	3	0	0	3
ELECTIVES – IV							
19CHX13	Petroleum Refinery Engineering	I, II	1,2,3,4,8	3	0	0	3
19CHX14	Plant wide control	I, II	1,2,3,4,5,6, 10	3	0	0	3
19CHX15	Heterogeneous Catalysis	I, II	1,2,3,4	3	0	0	3
19CHX16	Process Modelling and simulation	I, II	1,2,3,4,5,7, 8,12	3	0	0	3
ELECTIVES – V							
19CHX17	Drugs and Pharmaceutical Technology	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHX18	Biochemical Engineering	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHX19	Professional Ethics for Chemical Engineers	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHX20	Programming using MATLAB	I, II	1,2,3,4,5,7, 8,12	3	0	0	3
OPEN ELECTIVES OFFERED BY CHEMICAL ENGINEERING DEPARTMENT							
19CHY01	Electro Chemical Engineering	I, II	1,2,3,4,7,8	3	0	0	3
19CHY02	Advances in Pollution Control	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHY03	Industrial Wastewater Treatment	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHY04	Total Quality Management	I, II	1,2,3,4,5,6,8, 9,10,12	3	0	0	3
19CHY05	Nano science and Nano technology	I, II	1,2,3,4,7,8, 12	3	0	0	3
19CHY06	Piping Engineering	I, II	1,2,3,4,5	3	0	0	3
19CHY07	Non - conventional Energy sources	I, II	1,2,3,4,6,7,8	3	0	0	3
19CHY08	Fuel and Combustion Technologies	I, II	1,2,3,4,6,7,8	3	0	0	3
MANDATORY COURSES							
19MC202	Environmental Science and Ecology	I,II	1,2,5,6, 7, 8,12	3	0	0	0

Chairman - BoS
Dept. of Chemical Engg - ESEC

19MC301	Indian Constitution	IV	1,2,3,4,6, 7,8	2	0	0	0
19HS402	Universal Human Values 2 : Understanding Harmony	IV	6,7,8,9,10,12	2	1	0	3

LANGUAGE ELECTIVE

Code No.	Course	Objectives & Outcomes			L	T	P	C
		PEOs	Pos	PSOs				
19HX201	English for Engineers	III	2,3,6, 9,10,12	3	3	0	0	3
19HX202	Hindi	III	2,3,6, 9,10,12	3	3	0	0	3
19HX203	Japanese	III	2,3,6, 9,10,12	3	3	0	0	3
19HX204	French	III	2,3,6, 9,10,12	3	3	0	0	3

NPTEL – VALUE ADDED COURSES

Code No.	Course	Objectives & Outcomes			L	T	P	C
		PEOs	Pos	PSOs				
19CHZ01	Particle Characterization	I, II,	1,2,3,4,7	3	3	0	0	3
19CHZ02	Introduction to Polymer Science	I, II,	1,2,3,4,7,11	3	3	0	0	3
19CHZ03	Electro-chemical Engineering	I, II,	1,2,3,4,7,8	3	3	0	0	3
19CHZ04	Nanoscience and Technology	I, II,	1,2,3,4,7,8, 12	3	3	0	0	3
19CHZ05	Chemical Process Intensification	I, II,	1,2,3,4,5,7, 8,9,11,12	3	3	0	0	3
19CHZ06	Process Control Design, Analysis and Assessment	I, II,	1,2,3,4,5,6, 10	3	3	0	0	3
19CHZ07	Thermodynamics of Fluid Phase Equilibria	I, II,	1,2,3,4,5,7	3	3	0	0	3
19CHZ08	Infrared Spectroscopy for Pollution Monitoring	I, II,	1,2,3,4,5,8,9	3	3	0	0	3
19CHZ09	Multiphase flows	I, II,	1,2,3,4,5	3	3	0	0	3

Chairman-BOS
Dept. of Chemical Engg. - ESEC

19CHZ10	Flow through Porous Media	I, II,	1,2,3,4,5	3	3	0	0	3
19CHZ11	Continuum Mechanics and Transport Phenomena	I, II,	1,2,3,4,5,7, 12	3	3	0	0	3
19CHZ12	Introduction to Process Modelling in Membrane Separation Process	I, II,	1,2,3,4,5,7, 8,12	3	3	0	0	3
19CHZ13	Waste to Energy Conversion	I, II,	1,2,3,4,5,7,8	3	3	0	0	3

Chairman - BoS
Dept. of Chemical Engg. - ESEC

CATEGORY	CREDITS FOR SEMESTER								TOTAL CREDIT
	I	II	III	IV	V	VI	VII	VIII	
BS	10	09	04	04	-	-	-	-	**27**
ES	07	07	05	-	-	-	-	-	**19**
HS	03	03	-	-	-	-	03	-	**09**
MC	-	-	-	03	-	-	-	-	**03**
PC	-	-	11	16	18	18	09	-	**72**
PE	-	-	-	-	03	06	03	03	**15**
OE	-	-	-	-	-	-	03	03	**06**
EEC	1.5	1.5	02	-	02	-	01	06	**14**
Total	**21.5**	**20.5**	**22**	**23**	**23**	**24**	**19**	**11**	**165**

BS – Basic Sciences
ES – Engineering Sciences
HS – Humanities & Social Sciences
PC – Professional Core
PE – Professional Elective Course
OE – Open Elective Course
EEC – Employability Enhancement course
CA – Continuous Assessment
EA - End Semester Assessment

TOTAL CREDIT = 165

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER I

Department	CHEMICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS101	CALCULUS AND ITS APPLICATIONS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Interpret the introductory concepts of Limit and continuity
- Interpret the introductory concepts of calculus, this will enable them to model and analyze physical phenomena involving continuous change of variables
- Summarize and apply the methodologies involved in solving problems related to functions of several variables.
- Develop enough confidence to identify surface and area there by solving using integration
- Find Eigen values and Eigen vectors which is one of the powerful tools to handle practical problems arising in the field of engineering.

Course Outcomes: At the end of this course, learners will be able to:

- Apply differentiation to solve maxima and minima problems use both the limit definition and rules of differentiation to differentiate functions
- Identify and model the real time problems using first order linear differential equations. Recognize and solve the higher order ordinary differential equations.
- Characterize the functions of several variables and get the solutions of the same.
- Integrate the functions for evaluating the surface area and volume.
- Analyze the characteristics of a linear system with Eigen values and Eigen vectors

UNIT I	LIMITS AND CONTINUITY	12

Representation of functions – Limit of a function – continuity – derivative--Differentiation Rule--.Maxima and Minima of function of one variable

UNIT II	ORDINARY DIFFERENTIAL EQUATIONS	12

Linear differential equations of second and higher order with constant coefficients. Linear differential equations of higher order with variable coefficients: Cauchy's linear differential equation - Method of variation of parameters for second order differential equations-Vibrating string-Electrical circuits

UNIT III	MULTIVARIABLE CALCULUS	12

Functions of Two Variables and their solutions- Total Differential - Derivative of implicit functions- Jacobian's, Unconstrained maxima and minima.

UNIT IV	MULTIPLE INTEGRALS	12

Double integration with constant and variable limits-Region of integration -Change the order of integration - Area as double integral in cartesian coordinates. Triple integral in Cartesian coordinates.

UNIT V	EIGEN VALUES AND EIGEN VECTORS	12

Eigen Values and Eigen Vectors of a real matrix - Properties of Eigen Values- Cayley - Hamilton Theorem Orthogonal matrix- Diagonalisation-Quadratic form: Reduction of a quadratic form to a canonical form.

Content Beyond the Syllabus: Newton's Method, Besse'ls function for first kind, Curvature, Change of variables in Cylindrical coordinates, Stochastic Matrix

REFERENCE(S):

1. George B. Thomas, Jr.-" Thomas'Calculus" , Thirteenth Edition.
2. Erwin Kreyszig Advanced Engg Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015.
3. Peter V. O Neil, Advanced Engineering Mathematics, Seventh Edition, Cengage Learning India Private Limited, 2012

Chairman (BoS)
Dept. of Chemical Engg. - ESEC

4. B.S. Grewal, Higher Engineering Mathematics, Forty Third Edition, Khanna Publications , New Delhi 2014
5. Glyn James, Advanced Engineering Mathematics, Third Edition, Wiley India, 2014.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS102	ENGINEERING PHYSICS (Laboratory Embedded)	2	0	2	3	60	100	

Course Objective (s): The purpose of learning this course is

- Enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology

Course Outcomes: At the end of this course, learners will be able to

- Gain knowledge on the basics of properties of matter and its applications
- Acquire knowledge on the concepts of Ultrasonics and their applications
- Have adequate knowledge on the concepts of fiber & Laser and their applications
- Get knowledge on advanced Physics concepts of quantum theory and its applications in tunneling microscopes and
- Understand knowledge on the concepts of thermal properties of materials and their applications in expansion of joints and heat exchangers

UNIT I PROPERTIES OF MATTER **6+6**

Elasticity – Stress-strain diagram and its uses - torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders.

UNIT II ULTRASONICS **6+6**

Introduction–Classification of Sound- Ultrasonics Production - Magnetostriction generator - Piezo electric generator-cavitations-ultrasonic cleaning-Non Destructive Testing- Pulse echo system through transmission and reflection modes- A, B and C – scan displays- Engineering Applications-Cutting, welding and drilling.

UNIT III LASER AND FIBRE OPTICS **6+6**

Lasers: population of energy levels, Einstein's A and B coefficients derivation – Semiconductor lasers: homojunction and heterojunction – Industrial applications of laser. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – fibre optic sensors: pressure and displacement.

UNIT IV QUANTUM PHYSICS **6+6**

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box.

UNIT V THERMAL PHYSICS **6+6**

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity - Lee'sdiscmethod:theoryandexperiment-conductionthroughcompoundmedia(seriesandparallel) – applications: heat exchangers, ovens and solar water heaters.

TEXT BOOK(S):

- Bhattacharya, D.K. & Poonam, T, "Engineering Physics". Oxford University Press, 2015
- Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012
- Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012

Chairman - BoS
Dept. of Physics - ESEC

Chairman - BoS
Dept. of Chemical Engg. - ESEC

REFERENCE(S):	
1.	Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015
2.	Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010
3.	Tipler, P.A. & Mosca.G, "Physics for Scientists and Engineers with ModernPhysics".W.H.Freeman,2007.

LIST OF EXPERIMENTS (ANY FIVE)	30 Hours

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. Determination of Young's modulus by uniform bending method
4. Determination of wavelength, and particle size using Laser
5. Determination of acceptance angle in an optical fiber.
6. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
7. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
8. Determination of wavelength of mercury spectrum – spectrometer grating
9. Determination of band gap of a semiconductor
10. Determination of thickness of a thin wire – Air wedge method.

Chairman - BoS
Dept. of Physics - ESEC

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS103	ENGINEERING CHEMISTRY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basic concepts of water characterization and treatment methods.
- Know the fundamental concepts of Electrochemistry and corrosion.
- Understand the principles and generation of energy in Batteries, Solar cells & Nuclear reactors.
- Gain knowledge on nanomaterials.
- Know the types of fuels and the manufacture of solid, liquid and gaseous fuels.

Course Outcomes: At the end of this course, learners will be able to

- Make the students conversant with water treatment techniques
- Know the reaction involved in corrosion and corrosion protection methods
- Impart knowledge on renewable energy sources like nuclear, solar and wind and to impart knowledge on energy storage devices
- Impart knowledge on various preparation methods of nano particles and know the applications.
- Impart knowledge on different types of fuels (solid liquid, gas, primary, secondary and synthetic) and about combustion

UNIT I	WATER CHEMISTRY	9

Hardness of water – types – Estimation of hardness of water by EDTA – problems – Domestic water treatment-boiler troubles (scales, sludge, Priming, Foaming, Caustic embrittlement) – Internal conditioning (Carbonate, phosphate, sodium aluminate and calgon conditioning) external treatment – Demineralization process – Desalination - Reverse Osmosis.

UNIT II	ELECTROCHEMISTRYAND CORROSION	9

Electrochemical cell - redox reaction, electrode potential- Nernst equation (derivation and problems). Standard hydrogen electrode-Calomel Electrode- Corrosion- factors- types- chemical, electrochemical corrosion (galvanic, differential aeration)-factors influencing corrosion-corrosion control - sacrificial anode and impressed current cathodic method.

UNIT III	ENERGYSOURCES	9

Introduction- nuclear energy- nuclear fission- nuclear fusion- nuclear chain reactions- light water reacto breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells: Types batteries- alkaline battery- lead storage battery- lithium ion battery- fuel cell H_2-O_2fuel cell.

UNIT IV	NANOCHEMISTRY	9

Basics -Nanoparticles: nano cluster, nano rod, nanotube (CNT) and nanowire. Synthesis: precipitation, thermolysis,hydrothermal,solvothermal,electrodeposition,chemicalvapourdeposition,laserablation; Properties and applications.

UNIT V	FUELSANDCOMBUSTION	9

Fuel: Introduction- classification of fuels- solid fuels-coal- proximate and ultimate analysis- manufacture of metallurgical coke (Otto Hoffmann method) – Liquid fuels: petroleum- synthetic petrol Fischer-Trophs and Bergius processes- knocking- octane number- cetane number – Gaseous fuels: liquefied petroleum gases (LPG)- water gas- bio diesel. Combustion- flue gas analysis (ORSAT Method).

TEXT BOOK(S):

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd., NewDelhi,2010
2. Kannan P., Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai,2009

Chairman - BoS
Dept. of Chemical Engg. - ESEC

REFERENCE(S):	
1.	Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2010
2.	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi,2008.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	HS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS101	COMMUNICATIVE ENGLISH	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Acquire usage of grammar in English language.
- Develop listening skills which will enable to listen lectures and comprehend different types of texts.
- Enhance the reading skill to comprehend technical writings.
- Improve writing skills to express thoughts freely.
- Help learners develop their speaking skills and speak fluently in real contexts.

Course Outcomes: At the end of this course, learners will be able to:

- Improve their language usage in LSRW skills.
- Develop listening skills to comprehend general / technical talks.
- Acquire the ability to understand different written texts.
- Enhance the writing skills to express the ideas of the learners.
- Communicate fluently in real time context.

UNIT I	**LANGUAGE FOCUS**	**9**

Parts of speech - Word formation - Sentence types (declarative, imperative, exclamatory & interrogative) - Tense forms - Subject - Verb agreement - Verbs - Adverbs - Adjectives - Framing questions

UNIT II	**LISTENING**	**9**

Listening for specific information: Short conversations / monologues - Gap filling - Telephone conversations - Note-taking - Listening for gist / interviews - Listening to songs and completing the lyrics - Clear individual sounds - Word stress - Telephone etiquette

UNIT III	**READING**	**9**

Prediction - Skimming for gist - Scanning for specific information - Understanding text and sentence structure

UNIT IV	**WRITING**	**9**

Paragraph writing (descriptive, narrative, expository & persuasive) - Letter (formal and informal) - Dialogue writing - E-mail – Instructions

UNIT V	**SPEAKING**	**9**

Self-introduction - Giving personal and factual information - Talking about present circumstances, past experiences and future plans - Mini-presentation - Expressing opinions and justifying opinions - Agreement / disagreement - Likes and dislikes - Tongue twisters

TEXT BOOK(S):

1. Communicative English by KN Shoba, Lourdes Joavani Rayen Published by Cambridge University 2017.

REFERENCE(S):

1. Murphy, Raymond. "English Grammar in Use – A Self-Study Reference and Practice Book for Interm learners of English". IV edition. United Kingdom: Cambridge University Press. 2012.
2. Seely, John. "Oxford Guide to Effective Writing and Speaking". Indian ed. New Delhi: Oxford University Press. 2005.
3. Anderson, Kenneth,"Study Speaking: A Course in Spoken English for Academic Purposes". United Kingdom: Cambridge University Press 1992.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

4	Wren and Martin, "High school English Grammar and Composition", Publisher: S.Chand. 2019

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES101	PYTHON PROGRAMMING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand problem solving concepts.
- Understand why Python is a useful scripting language for developers and to read and write simple Python programs.
- Develop Python programs with conditionals and loops
- Use Python data structures — lists, tuples, dictionaries.

Course Outcomes: At the end of this course, learners will be able to

- Apply problems solving techniques to real world problems.
- Recognize and construct common programming idioms: variables, loop, branch, and input / output.
- Design, code, and test Python programs using List, Tuples and Strings
- Write code using dictionaries and functions
- Read and write data from/to files in Python Programs.

UNIT I	COMPUTATIONAL THINKING	9

Introduction to Computational Thinking –From abacus to machine – The first Software –First Modern Computer-Information and data - Converting information into data -Data Capacity Problem Solving Techniques: General Problem-Solving concepts-: Algorithm, Pseudo-code and Flowchart Problem Solving with Sequential Logic Structure - Problem Solving with Decisions - Problem Solving with Loops Case Study: Raptor and Scratch Tools.

UNIT II	INTRODUCTION TO PYTHON	9

History- Features - Setting up path - Working with Python -Basic Syntax - Variable and Data Types - Operator - Conditional Statements – Looping – Control Statements.

UNIT III	STRING MANIPULATION, LIST AND TUPLES	9

Creating String – Accessing Strings- Basic Operations - String slices - Function and Methods – Creating List - Accessing list - Operations on List - Working with lists - Function and Methods – Creating tuple - Tuple Operations – Functions and Methods

UNIT IV	DICTIONARIES AND FUNCTIONS	9

Creating Dictionaries - Accessing values in dictionaries - Working with dictionaries - Properties – Functions-Definingafunction-Callingafunction-Typesoffunctions-FunctionArguments- Anonymous functions - Global and local variables

UNIT V	MODULES, FILES AND EXCEPTION HANDLING	9

Modules - Importing module - Math module - Random module -Packages- Composition Files - Openingandclosingfile-FileOpeningModes-Readingandwritingfiles-FunctionsExceptionHandling -Exception - Exception Handling - Except clause - Try, finally clause User Defined Exceptions.

TEXT BOOK(S):

1,	David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman & Hall/CRC, 2014.
2,	M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011.

REFERENCE(S):

1.	Brian Heinold," Introduction to Programming Using Python", Mount St. Mary's University,

Chairman - BoS
Dept. of Chemical Engg. - ESEC

	2013.
2.	Michael Dawson, "Python Programming for the Absolute Beginner", 3rd Edition, 2010.
3.	Allen Downey, Green Tea Press Needham, "Think Python, How to Think Like a Computer Scientist", Massachusetts.
4.	Cunningham, sams teach yourself python in 24 hours, Second edition Pearson, 2014

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	Common to all Branches					R 2019	Semester I	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS01	SOFT SKILL -I	1	0	1	1.5	30	100	

Course Objective (s): The purpose of learning this course is

- To develop basic grammar knowledge in English.
- To enhance Speaking Skills in English
- To improve Verbal and Non-verbal Communication Skills
- To develop Confidence and Emotional Intelligence
- To develop Inter Personal Skills.

Course Outcomes: At the end of this course, learners will be able to:

- Have competent knowledge of grammar
- Speak fluent English by enriching Vocabulary Knowledge.
- Have good Presentation Skills through verbal and non-verbal communication.
- Handle any Situation with confidence by being emotionally stable.
- Work in a team by having team coherence and dealing with people.

UNIT 1	Effective English – Written English	6

Basic rules of Grammar - Parts of Speech – Tenses – Verbs.Sentence Construction.Dialogues and Conversations – Writing. Exercises to practice and improve these skills.

UNIT 2	Effective English – Spoken English	6

Vocabulary – Idioms & Phrases – Synonyms – Antonyms.Dialogues and Conversations –Writing. Exercises to practice and improve these skills.

UNIT 3	Art of Communication & The Hidden Data Involved	6

Verbal Communication - Effective Communication - Active listening –Paraphrasing – Feedback.

Non Verbal Communication - Body Language of self and others.
Importance of feelings in communication - dealing with feelings in communication.

UNIT 4	WORLD OF TEAMS – PART -01	6

Self Enhancement - importance of developing assertive skills- developing self-confidence – developing emotional intelligence.

UNIT 5	WORLD OF TEAMS – PART -02	6

Importance of Team work – Team vs. Group - Attributes of a successful team – Barriers involved Working with Groups – Dealing with People- Group Decision Making.

TOTAL : 30(15 Theory + 15 Practical) Hours

REFERENCES:

1. The Seven Habits of Highly Effective People - Stephen R. Covey.
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning – Viktor Frankl

Chairman - BoS
Dept. of Chemical Engg. / ESEC

4. The greatest miracle in the world – OgMandino
5. Goal - Eliyahu Goldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English – Sundra Samuel, Samuel Publications
8. Developing Communication Skills by Krishna Mohan and Meera Banerji; MacMillan India Ltd., Delhi
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India.
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. "Strategic interviewing" byRichaurd Camp, Mary E. Vielhaber and Jack L. Simonetti – Published by Wiley India Pvt. Ltd
12. "Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams , John K. Brilhart

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19ES104	PYTHON PROGRAMMING LABORATORY	L	T	P	C	30	100	
		0	0	2	1			

Course Objective (s): The purpose of learning this course is to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, and dictionaries.
- Read and write data from/to files in Python.

Course Outcomes: At the end of this course, learners will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

Exp No.	Name of Experiments
1	Find the Greatest among three numbers without using third variable
2	Sum of the Digits of a Number
3	Generation of Prime Numbers
4	Implement a sequential search
5	Create a calculator program
6	Explore string functions
7	Implement Selection Sort
8	Implement Stack
9	Read and write into a file
10	Demonstrate usage of basic regular expression
11	Demonstrate use of advanced regular expressions for data validation.
12	Demonstrate use of List
13	Demonstrate use of Dictionaries
14	Create Comma Separate Files (CSV), Load CSV files into internal Data Structure

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19ES106	ENGINEERING GRAPHICS	L	T	P	C	60	100	
		0	0	4	2			

Course Objectives: The purpose of learning this course is to:

- Learn conventions and use of drawing tools in making engineering drawings.
- Draw orthographic projection of points and lines.
- Draw the projection of planes and simple solids.
- Draw the section of solids and obtain the development of surfaces of given solids.
- Draw the isometric projection of the given solids.

Course Outcomes: At the end of this course, learners will be able to:

- Recognize the conventions and apply dimensioning concepts while drafting simple objects.
- Draw the orthographic projection of points and lines.
- Draw the projection of planes and simple solids.
- Draw the section of solid drawings and development of surfaces of given solids.
- Draw the isometric projection of the given objects.

CONCEPTS AND CONVENTIONS (Not for Examination) — 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES — 12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of triangle, square and circle – Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS AND LINES — 11

Orthographic projection- Principles-Principal Planes-First angle projection-projection of points. Projectionofstraightlines(onlyFirstangleprojections)inclinedtoboththeprincipalplanes- Determination of true lengths and true inclinations by rotating line method.

UNIT III PROJECTION OF PLANES & SOLIDS — 12

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes. Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES — 12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC PROJECTIONS — 12

Principles of isometric projection – isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.

TEXT BOOK(S):

1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2012.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

REFERENCE(S):

Chairman - BoS
Dept. of Chemical Engg. - ESEC

1.	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2.	Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3.	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4.	N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19ES107	WORKSHOP PRACTICES	L	T	P	C			
		0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment /tools.
- Gain the skills for making fitting joints and household pipe line connections using suitable tools.
- Develop the skills for preparing the green sand mould and to make simple household electrical connection
- Provide hands on training for dismantling and assembling of petrol engines, gear box and pumps.
- Develop the skills for making wood/sheet metal models using suitable tools.

Course Outcomes: At the end of this course, learners will be able to:

- Fabricate simple components using carpentry, sheet metal and welding equipment/tools
- Make fitting joints and household pipe line connections using suitable tools.
- Prepare green sand mould and make simple household electrical connections using suitable tools
- Dismantle and assemble petrol engines, gear box and pumps.
- Make simple models using wood and sheet metal.

Exp No.	Name of Experiments
1	Forming of simple object in sheet metal using suitable tools (Example: Dust Pan / Soap Box
2	Fabrication of a simple component using thin and thick plates. (Example: Book rack)
3	Making a simple component using carpentry power tools. (Example: Pen stand/Tool box/ Letter box.
4	Prepare a "V" (or) Half round (or) Square joint from the given mild Steel flat.
5	Construct a household pipe line connections using pipes, Tee joint, Four way joint, elbow, union, bend,Gate way and Taps (or) Construct a pipe connections of house application centrifugal pump using pipes,bend, gate valve, flanges and foot valve.
6	Prepare a green sand mould using solid pattern/split pattern.
7	Construct a domestic electrical wire connections using indicator, one way switch with calling bell, two way switch with lamp, one way switch with fan regulator and one way switch with socket.
8	Dismantling and assembly of Centrifugal Monoblock / Gear Pump / Gear box.
9	Dismantling and assembly of two stroke and four stroke petrol engine.
10	Mini Project (Fabrication of Small Components).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER II

Department	CHEMICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS201	VECTOR CALCULUS AND COMPLEX VARIABLES	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Summarize and apply the methodologies involved in solving problems related to fundamental principles of Calculus viz: Vector, Vector Differentiation and Vector Integration.
- Implement the Complex Analysis, an elegant method in the study of heat flow, fluid dynamics and electrostatics.
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.
- Defining a complex function and solving through complex integration

Course Outcomes: At the end of this course, learners will be able to:

- Characterize the calculus of vectors.
- Apply the theoretical aspects of vector integral calculus in their core areas.
- Recognize the differentiation properties of complex functions.
- Identify the complex functions and their mapping in certain complex planes.
- Use the concepts of integration to complex functions in certain regions.

UNIT I	DIFFERENTIATION OF VECTORS	12

Vector point function- Directional derivative - Gradient -Divergence -Curl - Solenoidal – Irrotational vector fields –Scalar potential

UNIT II	INTEGRATION OF VECTORS	12

Work done - Line Integral - Surface integral- Green's theorem in a plane- Stoke's Theorem- Gauss divergence theorem- Applications involving cubes and parallelepiped.

UNIT III	ANALYTIC FUNCTIONS	12

Analytic Functions- Necessary and Sufficient conditions of Analytic Function- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method -Applications to the problems of Potential Flow.

UNIT IV	MAPPING OF COMPLEX FUNCTIONS	12

Conformal mapping- Application of transformation: translation, rotation, magnification and inversion of multi valued functions - Linear fractional Transformation (Bilinear transformation).

UNIT V	COMPLEXINTEGRATION	12

Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent'sseries- Classification of Singularities - Cauchy's Residue Theorem

REFERENCE(S):

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015
2. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill

Chairman - BoS
Dept. of Chemical Engg. - ESEC

	Publishing Company Ltd, 2003
3.	J. A. Brown and R. V. Churchill, Complex Variables and Applications , Sixth Edition, McGraw Hill,New Delhi, 1996
4.	Peter V. O. Neil, Advanced Engineering Mathematics, Seventh Edition ,Cengage Learning India Private Limited, 2012
5.	Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India,2007

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS207	PHYSICS OF MATERIALS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To introduce the physics of various materials relevant to different branches of technology

Course Outcomes: At the end of this course, learners will be able :

- To gain knowledge on conducting materials,
- To acquire knowledge on basics of semiconducting materials and its applications
- To get knowledge on the magnetic materials and their applications,
- To understand the basic concepts of synthesis of nanomaterials and its uses,
- To have the necessary understanding on various advanced materials

UNIT I CONDUCTING MATERIALS 9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law – Lorentz number- Success and failures of classical free electron theory-Fermi-Distribution function – density of energy states-Effect of temperature on Fermi function

UNIT II SEMICONDUCTING MATERIALS 9

Elemental Semiconductors - Compound semiconductors – Intrinsic semiconductor -intrinsic carrier concentration (derivation) – Extrinsic semiconductor -carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration - Hall effect -Hall effect in n-type and p-type semiconductor– determination of Hall coefficient and applications

UNIT III MAGNETIC MATERIALS 9

Origin of magnetic moment-Bohr magneton-Introduction to magnetic materials – Properties of magnetic materials-Domain theory of ferromagnetism-Hysteresis- Soft and Hard magnetic materials – Anti-ferromagnetic materials-Ferrites and its application-Applications of magnetic materials in chemical industries

UNIT IV NANO MATERIALS 9

Nanomaterials: preparation (bottom up and top down approaches) – various techniques-chemical vapour deposition method, PVD method -Sol Gel method, solvothermal method, hydrothermal method, precipitation method and sono chemical method-properties and applications – carbon nanotubes: types and applications – Photocatalytic activity-de colorization of industrial effluent using nanomaterials and carbon nanotubes

UNIT V NEW ENGINEERING MATERIALS 9

Metallic glasses – Preparation, properties and applications-Shape memory alloys -.properties and applications-Fiber reinforced plastics and fiber reinforced metals-Ceramics-Classification-crystalline-Non crystalline-Bonded ceramics.

TEXT BOOK(S):

- Kasap, S.O. —Principles of Electronic Materials and Devicesll, McGraw-Hill Education, 2007.
- Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd. 2014.
- Wahab, M.A. —Solid State Physics: Structure and Properties of Materials, Narosa Publishing House, 2009.

Chairman - BoS
Dept. of Physics - ESEC

Chairman - BoS
Dept. of Chemical Engg. - ESEC

REFERENCE BOOK(S):

- Askeland, D. "Materials Science and Engineering". Brooks/Cole, 2010.
- Raghavan, V. "Materials Science and Engineering: A First course". PHI Learning, 2015.
- Smith, W.F., Hashemi, J. & Prakash. R. "Materials Science and Engineering". Tata Mc Graw Hill Education Pvt. Ltd., 2014.

Chairman - BoS
Dept. of Physics - ESEC

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	MC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MC202	ENVIRONMENTAL SCIENCE AND ECOLOGY	3	0	0	0	45	100	

Course Objective (s): The purpose of learning this course is to

- Realize the interdisciplinary and holistic nature of the environment
- Understand how natural resources and environment affect the quality of life and stimulate the quest for sustainable development
- Recognize the socio-economic, political and ethical issues in environmental science

Course Outcomes: At the end of this course, learners will be able to

- Assess the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources.
- Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
- Identify the existing environmental challenges related to pollution and its management.
- Select suitable strategies for sustainable management of components of environmental.
- Correlate the impacts of population and human activities on environment.

UNIT I	NATURAL RESOURCES	9

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use – over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, bio-magnification)-waterlogging-salinity-casestudies.Energyresources:renewable(solar,wind,tidal, Geo-thermal and hydroelectric power) - non - renewable energy sources.

UNIT II	ECOSYSTEMS AND BIODIVERSITY	9

Concept of an ecosystem: Structure and function of an ecosystem - producers- consumers - de-composers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value ofbiodiversity-threatstobiodiversity-endangeredandendemicspecies-Conservationofbiodiversity: In-situ and ex-situ conservation of biodiversity - field study.

UNIT III	ENVIRONMENTAL POLLUTION	9

Pollution: Definition - causes - effects - control measures of air pollution - water pollution: (Sewage water treatment by activated sludge and trickling filter process) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - Landslides

UNIT IV	SOCIAL ISSUES AND ENVIRONMENT	9

Sustainable development: Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes-effects-3RPrinciples(landfills,incineration,composting).Waterconservation-rainwater

Chairman - BoS
Dept. of Chemical Engg. - ESEC

harvesting -watershed management. Climate change- global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act.		
UNIT V	**HUMAN POPULATION AND ENVIRONMENT**	**9**
Human population: Population growth - characteristics- variation among nations - population explosion - women and child welfare programmes- value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA).		
TEXT BOOK(S):		
1.	Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering, 4th Multi ColourEdtion, New Age International Publishers, New Delhi, 2014	
2.	A. Ravikrishnan, Environmental Science and Engineering, 5th revised Edition, Sri Krishna Hitech Publishing company (P) Ltd, Chennai, 2010	
REFERENCE(S):		
1.	T. G. Jr. Miller,S.Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi,2014.	
2.	E. Bharucha, Textbook of Environmental studies, second Edition, Universities Press Pvt. Ltd., New Delhi, 2013.	
3.	A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.	

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES204	PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basic concepts of electric circuits and magnet ccircuits.
- Illustrate the construction and operation of various dc electrical machines.
- Illustrate the construction and operation of various ac electrical machines.
- Illustrate the construction and operation of various semiconductor devices.

Course Outcomes: At the end of this course, learners will be able to:

- Apply the fundamental laws to electric circuits and compute the different alternating quantities.
- Apply the laws of magnetism for the operation of DC machine.
- Examine the construction and working principle of different AC machines
- Apply the drive for different application and speed control methods of DC and AC motors.
- Analyze the performance characteristics and applications of semiconductor devices.

UNIT I	ELECTRIC CIRCUITS	9

Definition of Voltage, Current, Electromotive force, Resistance, Power & Energy, Ohms law and Kirchhoff's Law & its applications - Series and Parallel circuits - Voltage division and Current division techniques - Generation of alternating emf - RMS value, average value, peak factor and form factor- Definition of real, reactive and apparent power.

UNIT II	DC MACHINES	9

Introduction of magnetic circuits - Law of Electromagnetic induction – Principles and operation of DC Machines – EMF equation – Torque equation - Applications.

UNIT III	AC MACHINES	9

Single Phase and Three Phase Transformer - Single Phase and Three phase induction motor - Alternator – Constructions - Working Principle - Applications.

UNIT IV	ELECTRICAL DRIVES	9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives - heating and cooling curves – Loading conditions and classes of duty - Speed control methods of DC and AC motors

UNIT V	ELECTRONIC DEVICES AND COMMUNICATION	9

Characteristics of PN Junction diode and Zener diode - Half wave and Full wave Rectifiers – Bipolar Junction Transistor - Operation of NPN and PNP transistors - Logic gates - Introduction tocommunication systems.

TEXT BOOK(S):

1.	T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2.	Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010
REFERENCE(S):	
1.	A.Sudhakar,ShyammohanSPalli,CircuitsandNetworksAnalysisandSynthesis,TataMcGraw Hill, 2010
2.	R. S. Sedha, A Textbook of Applied Electronics, S.Chand& Company Ltd, 2013
3.	Muthusubramanian&Salivahanan, Basic Electrical and Electronics Engineeringand Communication Engineering, Seventh Edition, Tata Mc. Graw Hill Education Private Limited, 2011

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES211	INTRODUCTION TO CHEMICAL ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Introduce history, importance and components of chemical engineering
- Provide concepts of unit operations and unit processes, and current scenario of chemical and allied process industries.
- Provide Basic principles and calculations of chemical engineering; material balances and their applications.
- Provide basic principles of momentum, heat and mass transfer and equipment.
- Provide the foundation for Chemical reaction engineering and all subsequent Chemical Engineering courses.

Course Outcomes: At the end of this course, learners will be able to

- Awareness of career options, potential job functions, contemporary and professional issues.
- Understand what Chemical Engineering is and what careers are possible with a degree in Chemical Engineering.
- Acquire basic principles of momentum and heat transfer & heat transfer equipment.
- Acquire basic principles of mass transfer and equipment.
- Understand the reaction kinetics and various types of industrial reactors.

UNIT I	INTRODUCTION	9

Definition of Chemical Engineering, Role of Chemical Engineer in everyday life, History of Chemical Engineering and Chemical Technology; Scope of Chemical Engineering, nature of industries and applications. Flow diagram, Flow sheet, with simple examples. Batch Processing, continuous processing, transition from batch to continuous processing. Role of basic sciences in Chemical Engineering. Units & dimensions, Unit processes and Unit operations.

UNIT II	PRINCIPLES OF STOICHIOMETRY AND MOMENTUM TRANSFER	9

Principles of Stoichiometry: Stoichiometric relations, Basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity.

Momentum Transfer: Nature of a Fluid, viscosity, velocity profile, flow field, types of fluid motion, laminar and turbulent flow, conservation mass. Conservation of Energy, Total energy balance for steady flow, mechanical energy balance for study flow: Bernoulli's theorem, Friction loses in laminar flow through a circular tube: Hagen-Poiseuille equation, Friction losses in turbulent flow: Fanning equation.

UNIT III	HEAT TRANSFER	9

Conduction: Fourier's law, mean area of heat transfer, conduction through a composite plain wall. Convection: Newton's law of cooling, individual heat transfer coefficients, correlations for calculation of heat transfer coefficients, overall heat transfer coefficients and logarithmic mean temperature difference. Radiation: Stefan-Boltzmann law (Black body Radiation), radiation from the sun. Heat transfer equipment: Double pipe, shell & tube heat exchangers (description with diagrams).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

UNIT IV	MASS TRANSFER	9

Diffusion, Diffusion in different phases, diffusivity, role of concentration difference in diffusion, resistance to diffusion, diffusion in liquids, Relative volatility, Boiling point diagram. Distillation: Flash distillation, differential distillation, steam distillation, Fractional distillation McCabe-Thiele method. Mass Transfer Equipment: Equipment for Gas-Liquid operations plate and packed columns: description with diagrams.

UNIT V	MECHANICAL OPERATIONS AND CHEMICAL KINETICS	9

Introduction to Mechanical Operations: Size reduction, filtration, basic differences between agitation and mixing.

Chemical kinetics: Rate and order of the reaction, types of reactions, thermodynamic review, and determinationoftherateequation.Effectoftemperatureonreactionrate,catalysis,reactors(description with diagrams).

Text Books:

1. Introduction to Chemical Engineering, S. Pushpavanam, PHI Learning Private Limited, New Delhi (2012).
2. Introduction to Chemical Engineering, S. K. Ghosal, S. K. Sanyal & S. Datta, Tata McGraw-Hill,New Delhi (2006).

REFERENCES:

1. Unit Operations of Chemical Engineering, Warren L. McCabe, Julian C. Smith, Peter Harriot, 7th edition, McGraw Hill, NewDelhi.
2. ChemicalprocessPrinciplesPart–1,MaterialandEnergyBalancesbyO.A.Hougen,K.M.Watson, and R.A.Ragatz, 2nd Edition, John Wiley & Sons(2004).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	Common to all Branches					R 2019	Semester II	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS02	SOFT SKILL -II	1	0	1	1.5	30	100	

Course Objective (s): The purpose of learning this course is

- To train the Students on Group Discussion Do's and Don'ts.
- To coach the students on Interview Skills.
- To develop Presentation Skills.
- To develop Business Etiquette.
- To teach importance of Ethics and Values.

Course Outcomes: At the end of this course, learners will be able to:

- Participate Group Discussion with Confidence by knowing the tips and Tricks.
- Attend the interview with positive attitude by having Mock Interviews.
- Present them very well by enhancing their Presentation Skills.
- Behave very well in official gathering and Meeting by knowing Etiquette.
- Have good ethics and values in their Personal and Professional Life.

UNIT 1	GROUP DISCUSSION	6

GD skills – Understanding the objective and skills tested in a GD – General types of GDs – Roles in a GD – Do's & Don'ts – Mock GD & Feedback.

UNIT 2	INTERVIEW SKILLS	6

Interview handling Skills – Self preparation checklist – Grooming tips: do's & don'ts – mock interview & feedback.

UNIT 3	PRESENTATION SKILLS	6

Presentation Skills – Stages involved in an effective presentation – selection of topic, content, aids – Engaging the audience – Time management – Mock Presentations & Feedback.

UNIT 4	Business Etiquette	6

Grooming etiquette – Telephone & E-mail etiquette – Dining etiquette – do's & Don'ts in a formal setting – how to impress.

UNIT 5	Ethics	6

Ethics – Importance of Ethics and Values – Choices and Dilemmas faced – Discussions from news headlines.

TOTAL : 30(15 Theory +15 Practical) Hours

REFERENCES:

1. The Seven Habits of Highly Effective People - Stephen R. Covey.
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning – Viktor Frankl
4. The greatest miracle in the world – OgMandino
5. Goal - Eliyahu Goldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English – Sundra Samuel, Samuel Publications

Chairman - BoS
Dept. of Chemical Engg. - ESEC

8. Developing Communication Skills by Krishna Mohan and Meera Banerji; MacMillan India Ltd., Delhi.
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India.
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. "Strategic interviewing" byRichaurd Camp, Mary E. Vielhaber and Jack L. Simonetti – Published by Wiley India Pvt. Ltd
12. "Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams , John K. Brilhart

Chairman - BoS
Dept. of Chemical Engg. - BSEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS208	ENGINEERING CHEMISTRY LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.
- Determine of total, temporary & permanent hardness of water by EDTA method.
- Determine of chloride content of water sample by argentometric method & iron content of the given solution using potentiometer.
- Determine of strength of given hydrochloric acid using pH meter & Conductometric titration of strong acid vs strong base.

Course Outcomes: At the end of this course, learners will be able to

- Apply principles of elasticity, optics and thermal properties for engineering applications.
- Make the student to acquire practical skills in the determination of water quality parameters
- through volumetric analysis.
- Acquire the knowledge about chloride content in water sample.
- Make the student to acquire practical skills about strength of iron using potentiometric titrations.
- Understand the how to estimate hydrochloric acid in water sample using pH meter & conductance of ions.

LIST OF EXPERIMENTS

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of chloride content of water sample by argentometric method.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Determination of strength of acids in a mixture of acids using conductivity meter.
5. Estimation of iron content of the given solution using potentiometer.
6. Conductometric titration of strong acid vs strong base.
7. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer
8. Estimation of iron content of the water sample using spectrophotometer

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

1. Potentiometer 10 Nos.
2. pH meter 10 Nos.
3. Conductivity meter 10 Nos.
4. Spectrophotometer 2 Nos.
5. Oswald viscometer 30Nos.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES222	CHEMICAL ANALYSIS LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Make the student acquire practical skills in the wet chemical and \ instrumental methods for quantitative estimation of nitrite in water, cement, oil, coal and Phenol.

Course Outcomes: At the end of this course, learners will be able to

- Familiarize with equipment like viscometers, flash and fire point apparatus etc
- Familiarize the methods for determining COD
- Familiarize a few simple synthetic techniques for soap.

LIST OF EXPERIMENTS

1. Determination of Redwood / Saybolt numbers, kinematic viscosity and viscosity index of Lubricating oils.
2. Determination of flash point, fire point, cloud and pour point of oils
3. Determination of acid value and iodine value of oils
4. Determination of COD of water samples
5. Cement Analysis A. Estimation of silica content b. Estimation of mixed oxide content c. Estimation of calcium oxide content d. Estimation of calcium oxide by rapid method.
6. Coal Analysis a. Estimation of sulphur present in coal b. Ultimate analysis of coal c. Proximate analysis of coal.
7. Soap Analysis a. Estimation of total fatty acid b. Estimation of percentage alkali content
8. Flue gas analysis by Orsat's apparatus
9. Estimation of phenol.
10. Determination of calorific value using bomb calorimeter
11. Determination of nitrite in water.

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

1. Silica Crucible 20 Nos.
2. Heating Mantle 3 Nos.
3. Muffle Furnace 1 Nos.
4. Hot air oven 1 Nos.
5. Desiccator 5 Nos.
6. Vacuum Pump 1 No.
7. Condenser 10 Nos.
8. Reflux Condenser 10 Nos.
9. Pensky martens closed cup apparatus 1 No.
10. Cleveland Open cup apparatus 1 No.
11. Cloud point apparatus 1 No.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER III

Department	CHEMICAL ENGINEERING					R 2019	Semester III	BS
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS302	PROBABILITY AND STATISTICS	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- To understand the basic concepts of probability and the distributions with characteristics
- To summarize and apply the methodologies for the data analysis using statistical notions.
- To develop enough confidence to identify and model mathematical patterns in real world and offerappropriatesolutions,usingtheskillslearnedintheirinteractiveandsupporting environment.

Course Outcomes: At the end of this course, learners will be able to:

- Demonstrate and apply the basic probability axioms and concepts in their core areas.
- Apply the concepts of probability distributions in an appropriate place of science and Engineering.
- Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
- Design an experiment for an appropriate situation using ANOVA technique.
- Correlate and predict the valid outcome of a real time problem

UNIT I	PROBABILITY AND RANDOM VARIABLE	12

Probability - Axioms of probability - Conditional probability - Total probability - Baye's theorem -Random variable-Probabilitymassfunction-Probabilitydensityfunction-Properties–Momentgenerating functions.

UNIT II	PROBABILITY DISTRIBUTIONS	12

Moment generating functions of probability distributions- Concept and applications of standard probability distributions: Binomial- Poisson- Uniform -Exponential –Normal- Weibull distributions.

UNIT III	TESTING OF HYPOTHESIS	12

Sampling distributions – Estimation of parameters – Statistical hypothesis – Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, Chisquare and F distributions for mean, variance and proportion – Contingency table (test for independent) – Goodness of fit.

UNIT IV	DESIGN OF EXPERIMENTS	12

One way and Two way classifications – Completely randomized design – Randomized block design – latin square design

UNIT V	CORRELATION AND REGRESSION	12

Correlation –Multiple correlation-Regression-Multiple regression-Linear fit-Quadratic fit.

REFERENCE(S):

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning,New Delhi, 8th Edition, 2012.
2. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th Edition,2007.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

3.	Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier,2004.
4.	Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition,2004.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R 2019	SEMESTER III	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH301	ORGANIC CHEMISTRY FOR CHEMICAL ENGINEERS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- To study the reaction mechanism of electrophilic and nucleo philic reactions.
- To understand the preparation, important reactions and applications of carbohydrates.
- To know preparation, property and uses of polynuclear aromatic and hetero cyclic compounds.
- To gain the knowledge about classification and synthesis of proteins and amino acids.
- To learn the synthesis, properties and classifications of drugs and dyes.

Course Outcomes: At the end of this course, learners will be able to:

- Students able to write the reaction mechanism of electrophilic and nucleophilic reactions.
- Students acquire the knowledge about carbohydrates.
- Know the preparation, properties and uses of polynuclear heterocyclic compounds.
- Knowledge on classification and synthesis of proteins and amino acids.
- Students will have knowledge on various types of drugs and dyes.

UNIT I	ORGANIC REACTION MECHANISM	9

Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene $CH_3 - CH = CH_2$.

UNIT II	CARBOHYDRATES	9

Introduction – mono and disaccharides – important reactions – polysaccarides – starch and cellulose – derivatives of cellulose – carboxy methyl cellulose and gun cotton – structural aspects of cellulose.

UNIT III	POLYNUCLEAR AROMATICS AND HETEROCYCLES	9

Classification of polynuclear aromatics. Naphthalene preparation, properties and uses. Classification of heterocyclic compounds. Furan, Thiophene, pyrrole, pyridine, quinoline, isoquinoline -preparation, properties and uses.

UNIT IV	AMINO ACIDS AND PROTEINS	9

Classification, preparation (Strecker, Skraup, Gabriel phthalimide) and properties of Amino acids. Composition and classification of proteins. Structure of proteins – tests for proteins – general properties and relations of proteins – hydrolysis of proteins.

UNIT V	DRUGS & DYES	9

Classification and properties of drugs. Penicillin sulpha drugs, mode of action, synthesis of sulphanilamide, chloroquine and chloroamphenicol. Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing. Synthesis of dyes. Malachite green, methyl orange, congo red, phenolphthalein.

Text Books:

Chairman - BoS
Dept. of Chemical Engg. - ESEC

1.	B.S.Bhal and Arun Bhal, "A Text Book of Organic Chemistry", 17th Ed., S Chand & Co. New Delhi, 2005.
2.	R.T. Morrison and R.N. Boyd "Organic Chemistry", 7thEd., Prentice Hall Inc. USA, 2010.
Reference Books:	
1.	Jonathan Clayden, Nick Greeves, Staurt Warren and Peter Wothers, "Organic Chemistry", Oxford University Press, 2ndEd., New Delhi, 2013.
2.	K.S. Tiwari, N.K. Vishnoi, S.N. Mehrotra, "A Text Book of Organic Chemistry", Vikas Publishing House, 2ndEd., New Delhi, 2006.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	SEMESTER III	ES
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES303	ENGINEERING THERMODYNAMICS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Provide the students with the terminology of thermodynamics like system, properties, Processes, reversibility, equilibrium, phases, components; the relationship between heat and work by understanding the significance of the first law of thermodynamics.
- Learn how to estimate the thermal and volumetric properties of real fluids.
- Understand the limitations imposed by the second law of thermodynamics on the conversion of heat to work.
- Understand the applications of first and second law of thermodynamics to specific process. To understand the concept of adiabatic and theoretical flame temperatures and to explain the effect of temperature on the enthalpy change of a chemical reaction.

Course Outcome: At the end of this course, learners will be able to

- Understand the scope and relevance of Chemical Engineering Thermodynamics. Students will be able to estimate the volumetric properties of pure fluids.
- State the second law of thermodynamics and to estimate the efficiency of heat engines.
- Apply the concepts of first and second law of thermodynamics to analyze the specific process.
- Perceive the principles of heat effects of industrial reactions and temperature dependency of heat of reaction.

UNIT I	THE FIRST LAW AND OTHER BASIC CONCEPTS	9

Relevance and scope of chemical engineering thermodynamics, internal energy, first law of thermodynamics, energy balance for closed systems, Thermodynamic state and state functions. Equilibrium, the phase rule, the reversible process, constant volume and constant pressure processes, enthalpy, heat capacity, mass and energy balances for open systems.

UNIT II	PVT BEHAVIOR OF PURE SUBSTANCES	9

PT and PV diagram, the ideal gas, equations for process calculations (for an ideal gas in any mechanically reversible closed- system process): isothermal process, isobaric process, isochoric process, adiabatic process, and polytrophic process. Ideal gas equation. Virial equations of state, Application of the virial equations, introduction to cubic equations of state: Vander Waals equation, Redlich/Kwong equation, theorem of corresponding states; acentric factor. Generalized correlations for gases and liquids.

UNIT III	THE SECOND LAW OF THERMODYNAMICS	9

Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale. Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, and entropy from the microscopic view point, calculation of ideal work and lost work.

UNIT IV	APPLICATIONS OF THERMODYNAMICS TO FLOW PROCESSES	9

Principles of conservation of mass, entropy and energy for flow systems, analysis ofexpansion processes; turbines, throttling; compression processes –compressors and pumps. Refrigeration, Carnotrefrigeration,vapor–compressioncycle,choiceofrefrigerant,absorptionrefrigeration,Heat

Chairman - BoS
Dept. of Chemical Engg. - ESEC

pump, liquefaction processes: Linde liquefaction process, Claude liquefaction process.		
UNIT V	**HEAT EFFECTS**	**9**
Sensible heat effects, temperature dependence of heat capacity, heat effects accompanying the phase changes. The standard heat of reaction, formation and combustion, temperature dependence of heat of reaction, heat effects of industrial reactions.		
Text Books:		
1.	"Introduction to Chemical Engineering Thermodynamics", Smith, J.M., Van Ness,H.C., and Abbott, M.M., 8thEdition, McGraw Hill. 2018.	
Reference Books:		
1.	K.V. Narayana, "A textbook of Chemical Engineering Thermodynamics," 2nd edition, PHI. 2004.	
2.	Daubert, "Chemical Engineering Thermodynamics", McGraw Hill. 1985.	
3.	Y.V.C.Rao, "Chemical Engineering Thermodynamics", Universities press. 1997.	

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R 2019	SEMESTER III	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH302	FLUID MECHANICS FOR CHEMICAL ENGINEERS	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Introduce basis and models for fluids. To provide basis for formulating conservative principles.
- Provide an understanding about compressible fluids and flow past immersed bodies.
- Study methods for transporting and measuring of flow in various conduits. To study Quantitative laws and equation of fluid flow.

Course Outcome: At the end of this course, learners will be able to

- Apply the concept of hydrostatic equilibrium and to have a knowledge on fluid flow Phenomena.
- Determine engineering design quantities for laminar and turbulent flows. To work with compressible fluids, packed bed and fluidized bed columns.
- Work with variety of pumps and to estimate pressure losses due to various flow measuring Apparatus.
- Handle important engineering tasks of moving fluids through process equipment and measuring and controlling inflow.

UNIT I	INTRODUCTION	9

Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II	FLUID STATICS	9

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer– Differential analysis of fluid motion– continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.

UNIT III	DIMENSIONAL ANALYSIS	9

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

UNIT IV	FLOW THROUGH IN PIPES	9

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V	FLOW MEASUREMENT	9

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

Text Books:

1. Unit Operations of Chemical Engineering, Warren L .Mc Cabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Reference Books:	
1.	Unit Operations, Brown et al. – Asia Publishing House.
2.	Perry's Chemical Engineers Hand Book, Robert H. Perry, 7th edition, McGraw Hill
3.	Coulson & Richardson's Chemical Engineering, Volume-1, J.F. Richardson, J. H. Harker and J. R. Backhurst, 4th edition, Elsevier.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER III	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH303	CHEMICAL PROCESS CALCULATIONS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand the stoichiometric approach to chemical reactions.
- Comprehend important principles such as Ideal gas Law, Raoult's Law and Humidity charts
- Understand the tie substance, conversion and yield. Comprehends and solves the material balances in a simple flow sheet involving chemical reactions.'
- Solve the energy balance in simple mixing and with reactions.

Course Outcome: At the end of this course, learners will be able to

- Troubleshoot problems in material flow rate handling in chemical Iproduction.
- Apply Ideal gas law for gaseous mixtures and gases in chemical reactions.
- Design air flow rates in drying and humidification processes.
- Calculate the yield in chemical production processes.
- Calculate energy requirement.

UNIT I	INTRODUCTION	9

Stoichiometric and composition relationships: Units and dimensions, Conservation of mass, Stoichiometric relations, Basis of calculations, methods of expressing the composition of mixtures and solutions, density and specific gravity. **Behavior of ideal gases:** Introduction, Applications of the Ideal-gas law, gaseous mixtures, volume changes with changes in composition, Gases in Chemical reactions.

UNIT II	VAPOUR PRESSURE AND HUMIDITY	9

Vapor Pressures: Introduction, Effect of temperature on vapor pressure, vapor pressure plots, vapor pressure of immiscible liquids, solution. **Humidity and Saturation:** Introduction, vaporization process, condensation, wet-bulb and dry bulb thermometry, psychometric charts.

UNIT III	MATERIAL BALANCES	9

Material Balances: Introduction, Material balances without chemical reaction. Material balances with chemical reaction. Material balances for unsteady state system, Calculations involving condensation, evaporation drying, dissolution and crystallization

UNIT IV	RECYCLE SYSTEM	9

Basic concepts of Limiting reactant, excess reactant, selectivity, and yield. Basic concepts of recycle bypass and purge streams. Material balances for non-reactive systems with recycle stream. Material balances for reactive systems with recycle stream.

UNIT V	ENERGY BALANCES	9

Thermo Physics: Introduction, Energy, energy balances, heat capacity of gases, heat capacities of solids, heat capacity of liquid and solutions, latent heats, heat of vaporization, evolution of enthalpy, enthalpy of humid air.

Thermo Chemistry: Introduction, Thermo chemistry of solution, Effect of pressure on heat of reaction, Heat of reaction at constant pressure and at constant volume, Effect of temperature on heat of reaction, Temperature of reaction, Theoretical flame temperature, Actual flame temperature.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Text Books:	
1.	Process Calculations, V.Venkataramani, N.Anantharaman, 2nd Edition, Kindle Edition.
2.	Chemical process Principles Part–1, Material and Energy Balances by O.A.Hougen,K.M. Watson, and R.A.Ragatz, 2nd Edition, John Wiley & Sons(2004).
3.	Basic Principles and Calculations in Chemical Engineering by David M.Himmelblau and James B.Riqqs,7th edition, Prentice Hall India(2003).
Reference Books:	
1.	Stoichiometry by B. Bhatt and S.Vora, 4th edition, Tata McGraw Hill(2004).
2.	Stoichiometry and Process Calculations by K. V. Narayanan and B. Lakshmikutty, Prentice-Hall of India Private Limited, New Delhi.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R 2019	Semester III	MC
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19MC301	INDIAN CONSTITUTION	2	0	0	0	30	100

Course Objective (s): The purpose of learning this course is

- To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: At the end of this course, learners will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 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 direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of1956.

UNIT I	HISTORY OF MAKING OF INDIAN CONSTITUTION	5
History of Indian Constitution - Drafting Committee, (Composition & Working)		
UNIT II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**5**
Preamble - Salient Features		
UNIT III	**CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES**	**5**
Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation -Right to Freedom ofReligion-CulturalandEducationalRights-RighttoConstitutionalRemedies-DirectivePrinciplesof State Policy - Fundamental Duties.		
UNIT IV	**ORGANS OF GOVERNANCE**	**5**
Parliament - Composition - Qualifications and Disqualifications - Powers and Functions Executive - President - Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications - Powers and Functions.		
UNIT V	**LOCAL ADMINISTRATION**	**5**
District's Administration head: Role and Importance, - Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation - Pachayati raj: Introduction, PRI: Zila Pachayat - Elected officials and their roles, CEO Zila Pachayat: Position and role- Block level: Organizational Hierarchy (Different departments) -Village level: Role of Elected and Appointed officials - Importance of grass root democracy.		
UNIT VI	**ELECTION COMMISSION**	**5**

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies forthe welfare of SC/ST/OBC and women
TEXT BOOK(S):
1. "The Constitution of India", 1950 (Bare Act), Government Publication
2. Dr. S. N. Busy, "Dr. B. R. Ambedkar Framing of Indian Constitution", 1st Edition, 2016.Ava Publishers
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis,2014.
REFERENCE (s)
1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	COMMON TO ALL BRANCHES					R 2019	Semesterlll EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19TPS03	QUANTITATIVE APTITUDE AND LOGICAL REASONING - I	2	0	0	0	30	100

Course Objective (s):

- To crack aptitude assessment by using speed math concepts.
- To solve problems using fast track method by learning simplification and numbers.
- To learn the basic of ratio and proportion and mixture concepts.
- To calculate different ways of solving problems on average and ages.
- To learn the logical skills by analyzing the objects.

Course Outcomes: At the end of this course, learners will be able to:

- Solve the question with speed and accuracy.
- Crack the quantitative aptitude questions by using simplification and numbers system.
- Solve most of the aptitude topics by knowing ratio and proportion topics with allegation.
- Solve the problems on average and ages by using logical way of approach.
- Develop their logical thinking.

UNIT 1	SPEED MATHS AND NUMBER SYSTEMS	6

SPEED MATHS: Square and square roots – Square for numbers from 31 to 50. Finding squares of numbers between 81 to 100. Cubes and cubes roots.

NUMBER SYSTEMS: Numbers and types of Numbers – Properties of Numbers –Face value and place value - Divisibility rules – Concept on unit digit and remainder theorem.

UNIT 2	SIMPLIFICATIONS & PROBLEMS ON NUMBERS	6

SIMPLIFICATIONS: BODMAS rule – Application of algebraic formulae –Simplification of decimal fraction & mixed fraction – Continued fraction and its simplification – Recurring decimals.
PROBLEMS ON NUMBERS: Set of numbers – Assume the unknown numbers and form equations

UNIT 3	RATIO &PROPORTION ,ALLIGATIONS& MIXTURE	6

.**RATIO AND PROPORTION:** Ratio between two or more persons – Miscellaneous problems.
ALLIGATIONS ANS MIXTURES: Definition – Allegation rule – Mean value (or cost price) of the mixture – Six golden rules to solve problems on mixture – Removal among the quantities more than two.

UNIT 4	AVERAGES &PROBLEM ON AGES	6

AVERAGES: Average from total –Total from the average – Miscellaneous problems.

PROBLEMS ON AGES: Ages - Persons in Past - Present - Future. Miscellaneous problem.

UNIT 5	ANALOGY & MIRROR & WATER IMAGES	6

ANALOGY: Study and topic relationship – Worker and tool relationship – Tool and action relationship – Work and working place – Worker and product – Product and raw materials – Instrument and measurement – Quantity and unit – Animals and young ones – Male and female.

Chairman - BoS
Dept. of Chemical Engg - ESEC

MIRROR IMAGES AND WATER IMAGES: Letter inverted – Object inverted.
TOTAL : 30 HOURS

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning" Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018.
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication,2020.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER III	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH304	FLUID MECHANICS LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

Course Outcome: At the end of this course, learners will be able to

- Use variable area flow meters and variable head flowmeters
- Analyze the flow of fluids through closed conduits, open channels and flow past immersedbodies
- Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties

LIST OF EXPERIMENTS

- Viscosity measurement of non-Newtonian fluids
- Calibration of constant and variable head meters
- Calibration of weirs and notches
- Open drum orifice and draining time
- Flow through straight pipe
- Flow through annular pipe
- Flow through helical coil and spiral coil
- Losses in pipe fittings and valves
- Characteristic curves of pumps (Centrifugal / Gear /Reciprocating)
- Pressure drop studies in packed column
- Hydrodynamics of fluidized bed
- Drag coefficient of solid particle

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

- Viscometer 1No.
- Venturi meter 1No.
- Orifice meter 1No.
- Rotameter 1No.
- Weir and Notches 1No.
- Open drum with orifice 1No.
- Pipes and fittings 1No.
- Helical and spiral coils 1No.
- Centrifugal pump / Gear pump / Reciprocating 1No
- Packed column 1 No. 11. Fluidized bed 1No.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER III	ES
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES306	ELECTRICALENGINEERING LABORATORY FOR CHEMICAL ENGINEERS	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Gain knowledge on characteristics of Electrical machines and Electronic Devices

Course Outcome: At the end of this course, learners will be able to

- Analyze the characteristics of DC generators
- Analyze and test different DC motors
- Test and analyze the different AC motors &transformers

LIST OF EXPERIMENTS

- Ohm's law and Kirchoff's law
- Diode characteristics
- Open circuit characteristics of a dc shunt generators
- Load characteristics of a dc shunt generators
- Load test of D.C. shunt motor
- Load test on single phase induction motor
- Equivalent circuit of a transformer
- Swinburn's test
- Load test on 3- phase squirrel cage induction motor
- Load test on 1 –phase transformer
- Characteristics of half and full wave rectifiers

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester III	EEC
CourseCode	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS301	COMMUNICATION SKILLS	0	0	2	0	30	100	

Course Objective (s): The purpose of learning this course is

- To involve the students in effective listening activities.
- To improve the oral communication skills in proper manner.
- To focus the effective reading of general and technical text.
- To enhance and comprehend the written text.
- To integrate LSRW skills.

Course Outcomes: At the end of this course, learners will be able to

- Understand the technical talks.
- Communicate to his peer group properly.
- Comprehend the general and technical text.
- Write the reports and job application in clear manner.
- Integrate LSRW skills.

UNIT I	LISTENING	6

Listening and its importance –Listening strategies - Listen to a process information - give information, as part of a simple explanation - Being an active listener: giving verbal and non-verbal feedback – taking lecture Notes

UNIT II	SPEAKING	6

Give personal information - ask for personal information - express ability - ask for clarification - pronunciation basics - pronunciation practice - conversation starters: Pep talk - stressing syllables and speaking clearly - summarizing academic readings and lectures

UNIT III	READING	6

Strategies for effective reading - Read and recognize different types of texts - Predicting content using photos and title - Read for details - Use of graphic organizers to review and aid comprehension - Understanding pronoun reference and use of connectors in a passage- speed reading techniques

UNIT IV	WRITING	6

Plan before writing - Develop a paragraph: topic sentence, supporting sentences, concluding sentence – Write a descriptive paragraph – Write a paragraph with reasons and examples - Write an opinion paragraph – E-mail writing - Types of essays- descriptive-narrative- issue-based-argumentative-analytical

UNIT V	INTEGRATION OF LSRW	6

Task based Instruction: watching a video – Listing, Sorting, ordering, comparing and analyzing the ideas – Reading a newspaper and creating topic-based videos

TEXT BOOK(S):

1	Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011
2	Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011
3	Richards,C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

REFERENCE(S):

Chairman - BoS
Dept. of Chemical Engg. - KSEC

1.	Davis, Jason and Rhonda Liss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
2.	E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan
3.	Anderson, Kenneth et al. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press 1992.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER IV

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	BS
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS402	NUMERICAL METHODS	3	1	0	4	60	100	

Course Objectives: The purpose of learning this course is to

- Introduce the basic concepts of solving algebraic and transcendental equations.
- Introduce the numerical techniques of interpolation in various intervals in real life situations.
- Acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- Acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- Understand the knowledge of various techniques and methods of solving various types of partial differential equations.

Course Outcome: At the end of this course, learners will be able to

- Understand the basic concepts and techniques of solving algebraic and transcendental equations.
- Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

Unit I	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

Unit II	INTERPOLATION AND APPROXIMATION	12

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

Unit III	NUMERICAL DIFFERENTIATION AND INTEGRATION	12

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

Unit IV	INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS	12

Single step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

Unit V	BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	12

Finite difference methods for solving second order two - point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Text Books:	
1.	Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2.	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015
Reference Books:	
1.	Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2.	Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6thEdition, New Delhi, 2006.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester IV	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH401	PHYSICAL CHEMISTRY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Know the electrical conductance, resistance, cell constant, electrode potential, emf series and its applications.
- Understand the types of corrosion and its mechanism, prevention methods.
- Know the phase diagram of one component and two component systems.
- Understand the preparation, properties of colloidal particles.
- Know conditions for the validity of the distribution law and osmosis and osmotic pressure.

Course Outcomes: At the end of this course, learners will be able to:

- Know the conductance, resistance, electrode potential, emf series and its applications.
- Students acquire the knowledge about types of corrosion and its prevention methods.
- Students can calculate the phase, component and degree of freedom of one and two component systems.
- Know the preparation, properties and uses of colloids, emulsion,gels.
- Knowledge on omosis and osmotic pressure and colligative properties.

Unit I	ELECTROCHEMISTRY	9

Electrical Resistance - Specific Resistance - Electrical conductance - Specific Conductance - Equivalent Conductance - Cell Constant - Determination of Cell Constant - Variation of conductance with dilution - Kohlrausch's law - Single electrode potential - Galvanic cell - Cu - Zn cell - EMF and its measurement - Reference electrode - Standard hydrogen Electrode - Calornel electrode - Nerst equation - Electrochemical series - Applications of EMF Measurements.

Unit II	CORROSION AND ITS CONTROL	9

Introduction - Dry or Wet Corrosion Types - Wet or Electrochemical Corrosion - Mechanism - Galvanic corrosion - Concentration Cell Corrosion - Soil Corrosion - Pitting Corrosion- pipeline corrosion - Water line Corrosion - Factors influencing Corrosion and Corrosion Control.

Unit III	PHASE EQUILLIBRIA	9

Phase - Components - Degrees of freedom - The Gibbs Phase rule - Derivation of the Phase rule - One Component system - The water System - The Sulphur System - Two Component system -Lead-Silver System - Desilverisation of Lead ,Thermal analysis - cooling curves.

Unit IV	COLLOIDS	9

Introduction to colloids - Classification of Colloids - Preparation of lyophobic colloidal solutions - Purification of Colloidal Solutions - Properties of Colloids - Origin of charge on colloidal particles - Determination of Size of colloidal particles - Donnan Membrane equilibrium - Emulsions - Gels - Application of Colloids in Catalysis and drug delivery systems.

Unit V	THE DISTRIBUTION LAW AND COLLIGATIVE PROPERTIES	9

Chairman - BoS
Dept. of Chemical Engg. - SSEC

Distribution Co-efficient - Distribution Law -I_2-CCl_4-H_2O System - Nature of interaction of the solute with one of the solvents - Dissociation - Association - applications of Distribution law - Process of Extraction - Colligative properties - Vapour Pressure Lowering - Osmosis and Osmotic Pressure - The boiling Point elevation - The freezing point depression.	
TEXT BOOK(S):	
1.	Kundu and Jain, Physical Chemistry, S. Chand and Company, New Delhi (1996).
2.	Puri B. H. Sharma L.R. and M.S. Prathma, " Principles of Physical Chemistry", S. Chand and Company, New Delhi(2005).
3	B.S.Bahl, ArunBahl and G.D. Tuli, "Essentials of Physical Chemistry", S. Chand and Company, New Delhi , (2005).
REFERENCE(S):	
1.	Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (1998).
2.	Peters Atkins & Julio de Paula, Atkins' Physical Chemistry, 8th Edition, Oxford university press. (2006).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH402	CHEMICAL ENGINEERING THERMODYNAMICS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

Learn the estimation of thermodynamic properties of fluids and to provide the knowledge on power cycles.

- Learn the concepts of solution thermodynamics and estimation of the fugacity coefficients.
- Develop the theoretical foundation for applications of thermodynamics to gas mixtures and liquid solutions and to familiarize on vapour liquid equilibrium.
- Perform the phase equilibrium calculations using simple models to provide knowledge on phase equilibria.
- Determine the effect of temperature, pressure on the equilibrium conversion of chemical reactions.

Course Outcomes:

- Estimate the thermodynamic properties of pure fluids and to apply the power cycles for the production of heat.
- Estimate partial properties and fugacity coefficients.
- Apply the concepts of solution thermodynamics to estimate the properties of gas mixtures and liquid solutions.
- Perform the bubble point and dew point calculations.
- Estimate the equilibrium compositions of mixtures under chemical reaction equilibria.

UNIT I	THERMODYNAMIC PROPERTIES OF FLUIDS	9

Property relations for homogeneous phases, Maxwell's equations, residual properties, two phase systems, thermodynamic diagrams, generalized property correlations for gases. Production of power from heat: steam power plant, Rankine cycle. Otto engine, Diesel engine, Jet engines (Qualitative Discussion only).

UNIT II	SOLUTION THERMODYNAMICS	9

Fundamental property relation, chemical potential, criterion for phase equilibria, partial properties, ideal gas mixtures. Fugacity and fugacity coefficients, generalized correlations for fugacity coefficients, the ideal solution, excess properties.

UNIT III	SOLUTION THERMODYNAMICS APPLICATIONS	9

Liquid phase properties from VLE data, activity coefficient, excess Gibb's energy, Gibb's Duhem equation, data reduction, thermodynamic consistency, models for excess Gibb's energy, property changes of mixing, heat effects of mixing processes.

Vapor-Liquid Equilibrium: Nature of equilibrium, Phase rule, Duhem's Theorem, VLE: Qualitative behavior, simple models for VLE, Dew point and bubble point calculations.

UNIT IV	VLE FROM MODIFIED RAOULT'S LAW	9

Dew point and bubble point calculations. VLE from k – values correlations and flash calculations. Topics in phase Equilibria: VLE from cubic equations of state, Equilibrium and stability, liquid-liquid equilibrium (LLE), vapor- liquid–liquid equilibrium (VLLE), solid-liquid equilibrium (SLE), solid vapor equilibrium (SVE).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

UNIT V	CHEMICAL REACTION EQUILIBRIUM	9
The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs Energy change and the equilibrium constant, Effect of temperature on the equilibrium constant, evaluation of equilibrium constants. Relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems, Multireaction equilibria.		
Text Books:		
1.	Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness, H.C., and Abbott,M.M., 6thEdition, McGraw Hill.	
Reference Books:		
1.	Chemical Engineering Thermodynamics, Daubert, McGraw Hill.	
2.	Chemical Engineering Thermodynamics, Y.V.C.Rao, University Press.	
3.	A textbook of Chemical Engineering Thermodynamics by K.V. Narayana, PHI.	

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH403	MECHANICAL OPERATIONS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Learn the equipment involved in mechanical separation, mixing and size reduction.
- Learn mathematical problems related to different unit operations by using different laws to learn about the basic concepts of screening procedure.
- Learn the unit operations involved in the contacting and physical separation of phases, such as filtration, sedimentation and centrifugation, floatation is also studied.
- Learn the concepts of clarifiers, cyclone separators, and other separation equipment.

Course Outcome: At the end of this course, learners will be able to

- Understand the characterization of solid particles and Properties of particulate.
- Solve mathematical problems related to comminution operations by using different laws.
- Choose appropriate screening equipment and calculate the screening effectiveness.
- Understand the concepts of filtration, equipment and design of filtration equipment.
- Understand the concepts of clarifiers, cyclone separators and other separation equipment.
- Selection of appropriate mixing process for the fluids and solids.

UNIT I	PROPERTIES AND HANDLING OF PARTICULATE SOLIDS	9

Characterization of solid particles, shape and size, mixed particle size analysis, specific surface of mixtures, average particle size, screen analysis and standard screen series. Properties of particulate masses, different types of conveyers and storage of solids. **Size Reduction**: Principles of comminution, size reduction equipment–crushers, grinders, ultra-fine grinders and cutting machines. Open circuit and closed-circuit operation.

UNIT II	SEPARATION	9

Screening, screening equipment–grizzlying, gyratory, vibrating, revolving screens. Capacity and effectiveness of screens. Magnetic separators, Electro- static separators and froth flotation.

UNIT III	FILTRATION	9

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT IV	PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)	9

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging.

UNIT V	MIXING AND PARTICLE HANDLING	9

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

Text Books:

1.	Unit Operations of Chemical Engineering, Warren,L., McCabe, Julian C.Smith, Peter

Chairman - BoS
Dept. of Chemical Engg. - ESEC

	Harriot, 7th Edition. – McGraw Hill.
2.	Unit Operations, R. S. Kulakarni and Hiremath, Everest Publishers.
Reference Books:	
1.	Chemical Engineering vol.–II, Coulson,J.H., and Richardson, Paragon Press and ELBS.
2.	Unit Operations, Brown George, CBS
3.	Mechanical Operations for Chemical Engineers, C. M. Narayana and B.C.Bhattacharyya,
4.	Coulson & Richardson's Chemical Engineering, Volume:2, 4th edition, J.F. Richardson, J. H. Harker and J. R. Backhurst, Elsevier.
5.	Perry's Chemical Engineers Hand Book, Perry Rober H, 7th edition, McGraw Hill

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH404	INTERNET OF THINGS FOR CHEMICAL ENGINEERS	2	0	2	3	60	100	

Course Objectives: The purpose of learning this course is to

- Understand what Internet of Things is and to identify the various elements of an IoT System
- Understand the various means of communication from Node / Gateway to Cloud Platforms
- Understand Cloud Computing & its relevance in IoT
- Identify types of data analytics and data visualization tools
- Make students aware of security concerns and challenges while implementing IoT olutions

Course Outcome: At the end of this course, learners will be able to

- Explain what Internet of Things is and to describe components of IoT Architecture and platforms of IoT ecosystem
- Describe and choose Sensors and Actuators
- Describe and implement edge network
- Describe Big Data Analytics, transform data and draw meaningful conclusions
- Identify the DIY (Do it yourself) open source electronics platforms for building IoT prototypes

UNIT I	Introduction to IoT	12
Definition of IoT - Evolution of IoT - IoT and related terms - Business Scope.		
UNIT II	**Elements of IoT**	**12**
Introduction to Elements of IoT - Basic Architecture of an IoT Application Sensors & Actuators - Edge Networking (WSN) – Gateways - IoT Communication Model – WPAN & LPWA.		
UNIT III	**Communication and Connectivity Technologies**	**12**
Cloud Computing in IoT - IoT Communication Model – Cloud Connectivity.		
UNIT IV	**Data Analytics and IoT Platforms**	**12**
Big Data Analytics - Data Visualization - IoT Platforms.		
UNIT V	**Concerns and Future Trends**	**12**
Different Players of IoT - Security Concerns and Challenges - Future Trends – Standards. Hands on projects.		

Text Books:

1.	The Internet of Things: Applications and Protocols, Wiley publications. Author(s): Oliver Hersent, David Boswarthick, Omar Elloumi
2.	Architecting the Internet of Things, Springer publications. Author(s): Dieter Uckelmann, Mark Harrison, Florian Michahelles

Reference Books:

1.	Internet of Things with Arduino Cookbook, Packt Publications. Author(s): Marco Schwatrz.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	NAME OF THE DEPARTMENT					R 2019	Semester IV	HS
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS402	UNIVERSAL HUMAN VALUES 2 : UNDERSTANDING HARMONY	2	1	0	3	60	100	

Course Objective (s): The purpose of learning this course is to

- To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature

Salient Features of the Course: The salient features this course is to

- It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
- The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
- The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
- While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology: The methodology of this course is :

- To explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
- The course is in the form of 28 lectures (discussions) and 14 practice sessions.
- It is free from any dogma or value prescriptions.
- It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
- This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
- This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

Chairman - Bo
Dept. of Chemical Engg. - ESEC

Module 1 – Introduction to Value Education	**6+3**
Lectures - Understanding Value Education - Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Right Understanding, Relationship and Physical Facility - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations ***Tutorials*** *[Practice Session] - Sharing about Oneself - Exploring Human Consciousness - Exploring Natural Acceptance*	
Module 2 – Harmony in the Human Being	**6+3**
Lectures - Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body – The Body as an Instrument of the Self - Understanding Harmony in the Self - Harmony of the Self with the Body - Programme to ensure self-regulation and Health ***Tutorials*** *[Practice Session] - Exploring the difference of Needs of Self and Body - Exploring Sources of Imagination in the Self - Exploring Harmony of Self with the Body*	
Module 3 – Harmony in the Family and Society	**6+3**
Lectures - Harmony in the Family – the Basic Unit of Human Interaction - Values in Human-to-Human Relationship – 'Trust' – the Foundational Value in Relationship - 'Respect' – as the Right Evaluation - Understanding Harmony in the Society - Vision for the Universal Human Order ***Tutorials*** *[Practice Session] - Exploring the Feeling of Trust - Exploring the Feeling of Respect - Exploring Systems to fulfil Human Goal*	
Module 4 – Harmony in the Nature/Existence	**4+2**
Lectures - Understanding Harmony in the Nature - Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature – Realizing Existence as Co-existence at All Levels - The Holistic Perception of Harmony in Existence ***Tutorials*** *[Practice Session] - Exploring the Four Orders of Nature - Exploring Co-existence in Existence*	
Module 5 – Implications of the Holistic Understanding	**6+3**
Lectures - Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct – A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order - Competence in Professional Ethics - Holistic Technologies, Production Systems and Management Models-Typical Case Studies - Strategies for Transition towards Value-based Life and Profession ***Tutorials*** *[Practice Session] - Exploring Ethical Human Conduct - Exploring Humanistic Models in Education - Exploring Steps of Transition towards Universal Human Order*	
Course Outcomes: At the end of this course, learners will be able to: • Students are expected to become more aware of themselves, and their surroundings (family, society, nature) • Students would become more responsible in life, and in handling problems with sustainable solutions. • Students become sensitive to their commitment towards what they have understood (human values, human relationship and human society). • Students would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. • Students would have better critical ability.	
TEXT BOOK(S):	

Chairman BoS
Dept. of Chemical Engg. / ESEC

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034-53-2

REFERENCE BOOK(S):

Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004
The Story of Stuff (Book)
The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
Small is Beautiful - E. F Schumacher
Slow is Beautiful - Cecile Andrews
Economy of Permanence - J C Kumarappa
Bharat Mein Angreji Raj – PanditSunderlal
Rediscovering India - by Dharampal
Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

SUGGESTED ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation. ***Example***:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks & *Assessment by peers*: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	COMMON TO ALL BRANCHES					R 2019	Semester IV	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS04	QUANTITATIVE APTITUDE AND LOGICAL REASONING - II	2	0	0	0	30	100	

Course Objective (s):

- To learn the basic of partnership and chain rule in simplified way.
- To solve problems using fast track method by learning profit and loss with percentage.
- To teach the angle of elevation and depression.
- To know the relationship, direction concepts in easy way.
- To know about coding and decoding through logical way.

Course Outcomes: At the end of this course, learners will be able to:

- Solve problems by using shortcut in partnership and chain rule.
- Know the tips and tricks of profit and loss with percentage through fast track methods.
- Understand the concepts of angles.
- Evaluate critically the real life situations by resorting and analyzing analytical reasoning of key issues and factors.
- Enhance the logical way of thinking by solving problems codes and rankings concepts.

UNIT 1	PARTNERSHIP & CHAIN RULE	6

PARTNERSHIP: Ratio of division of gains: Simple Partnership – Compound Partnership - Working and sleeping partners.
CHAIN RULE: Definition – Direct proportion and Indirect proportion.

UNIT 2	PROFIT &LOSS, PERCENTAGE	6

PROFIT AND LOSS: Basic definition and types of profit and loss – Concept of discount and marked price – Concept of true v/s false value – Application in data interpretation problems.
PERCENTAGE: Percentage – Percentage using shortcuts.

UNIT 3	HEIGHT AND DISTANCE	6

HEIGHT AND DISTANCES: Line of sight – Angle of elevation – Angle of depression.

UNIT 4	BLOOD RELATIONSHIP & DIRECTION SENSE TEST	6

BLOOD RELATIONSHIP: Analysis the gender relationship –Relationship diagram - Family tree.
DIRECTION SENSE TEST: Distance between the starting and ending points - Sense the direction correctly.

UNIT 5	LOGICAL SEQUENCE OF WORD, CODING AND DECODING, NUMBER RANKING & TIME SEQUENCE TEST	6

LOGICAL SEQUENCE OF WORDS: Sequence of occurrence of events – Sequence of objects in a class or group – Sequence of increasing/decreasing size, value, intensity, etc.
CODING AND DECODING: Introduction – Description of coding method, Coding patterns – Concepts of

Chairman - BoS
Dept. of Chemical Engg. - SSEC

coding & decoding – Problems involving coding & decoding method.
NUMBER RANKINGS & TIME SEQUENCE TEST: Number test – Ranking test – Time sequence test.

TOTAL : 30 HOURS

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen," Quantitative Aptitude and Reasoning " Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH406	ORGANIC CHEMISTRY LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Learn basic principles involved in analysis and synthesis of different organic derivatives.

Course Outcome: At the end of this course, learners will be able to

- Identify what distinguishes a strong and weak nucleophile and recall the rules of reactions. The student shows their mastery of nomenclature since ethyl bromide is not drawn out. The student analyzes a list of compounds and determines their reactivity.

LIST OF EXPERIMENTS

1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions:
a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) imide i) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
4. Analysis of carbohydrates.
5. Analysis of proteins.
6. Methodology of filtration and recrystallization.
7. Introduction to organic synthetic procedures:
i. Acetylation – Preparation of acetanilide from aniline.
ii. Hydrolysis – Preparation of salycilic acid from methylsalyciliate.
iii. Substitution – Conversion of acetone toiodo form.
iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol.

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

1. Silica Crucible 30No.
2. Heating Mantle 5No.
3. Muffle Furnace 1No.
4. Hot air oven 1No.
5. Desiccator 5No.
6. Vacuum pump 5No.
7. Condenser 5No.
8. Reflux Condenser 5No.

Reference Books:

1.	Vogels'sText Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore (1989).
2.	Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Department, A.C. Tech, Anna University (2007).

Chairman - BoS
Dept. of Chemical Engg. ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH407	MECHANICAL OPERATIONS LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is

- Enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

Course Outcome: At the end of this course, learners will be able to

- Gain the practical knowledge and hands on various separation techniques like filtration, sedimentation, screening, elutriation, and centrifugation.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher / Pulverizer/ Hammer Mill
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving
12. Determination of specific surface area using air permeability setup

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

1. Sieve shaker 1No.
2. Leaf filter 1No.
3. Plate and Frame Filter Press 1No.
4. Sedimentation Jar 1No.
5. Jaw Crusher 1No.
6. Ball Mill / Pulverizer / Hammer Mill Any one mill
7. Cyclone Separator 1No.
8. Roll Crusher 1No.
9. Elutriator 1No.
10. Drop Weight Crusher 1No.
11. Test Sieves. 1No.
12. Air Permeability apparatus 1No.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER V

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH501	CHEMICAL REACTION ENGINEERING – I	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Provide knowledge on different types of reactions, reaction rate, collection and analysis of reaction rate data to derive rate expressions.
- Provide knowledge on different kinetic models to analyze the batch reactor, data to provide knowledge of different types of reactors (Batch, semi batch, CSTR, PFR) and to derive the design equations of ideal reactors from mole balance.
- Provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions.
- Provide the knowledge on thermal characteristics of various reactions

Course Outcome: At the end of this course, learners will be able to

- Analyze kinetic data and determine the rate expressions (reaction order and specific reaction rate) for a reaction.
- Derive and solve design equations for batch, semi batch and steady state flow reactors. Solve appropriate rate expressions for series, parallel and reversible reactions.
- Understand the performance characteristics and the advantages and disadvantages of major reactor types.
- Analyze multiple reactions to determine selectivity and yield.
- Able to explain the thermal characteristics and design of adiabatic reactors for single and multiple reactions

UNIT I	INTRODUCTION	9

Introduction to Chemical Reaction Engineering; Elementary and Non-elementary Reactions, Homogeneous and Heterogeneous Reactions, the definition of rate of reaction, variables affecting the rate of reaction. Kinetics of homogeneous reactions: Concentration dependent term of rate equation, temperature dependent term for rate equation, searching for a mechanism, predictability of reaction rate from theory.

UNIT II	BATCH REACTOR	9

Constant volume batch reactor- Analysis of Rate Data: integral and differential Methods Method of Half-Lives, Method of Initial Rates, Method of Fractional life. Analysis of total pressure data. Variable volume batch reactor, fractional volume change, temperature and reaction rate, and search for a rate equation. Reactions of shifting order, design of batch reactor

UNIT III	IDEAL FLOW REACTOR	9

Design of Isothermal Flow reactors-general discussion, symbols and relationship between CA and XA,space time and space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time and space time for flow systems. Size comparison of single reactors, multiple reactor systems Autocatalytic reactions and Recycle Reactors.

UNIT IV	MULTIPLE REACTOR	9

Design for parallel reactions- introduction to multiple reactions, qualitative discussion about product distribution, quantitative treatment of product distribution and of reactor size. Irreversible first order reactions in series, qualitative discussion about product distribution, quantitative treatment of batch or plug flow reactor, quantitative treatment of mixed flow reactor.

UNIT V	NON-ISOTHERMAL REACTORS	9

Finite difference methods for solving second order two - point linear boundary value Temperature and pressure effects: Single reaction-heats of reactions from thermodynamics, heat of reaction and

Chairman - BoS
Dept. of Chemical Engg. - ESEC

temperature, equilibrium constants from thermodynamics, equilibrium conversion from thermodynamics, general graphical design procedure, optimum temperature progression. Design of non-isothermal reactors: heat effects, adiabatic and non-adiabatic operations. Exothermic reactions in mixed flow reactors, multiple reactions.	
TEXT BOOK(S):	
1.	Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, Wiley Eastern
REFERENCE BOOK(S):	
1.	Elements of chemical reaction engineering, H.S.Fogler, 2nd edition, PHI
2.	Chemical Engineering Kinetics, J.M.Smith, 3rd edition, McGraw Hill.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH502	MATERIAL SCIENCE AND TECHNOLOGY	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Provide knowledge on different types of materials &properties.
- Provide knowledge on nano materials and its fabrication.
- Provide a foundation on deriving materials from its sources.
- Provide the knowledge on thermal characteristics of materials.

Course Outcome: At the end of this course, learners will be able to

- Analyze different properties of materials.
- Derive alloy with required characteristics.
- Understand the performance characteristics and the advantages and disadvantages of different materials.
- Able to explain the characteristics and fabrication of nanomaterials.

UNIT I	INTRODUCTION	9

Atomic structure and chemical bonding: Structure of an atom, quantum states, periodic table, Ionization potential, electron affinity and Electro negativity. Chemical bonding: Types of bonds, Ionic covalent, metallic and secondary bonding, properties and bond characteristics. Crystal geometry and structure determination geometry of crystals: space lattices, crystal structures, miller indices of crystallographic phases and directions, structure determination by x-ray diffraction, Bragg law powder method.
Structures of solids and crystal imperfections: crystalline and non-crystalline solids, inorganic solids, ionic solids, metals and alloys, cubic systems packing efficiency and co-ordination number. Crystal imperfections: point, line and surface imperfections.

UNIT II	PHASE DIAGRAMS AND PHASE TRANSFORMATIONS	9

Phase diagrams and phase transformations: Constitution of alloys, phase rule, single component systems and two component systems, binary phase diagrams – tie line rule, lever rule, isomorphous, eutectic, eutectoid, peritectic and peritectoid systems with examples. Non equilibrium cooling: coring, Phase transformation, solidification and crystallization.
Strengthening of metals and alloys: Grain refinement, solid solution strengthening, dispersion strengthening, strain hardening and precipitation hardening.
Heat treatment of steels applied to the materials used in chemical industry: Annealing, normalizing, hardening and tempering.

UNIT III	ELASTIC BEHAVIOR OF MATERIALS PLASTICDEFORMATION	9

Elastic behavior of materials Plastic deformation: Mechanism of slip and twinning.
Creep: Mechanism and methods to reduce Creep in materials.
Fracture in ductile and brittle materials, Fatigue-Mechanism and preventive methods.
Oxidation and corrosion: Basic principle, types of corrosion, various combating methods.

UNIT IV	COMPOSITE MATERIALS	9

Types of metals and alloys used in chemical process industry, Criteria of selection of materials of construction in process industry.
Composite Materials: Classification, Large particle reinforced and dispersion strengthened composites; Fiber orientation and Concentration Influences, discontinuous and alignment randomlyoriented;processingtechniquesforcompositematerialsandfibrereinforced composites, applications.

UNIT V	INTRODUCTION TO NANOTECHNOLOGY	9

Introduction to Nanotechnology- Zero-Dimensional Nano Structures – Nano particles – One. Dimensional Nano Structures- Nano wires and Nano rods –Two-Dimensional Nano

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Structures, Films – Special Nano Materials – Nanostructures fabricated by Physical Techniques – Characterization and Properties of Nano Materials – Applications of Nano Structures.	
TEXT BOOK(S):	
1.	Material Science and Engineering, V.Raghavan, PHI
2.	Material Science and Engineering, William D.Callisters Jr, Weily& Sons
REFERENCE BOOK(S):	
1.	Material Science and Metallurgy, Dr.V.D.Kodgire,New age India.
2.	Material Science and Engineering, R.K.Rajput, S.K.Kataria& Sons.
3.	Brenner D, "Hand book of Nanoscience and technology" (2002).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH503	MASS TRANSFER OPERATIONS – I	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit the properties according to the changed environment.
- L arn given a physical description of a system, be able to compute or determine the applicable diffusion and mass transfer coefficients from mathematical models, engineering data, or correlations.
- Explain the students with the basic principles of mass transfer operations and other separation processes with examples.
- Discuss the principles of drying.
- Describe and illustrate to the students the equipment used in operations involving crystallization.

Course Outcome: At the end of this course, learners will be able to

- Define the basic principles of mass transfer operations and other separation processes.
- Calculate the mass transfer coefficients.
- Identify the major parts of various drying equipment
- Design humidification and dehumidification processes.
- An ability to calculate the design the crystallizer, crystallization rate and equipment

UNIT I	DIFFUSION	9

Molecular Diffusion: Steady state diffusion into fluids at rest and in laminar flow, Fick's law, diffusion coefficient, continuity equation, diffusion in binary gas mixtures–one component stagnant, equimolar counter diffusion. Diffusivity of liquids, estimation of diffusivities in liquids and gases. Diffusion in solids: Types of solid diffusion-diffusion through polymers, crystalline solids, porous solids.

UNIT II	MASS TRANSFER COEFFICIENTS	9

Mass transfer coefficients: notation for mass transfer coefficients for liquids and gases, mass transfer from gas into a flat falling liquid film, Sherwood number, Peclet number, Schmidt number, Reynolds number, mass transfer coefficient correlations for laminar and turbulent flow in circular pipes. Mass transfer theories: film theory, penetration theory, surface renewal theory; analogy between mass, heat and momentum transfer.Inter-phase Mass Transfer: Equilibrium, Diffusion on both sides of an interface, relationship of overall mass transfer coefficient with either side mass transfer coefficient

UNIT III	HUMIDIFICATION	9

Humidification: Vapor-gas mixtures, absolute humidity, dry bulb temperature, relative saturation, percentage saturation, dew point, enthalpy, Humid Volume and heat, psychrometric charts, air-water system, wet bulb temperature,Lewisrelation,Adiabaticoperation–designofwatercoolingwithair.
Humidification Equipment: water-cooling towers, spray chambers and ponds, Dehumidification, Non-adiabatic operation – evaporative cooling.

UNIT IV	DRYING	9

Drying: Batch drying, rate of batch drying, time of drying, mechanism of batch drying, equipment for batch and continuous drying operations.

Chairman - BoS
Dept. of Chemical Engg. ESEC

UNIT V	**CRYSTALLIZATION**	**9**
Crystallization: Crystal geometry, nucleation, crystal growth, equipment – vacuum crystallizer & draft tube crystallizer.		
TEXT BOOK(S):		
1.	N. Anantharaman, "Mass Transfer Theory and Practice", PHI Learning Pvt. Ltd. June 1 2017.	
2.	Robert E. Treybal, "Mass Transfer Operations", 3rd edition, International Edition, McGraw Hill.	
3.	Binay K. Dutta, "Principles of Mass Transfer and Separation Process", PHI, New Delhi.	
REFERENCE BOOK(S):		
1.	Warren,L., McCabe, Julian C.Smith, Peter Harriot, "Unit Operations of Chemical Engineering", 7thEdition, McGraw Hill.	
2.	Christie JohnGeankoplis, "Transport process and separation process principles" 4th edition, PHI	
3.	J D Seader and E J Henly, "Separation Process Principles", John Wiley & sons.	
4.	Robert H. Perry, "Perry's Chemical Engineers Hand Book", 7thedition, McGraw Hill	

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTERV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH504	HEAT TRANSFER OPERATIONS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Solve analytically using basic laws and semi-empirical correlations one dimensional steady heat transfer problems for a variety of geometries.
- Solve problems involving heat transfer by convection and acquire a basic understanding of heat transfer operations.
- Develop the student's ability to design or predict the performance of heat exchangers. Understand radiation, Heat exchangers & evaporators.

Course Outcome: At the end of this course, learners will be able to

- Describe the three modes of heat transfer mathematically and physically.
- Estimate the thermal conductivity, convective heat transfer coefficient and emissivity for any application.
- Calculate convective heat transfer coefficients for forced, free, phase change problems.
- Design or predict the performance of different types of heat exchangers.
- Design different types of evaporators.

UNIT I	CONDUCTION	9

Introduction: Modes of heat transfer, basic laws of heat transfer, Thermal conductivity, Conduction: Steady state one dimensional heat conduction through a flat plate, cylindrical wall, spherical wall, Critical insulation thickness, composite resistance in series. Unsteady state heat conduction: through infinite slab, infinite long solid cylinder, and sphere. Heat flow with variable surface temperature. Heat flow in semi-infinite solids.

UNIT II	RADIATION & CONVECTION	9

Radiation: Thermal radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfers by conduction, convection and radiation. Convection: Heat exchange equipment, energy balances, heat flux and heat transfer coefficients, LMTD, relation between individual and overall heat transfer coefficients, thermal boundary layer, dimensionless numbers in heat transfer and their significance.

UNIT III	NATURAL CONVECTION AND FORCED CONVECTION	9

Forced Convection: Heat transfer by forced convection inside tubes and ducts in laminar, transition & turbulent flow. Analogy between heat and momentum transfer, Reynold's, Prandtl and Colburn analogies. Heat transfer to liquid metals, forced convection over exterior surfaces. Heat transfer for tubes in cross flow. Natural convection:Grashoff number, natural convection from vertical and horizontal surfaces.

UNIT IV	HEAT EXCHANGE WITH PHASE CHANGE AND RADIATION	9

Heat transfer to fluids with phase change: Heat transfer from condensing vapours; film wise and drop wise condensation, derivation and practical use of Nusselt equation, condensation of superheatedvapours, Effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids; Boiling of saturated liquid, maximum flux and critical temperature drop, minimum flux andfilm boiling, sub-cooled boiling.

UNIT V	HEAT EXCHANGER AND EVAPORATOR	9

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Heat-Exchange Equipment: Shell & tube heat exchangers, plate – type exchangers, extended surface equipment, scraped - surface exchangers, condensers and vaporizers, heat transfer in agitated vessels and packed beds. Evaporation: Types of evaporators. Performance of evaporators; capacity and economy of evaporators, boiling point elevation and Duhring's rule, material and energy balances in single effect evaporator. Multi effect evaporators; methods of feeding, capacity and economy.	
TEXT BOOK(S):	
1.	Warren,L., McCabe, Julian C.Smith, Peter, "Unit Operations of Chemical Engineering". Harriot, 7th Edition, McGraw Hill.
2.	Kern, "Process Heat Transfer", Mcgraw Hill Publishers.
REFERENCE BOOK(S):	
1.	Christie John Geankoplis, "Transport process and separation process principles", 4th edition, PHI
2.	Robert H. Perry, "Perry's Chemical Engineers Hand Book", 7th edition, McGraw Hill.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH405	INSTRUMENTAL METHODS OF ANALYSIS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Know the principle and importance of various analytical instruments used for the characterization of various materials.

Course Outcome: At the end of this course, learners will be able to

- Have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials, intermediates and finishedproducts.
- Know the importance of analytical instrumentation during the purification, compounding and formulating the finished product.

UNIT I	INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS	9

Electromagnetic radiation: various ranges, dual properties, various energy levels, interaction of photons with matter, absorbance & transmittance and their relationship, permitted energy levels for the electrons of an atom and simple molecules, various electronic transitions in organic and inorganic compounds effected by UV, and visible radiations, various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and visible radiations, choice of solvents, cut off wavelengths for solvents.

UNIT II	QUALITATIVE ANALYSIS BY UV AND VISIBLE SPECTROCOPY	9

Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic), Instrumentation for UV and Visible spectrophotometers (source, optical parts and detectors), Applications of UV and Visible spectroscopy.

UNIT III	QUANTITATIVEANALYSIS BY UV AND VISIBLE SPECTROCOPY	9

Beer-Lambert's law, limitations, deviations (real, chemical, instrumental), estimation of inorganic ions such as Fe, Ni and estimation of nitrite using Beer -Lambert's law, multicomponent analysis (no overlap, single way over lap and two-way overlap), photometric titration (experimental set-up and various types of titrations and their corresponding curves).

UNIT IV	IR SPECTROSCOPY	9

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (near, mid, finger print and far) and their usefulness, Instrumentation (only the sources and detectors used in different regions), sample preparation techniques, qualitative analysis of alkanes, alkenes and carbonyl compounds.

UNIT V	CHROMATOGRAPHIC METHODS	9

Classification of chromatographic methods, column, thin layer, paper, gas, High PerformanceLiquid Chromatographical methods (principle, mode of separation and technique).

Text Books:

1.	Sivasankar B., "Instrumental Methods of Analysis", Oxford University Press, 2012.
2.	William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007

Reference Books:

1.	Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, CENGAGE Learning, India, 7th Edition, 2007.
2.	Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7th edition, Wadsworth Publishing Company, 1988.

Chairman - BOS
Dept. of Chemical Engg. - ESEC

3.	Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of ChemicalAnalysis, Himalaya Publishers, New Delhi, 2014

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	COMMON TO ALL BRANCHES					R 2019	Semester V	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS05	QUANTITATIVE APTITUDE AND LOGICAL REASONING - III	2	0	0	0	30	100	

Course Objective (s):

- To design to help people make sense of numerical data.
- To calculate the calendars and series in simplified way.
- To understand the concept of the interest amount in SI and CI.
- To know the procedure to deal with a situation and sufficient to determine the answer.
- To teach seating arrangements in rows or in small groups.

Course Outcomes: At the end of this course, learners will be able to:

- Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken to solve Aptitude Questions.
- Solve the question based on calendar, odd man out and series by using shortcut methods.
- Calculate the interest by using shortcut methods instead of traditional methods.
- Induce their critical thinking by solving the syllogism and course of action.
- Analyze the conditions and do interpretation.

UNIT 1	DATA INTERPRETATION & CLOCKS	6

DATA INTERPRETATION: Tabulation – Bar graphs – Pie charts – Line graphs.
CLOCKS: Definition – important points – Angular difference between two hands at different timings- Incorrect clock.

UNIT 2	CALENDARS, ODDMAN OUT & SERIES	6

CALENDARS: Odd days – Leap year – Ordinary year – Counting of odd days – Day of the week.
ODDMAN OUT & SERIES: Odd man out – Power series – Number series-Sequence of real numbers.

UNIT 3	SIMPLE & COMPOUND INTEREST	6

SIMPLE INTEREST: Principal – Rate of interest – Number of years – Using formulae and shortcuts methods.
COMPOUND INTEREST: Compounded Annually – Compounded Half-Yearly – Compounded Quarterly – Compounded annually – Rates are different for different years.

UNIT 4	STATEMENT & COURSE OF ACTION, SYLLOGISM	6

STATEMENT AND COURSE OF ACTION: Courses of action - Decision taken - Improvement, Follow-up or further action in regard to the given statement.
SYLLOGISM/ LOGICAL VENN DIAGRAMS: Relationship between the two things or not - Classification of propositions – Immediate deductive inference – Immediate deductive inference.

UNIT 5	SEATING ARRANGEMENTS & DATA SUFFICIENCY	6

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEATING ARRANGEMENTS: Persons seating in the circular – Rectangular – Square.
DATA SUFFICIENCY: Reasoning ability using a set of directions.

TOTAL : 30 HOURS

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning ,2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education,2018.
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication,2020.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH505	HEAT TRANSFER LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Enable the students to develop a sound working knowledge on different types of heat transfer equipment.

Course Outcome: At the end of this course, learners will be able to

- Calculate heat transfer by conduction, different types of convection using classical models for these phenomena.

LIST OF EXPERIMENTS

1. Heat Transfer in a Double Pipe Heat Exchanger
2. Heat transfer in Shell and Tube Heat Exchanger
3. Heat Transfer in a Bare and Finned Tube Heat Exchanger
4. Heat transfer in composite wall
5. Heat transfer by Forced / Natural Convection
6. Heat Transfer by Radiation - Determination of Stefan Boltzmann constant
7. Heat Transfer by Radiation – Emissivity measurement
8. Heat transfer in Open Pan Evaporator
9. Heat transfer by Single effect evaporation / Multiple effect evaporation
10. Boiling Heat Transfer
11. Heat Transfer through Packed Bed
12. Heat Transfer in a Horizontal Condenser / Vertical Condenser
13. Heat Transfer in Helical Coils
14. Heat Transfer in Agitated Vessels

LIST OF EQUIPMENT FOR BATCH OF 30STUDENTS

1. Double Pipe Heat Exchanger 1 No.
2. Shell and Tube heat exchanger 1No.
3. Bare and Finned Tube Heat Exchanger 1No.
4. Composite wall set up 1No.
5. Natural convection set up or Forced convection set up 1No.
6. Stefan Boltzmann Apparatus 1No.
7. Emissivity measurement set up 1No.
8. Open Pan Evaporator 1No.
9. Single effect evaporator or Multiple effect evaporator 1No.
10. Boiler 1 Compulsory equipment
11. Packed Bed 1No.
12. Vertical Condenser or Horizontal Condenser 1No.
13. Helical Coil 1No.
14. Agitated Vessel 1No.
15. Jacketed vessel 1No.

Any 10-equipment excluding boiler.

Chairman - BOS
Dept. of Chemical Engg. ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER V	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH506	COMPUTATIONAL ENGINEERING PRACTICES LABORATORY	1	0	2	2	45	100

Course Objectives: The purpose of learning this course is to

- Learn basics in EXCEL/MATLAB skills
- Solve linear/polynomial regression problems
- Solve problems involving iterative solutions
- Successfully employ programming both In EXCEL and MATLAB

Course Outcome: At the end of this course, learners will be able to

- Successfully employ EXCEL/MATLAB skills
- Solve linear/polynomial regression problems
- Solve problems involving iterative solutions
- Successfully employ programming both In EXCEL and MATLAB.

EXCEL and MATLAB

EXCEL And MATLAB Basics: Introduction, plotting Graphs, Using Built in Functions to Solve Regression and Iterative Solutions, Using Macros, Programming in Excel and MATLAB.
Numerical Methods: Roots of algebraic equation; Solution of simultaneous equations; Regression analysis; Interpolation, Extrapolation and Numerical Differentiation; Numerical Integration; Solution of ordinary differential equations.
Application of Numerical Methods to Solve Chemical Engineering Problems: Material and Energy Balances-Fluid flow operations-Heat transfer and Evaporation-Mass transfer operations-Thermodynamics-Mechanical Operations

TOTAL HOURS : 30 Hours

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester V	EEC
Course Code	Course Name	Hours/Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS501	CAREER SKILLS	0	0	2	0	30	100	

Course Objective (s): The purpose of learning this course is to

- Develop strategies for vocabulary development.
- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values.
- Manage the time during each activity in their career

Course Outcomes: At the end of this course, learners will be able to

- Calculate percentages in real life contexts, find any percentage of a given whole using their knowledge of fraction multiplication and increase / decrease a given whole by a percentage.
- Produce solutions the Ratio, Proportions and Variation.
- Identify the percentage gain or percentage loss.
- Improve their performance in the verbal ability sections of different competitive examinations.
- Manage the time for various activities in day to day life.

UNIT 1	PERCENTAGES & AVERAGES	6

Introduction - definition and Utility of percentage - importance of base/denominator for percentage calculations - concept of percentage values through additions - fraction to percentage conversion table.

Introduction - average of different groups - addition or removal of items and change in average replacement of some of the items.

UNIT 2	RATIO, PROPORTIONS AND VARIATION & PROFIT AND LOSS	6

Introduction- Ratio- properties-dividing a given number in the given ratio - comparison of ratios - proportions - useful results on proportion- continued proportion - relation among the quantities more than two – variation. Gain/Loss and percentage gain or percentage loss-multiplying equivalents to find sale price – relation among cost price, sale price, gain/loss and percentage gain or percentage loss - an article sold at two different selling price - two different articles sold at same selling price - percentage gain or percentage loss on selling price - percentage gain or percentage loss on whole property.

UNIT 3	TIME MANAGEMENT	6

Time Management – Tips and strategies- Time wasters – Procrastination – Advantages of time management.

UNIT 4	GRAMMAR	6

Passive voice, Reported Speech – Infinitives and Gerund,

UNIT 5	VERBAL REASONING – I	6

Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text Completion.

REFERENCE(S):

1. Murphy, Raymond. "English in Use - A Self - study Reference and Practice Book for Intermediate Learners of English".IVedition. United Kingdom: Cambridge University Press. 2012.

Chairman - BoS
Dept. of Chemical Engg. ESEC

SEMESTER VI

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH601	MASS TRANSFER OPERATIONS – II	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand the concept of vapor liquid equilibrium given specifications for a feed and desired product streams, select a separation method and design a process utilizing that method to achieve the desired products.
- Apply the fundamentals of mass transfer and engineering correlations to unit-level design of process equipment.
- Choose an appropriate separation technology for a particular application. To understand the principles of membrane separations and industrial uses.

Course Outcome: At the end of this course, learners will be able to

- Understand the basic concepts of different principles of distillation.
- Understand the Continuous rectification and design of distillation process.
- Apply the principles Liquid-Liquid Extraction and equipment for Liquid-Liquid Extraction.
- Design absorption column.
- Select suitable equipment for leaching and design of solid liquid extraction, membrane techniques for the separation of miscible systems.

UNIT I	ABSORPTION	9

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II	DISTILLATION	9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe - Thiele method and Ponchon - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation.

UNIT III	LIQUID-LIQUID EXTRACTION	9

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction.

UNIT IV	LEACHING	9

Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipment for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V	ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS	9

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principles of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TEXT BOOK(S):

1. Robert E. Treybal, "Mass Transfer Operations", Third Edition, International Publishers, Mc GrawHill.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2.	N. Anantharaman, K.M. Meera Sheriffa Begum,"Mass Transfer Theory and Practice" (2011, Prentice Hall).
3.	Binay K. Dutta, "Principles of Mass Transfer and Separation Process", PHI, New Delhi.
REFERENCE BOOK(S):	
1.	Warren, L., McCabe, Julian C.Smith, Peter, "Unit Operations of Chemical Engineering", Harriot, 7th Edition, McGraw Hill.
2.	Christie John Geankoplis, "Transport process and separation process principles", 4th edition, PHI
3.	J D Seader and E J Henly, "Separation Process Principles", John Wiley & sons, NY 1998.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH602	CHEMICAL REACTION ENGINEERING – II	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is

- Accomplish knowledge on non-ideal reactors.
- Provide the knowledge on kinetics of fluid particle reacting systems along with describing the different kinetic models for non-catalytic fluid particle reactions.
- Provide knowledge on determination of surface area of catalysts.
- Provide the knowledge on mechanisms of catalytic heterogeneous reactions.
- Provide the knowledge on mechanisms of catalyst deactivation.

Course Outcome: At the end of this course, learners will be able to

- Apply the non-ideality concepts in the reacting system for better understanding of the deviations from ideality by applying the tanks-in-series model and the dispersion model.
- Develop the progressive conversion model and shrinking core model for explaining the fluid particle reaction.
- Understand the properties of catalyst and to estimate the surface area of the catalyst.
- Understand the principles and mechanism involved in heterogeneous catalysis and analyze the data of heterogeneous catalytic reactions.
- Estimate the conversion of reactions involving deactivating catalysts.

UNIT I	NON-IDEAL FLOW	9

Basics of Non -Ideal flow, the residence time distribution (RTD), State of aggregation of the flowing stream, earliness of mixing, Role of RTD, state of aggregation and earliness of mixing in determining reactor behaviour. Exit age distribution of fluid, Experimental methods for finding E –pulse, step experiments, Relationship between F and E curves. Analysis of Non-ideal reactors - basic idea. Compartment models - hints, suggestions and possibleapplications.DispersionnumberfromCandFcurves,ConversionusingDispersion and Tanks in series models for the first order irreversible reaction.

UNIT II	HETEROGENEOUS REACTING SYSTEM	9

Introduction to design for heterogeneous reacting systems: Rate equations for heterogeneous reactions, contacting patterns for two phase systems. Kinetics of fluid - fluid reactions. The rate equation for straight mass transfer of A (absorption). The general rate equation and the rate equation for reaction with mass transfer. Kinetics of fluid-particle reactions, selection of a model, PCM, SCM, comparison of models with real situations. Shrinking core model for spherical particles of unchanging size: Diffusion through gas film controls, Diffusion through ash layer controls, chemical reaction controls. Rate of reaction for shrinking spherical particles.

UNIT III	CATALYTIC REACTION	9

Solid catalysts - Adsorption, Adsorption isotherms, Surface area, Void volume and solid density, Pore volume Distribution. Theories of heterogeneous catalysis, Classification of catalysts, Catalyst preparation, Promoters and inhibitors.

UNIT IV	CATALYTIC REACTOR I	9

Heterogeneous Reactions - Introduction. Solid Catalyzed reactions; Development of rate expressions from L - H - H - W models for reaction A + B → R + S under Adsorption, surface reaction and desorption controlling condition. Pore diffusion resistance combined with surface kinetics (Single cylindrical pore, first order reaction) Porous catalyst particles. Data analysis for heterogeneous catalytic reactors, isothermal packed bed (PFR) reactor design Experimental methods for finding rates.

UNIT V	CATALYTIC REACTOR II	9

Chairman - BoS
Dept. of Chemical Engg. ESEC

Deactivating catalysts, Mechanisms of catalyst deactivation, the rate and performance equations: The rate equation from experiment. Determining the rate for batch solids in contact with fluid in batch, mixed flow and plug flow modes for independent deactivation. Effect of pore diffusion resistance	
TEXT BOOK(S):	
1.	Levenspiel, Octave, "Chemical Reaction Engineering", 3rd edition, Wiley Eastern
2.	Smith J.M. "Chemical Engineering Kinetics", McGraw Hill.
REFERENCE BOOK(S):	
1.	Fogler, H.S. "Elements of Chemical Reaction Engineering", 2nd edition, PHI

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH603	PROCESS DYNAMICS AND CONTROL	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is

- Provide the working knowledge of Laplace transforms to express the dynamics of linear control system in terms of transfer functions.
- Provide fundamental background of process control theory To provide the working knowledge of automatic control systems for chemical process.
- Provide the knowledge of stability analysis, frequency response analysis and control system design approaches.
- Provide working knowledge in analysis, design and turning of feedback / feed forward controllers in the context of various control strategies used to control chemical processes.

Course Outcome: At the end of this course, learners will be able to

- Analyze typical process dynamics with and without feedback control using both time domain and Laplace domain approaches.
- Be able to analyze open loop and closed loop system properties.
- Be able to develop the closed loop transfer functions for single and multi-loop systems and to apply the Routh test, root locus methods for stability analysis.
- Be able to apply the frequency response based analysis for control system stability and performance.
- Be able to perform model based tuning and testing of PID controllers and other types of controllers.

UNIT I	INTRODUCTION	9

Basic Concepts in Process control, Laplace transforms, inversion by partial fractions and properties of transforms. Linear open loop systems: Response of first order systems. Physical examples of first order systems, response of first order systems in series. Measurement of process variables; sensors, Transducers and their dynamics. Controller modes (P, PI and PID); Control valves.

UNIT II	SECOND ORDER SYSTEMS	9

Transfer function development, response of second order systems, and transportation lag. Linear closed loop systems: Control system, controllers and final control elements, block diagram of achemical reactor control system.

UNIT iII	CLOSED LOOP TRANSFER FUNCTIONS	9

Transfer functions for single loop and multiloop systems, transient response of simple control systems. Stability: Routh test for stability and Root locus.

UNIT IV	FREQUENCY RESPONSE	9

Introduction, substitution rule, Bode diagrams. Control system design by frequency response Temperature control systems, Bode stability criteria, Ziegler–Nichols control settings, transient responses.

UNIT V	CASCADE AND FEED FORWARD CONTROL	9

Cascade control, feed forward control, ratio control and internal model control. Controller tuning and process identification: Tuning, tuning rules, process identification, Control Valves: Valve construction, sizing, characteristics, and positioner.

TEXT BOOK(S):

1. Coughanour, D.R. &Koppel, "Process systems analysis and control", McGraw Hill.

REFERENCE BOOK(S):

1. George Stephanopoulos, "Chemical Process Control" PHI.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2.	Peter Harriot, Coulson& Richardson,"Chemical Engineering", Volume:3, Tata-McGraw-Hill, 4th edition, Elsevier.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER IV	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH604	CHEMICAL PROCESS INDUSTRIES	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

Study the basic concepts of process industries and various methodology used in process industries.

Know the process methodology regarding chlorine and sulphur.

Study the basic ideas of fertilizer and nitrogen and phosphorous industries.

Know the process methodology regarding paper, pulp and oil industry.

Course Outcome: At the end of this course, learners will be able to

Acquire knowledge about basics of various aspects of process industries and understands the methods of production of different chemicals.

Get fundamental knowledge about plant and equipment design.

Apply knowledge about sulphur, nitrogen and fertilizer industry.

Acquire knowledge about the Manufacturing and processing of paper and pulp, Sugar, byproducts of sugar and starch and oil, fat products.

Get skilled in monomers, types of polymers, properties and applications of Resins, types of rubbers.

Know the properties and manufacture of Natural and synthetic fibers and films.

Unit I	Introduction & Inorganic Chemical Industries	9

The role of a chemical engineers in process industries, Introduction to common devices used in manufacturing processes, block diagrams, flow charts and standard symbols used for devices, unit operations, unit process, process utilities and economics.

Manufacture of Soda ash, sodium bicarbonate, sodium chloride, caustic soda, Bleaching powder.

Unit II	Acid and Fertilized Industries	9

Sulphuric acid, Hydrochloric acid, Phosphoric acid, Ammonia and Nitric acid Plant nutrients, growth elements and regulators. Manufacture of ammonium sulphate, ammonium nitrate, ammonium phosphate, potassium chloride, potassium sulphate, single, triple super phosphate and Urea.

Unit III	Pulp and Paper, Sugar Industries	9

Manufacture of pulp – different processes of pulping – Manufacture of paper and Boards. Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

Unit IV	Oil & Dye Industries	9

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, soaps, synthetic detergent. Manufacture of dye- Azo Dyes, anthraquinone dye, vat dyes, pigments and explosives – TNT, RDX & HMX.

Unit V	Rubber and Polymers, Synthetic Fibre and Film Industries	9

Monomers – Thermosetting and Thermoplastic materials, Natural rubber. Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic rubbers. Natural and synthetic fibers – properties of - Poly amides – manufacture of Nylon 6. 6. Polyesters Fibers – manufacturer of– Viscose Rayon production manufacture of films - PVC, Polyesters – polyethylene.

Text Books:

1. Austin, G.T.,Shreve's "Chemical Process Industries", Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.
2. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig, Third Edition, Affiliated East-West press, 1997.

Reference Books:

1. Shukla and G.N. Pandey "Text book on Chemical Technology", Vikas publishing company,1997

Chairman - BOS
Dept. of Chemical Engg - PSEC

2.	Kirk and Othmer,"Encyclopedia of Chemical Technology", Fifth Edition, Wiley, 2007.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	COMMON TO ALL BRANCHES					R 2019	Semester VI	EEC
Course Code	Course Name	Hours/ Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS06	QUANTITATIVE APTITUDE AND LOGICAL REASONING - IV	2	0	0	0	30	100	

Course Objective (s):

- To ascertains the occurrence of an event on the basis of already present information.
- To use area models to represent the distributive property in mathematical reasoning.
- To calculate the work capacity by chocolate based method.
- To work with time, speed and distance by relative speed concepts.
- To determine how various phenomena are related.

Course Outcomes: At the end of this course, learners will be able to

- Know the outcome of an event developed the concept of probability.
- Calculate the area and surface volume in real time application.
- Understand the concepts of Times and Work and Pipes and Cistern and Correlating the Concepts of both.
- Know the concepts of Time, Speed and Distance and concepts of Boats and Streams.
- Analyze the cause and effect of problems by using critical thinking.

UNIT 1	PROBABILITY , PERMUTATIONS & COMBINATIONS	6

PROBABILITY: Rolling an unbiased dice – Tossing a fair coin – Drawing a card from a pack of well shuffled cards – Picking up balls of certain color from a bag containing balls of different colors.
PERMUTATIONS: Numbers with digits - Words with letters - Arrangements of person in a row - Arrangements of books on a shelf.
COMBINATIONS: Formation of committee – Selection of questions from question papers.

UNIT 2	AREA & VOLUME	6

AREA: Area – Perimeter – Important points about triangle – Quadrilateral – Fast track techniques.
VOLUME: Cuboids – Cube – Cylinder – Cone – Frustum of a cone – Sphere – Hemisphere – Pyramid – their formulas.

UNIT 3	TIME & WORK, PIPE & CISTERNS	6

TIME AND WORK: Introduction – Basic concepts – Leaving and joining – Alternative days – In between days the works starting and ending.
PIPES AND CISTERNS: Introduction - Basic concepts – Capacity of the total liters –Water flow in the tank.

UNIT 4	TIME& DISTANCE, TRAINS, BOATS AND STREAMS	6

TIME AND DISTANCE: Definition – Average speed – Distance covered is same – Distance covered is different – Stoppage time per hour for a train – Time taken with two different modes of transport – Time and distance between two moving bodies.
PROBLEMS ON TRAINS: Basic concepts – Basic formulae – Different types of objects –Two trains crossing each other in both directions – Shortcuts.
BOATS AND STREAMS: Introduction – Speed of man (boat and streams) - Moving same and opposite directions – important formulae.

UNIT 5	STATEMENT - CONCLUSION , ARGUMENTS, CAUSE & EFFECT, ASSERTION & REASON	6

STATEMENT AND CONCLUSION: Statement to be true - Two conclusions together - Logically follows.
STATEMENT AND ARGUMENTS: Arguments strong with respect to the statement.
CAUSE AND EFFECT: Cause and effect relationship between the two statements.
ASSERTION AND REASON: Assertion (A) and Reason(R) – Both (A) and (R) are individually true and (R) - (A) is true but (R) is false – (A) is false but (R) is true.

TOTAL : 30 HOURS

Chairman - BOS
Dept. of Chemical Engg., KLNCE

REFERENCES:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen,"Quantitative Aptitude and Reasoning"Third Edition, PHI Learning, 2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education, 2018.
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH605	PROCESS CONTROL LABORATORY	0	0	4	2	60	100

Course Objectives: The purpose of learning this course is

- To determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

Course Outcome: At the end of this course, learners will be able to

- Students would have knowledge on the development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level system
4. Response of Interacting level system
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system
17. Optimum Controller Tuning using Ziegler Nichols method

LIST OF EQUIPMENTS FOR 30 MEMBERS

1. U tube manometer with controller 1No.
2. Interacting Tank 1No.
3. Non-Interacting Tank 1No.
4. Open loop control system 1No.
5. Closed loop control system 1No.
6. ON/OFF controller 1 No.
7. Control valve characteristics 1No.
8. Pressure Tuner 1No.
9. Temperature Tuner 1No.
10. Proportional Controller 1No.
11. Flow Transmitter 1No.
12. Level Transmitter 1No.
13. Cascade control system 1No.

Chairman - BoS
Dept. of Chemical Engg. - KSEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH606	MASS TRANSFER LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Develop sound working knowledge on different types of mass transfer equipments.

Course Outcome: At the end of this course, learners will be able to

- Determine important data for the design and operation of the process equipments like distillation, extraction, diffusivity and drying principles which are having wide applications in various industries.

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Surface evaporation
13. Adsorption studies
14. Leaching studies
15. Demonstration of Gas – Liquid absorption.

LIST OF EQUIPMENTS FOR 30 MEMBERS

1. Simple distillation setup 1No.
2. Steam distillation setup 1No.
3. Packed column 1 No.69
4. Liquid-liquid extractor 1No.
5. Vacuum Dryer 1No.
6. Tray dryer 1No.
7. Rotary dryer 1No.
8. Ion exchange column 1No.
9. Rotating disc contactor 1No.
10. Cooling tower 1No.
11. Absorption column 1No.
12. Surface evaporation set up 1No.
13. Adsorption column set up / Adsorption studies using conical flask 1No.
14. Leaching column set up / Leaching studies using conical flask 1No.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH607	CHEMICAL REACTION ENGINEERING AND IRON SPONGE LABORATORY	0	0	4	2	60	100	

Course Objectives: The purpose of learning this course is to

- Impart knowledge on design of reactors.

Course Outcome: At the end of this course, learners will be able to

- Get a sound working knowledge on different types of reactors.

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Semi Batch reactor
3. Kinetic studies in a Plug flow reactor
4. Kinetic studies in a CSTR
5. Kinetic studies in a Packed bed reactor
6. Combined reactor studies in a PFR and CSTR
7. RTD studies in a PFR
8. RTD studies in a Packed bed reactor
9. RTD studies in a CSTR / CSTR in series
10. Studies on micellar catalysis
11. Study of temperature dependence of rate constant
12. Kinetic studies in Sono chemical reactor
13. Kinetics of photochemical reaction
14. Estimation of Sulfur, Volatile matter, Inherent moisture, Ash content in given coal sample.
15. Estimation of Total iron, iron matter and loss of ignition in given iron ore sample.
16. Estimation of Calcium Oxide, Magnesium oxide and Silica from Dolamite.

Minimum 10 experiments to be offered

LIST OF EQUIPMENTS FOR 30 MEMBERS

1. Batch Reactor 1No.
2. Semi batch reactor 1No.
3. Plug flow reactor 2Nos.
4. CSTR 1No.
5. Sono-chemical reactor 1No.
6. Photochemical reactor 1No.
7. Packed bed reactor 1No.
8. Combined CSTR and PFR 1No.
9. CSTR in series 2Nos.
10. Temperature dependent kinetics set up 1No.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

SEMESTER VII

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH701	TRANSPORT PHENOMENA	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is to

- Study the different types of Fluids.
- Understand their flow characteristics and different mathematical models.
- Know the equations of change to determine the velocity, temperature and concentration profile of complex transport processes.
- Understand the mechanism of fluids in motion under different conditions.
- Understand the concept of turbulent flow.

Course Outcome: At the end of this course, learners will be able to

- Develop mathematical models of momentum, heat and mass transport to determine respective fluxes and velocity, temperature and concentration distribution.
- Apply equations of change to determine the velocity, temperature and concentration profile of complex transport processes.
- Understand the turbulence and boundary layer concept and analogy between transport processes.
- Apply in Transport in Turbulent and Boundary Layer Flow.
- Understand Analogies between Transport Processes.

UNIT I	MOMENTUM TRANSPORT IN LAMINAR FLOW (SHELL BALANCE)	9

Newton's law of viscosity ; Newtonian and non-Newtonian fluids; rheological models; General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus.

UNIT II	HEAT AND MASS TRANSPORT IN LAMINAR FLOW (SHELL BALANCE)	9

Fourier's law of heat conduction; Definitions of concentrations, velocities, and mass fluxes, Fick's law of diffusion. Heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT III	EQUATIONS OF CHANGE AND THEIR APPLICATIONS	9

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up.

UNIT IV	TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW	9

Turbulent phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface.

UNIT V	ANALOGIES BETWEEN TRANSPORT PROCESSES	9

Importance of analogy; development and applications of analogies between momentum heat and mass

Chairman - BoS
Dept. of Chemical Engg. - ESEC

transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.	
Text Books:	
1.	R.B. Bird, W.E. Stewart and E.W. Lighfoot, "Transport Phenomena", John Wiley, 1978.
2.	Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn. 1988.
3.	B.M.Suryavanshi and L.R..Dongre, "Transport Phenomena", NiraliPrakashan,First Edison.
Reference Books:	
1.	L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2.	R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.
3.	J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER VII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH702	CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Do in detail study on unit process.
- Understand the mechanical design of unit process equipment.
- Know how the engineering drawing can be implemented in process equipment design.
- Understand the thermal design of different chemical engineering equipment.
- Find the better way of design of the equipment.

Course Outcome: At the end of this course, learners will be able to

- Understand the unit process equipment.
- Apply the skill in thermal design of heat transfer equipment like shell and tube, double pipe heat exchangers and evaporators, and assessing thermal efficiency of the above equipment in practice.
- Demonstrate the skills in basic design and drawing of different dryers, cooling towers and cyclone separators.
- Apply the concepts involved in phase separation and design of distillation, Extraction and absorption columns.
- Demonstrate the skills in mechanical design of process equipment, design considerations of pressure vessels and its auxiliary devices design the layout of process industries

UNIT I	**HEAT TRANSFER EQUIPMENTS**	**9**
Heat Exchangers, Condensers, Evaporators		
UNIT II	**MASS TRANSFER EQUIPMENTS – I**	**9**
Cooling Tower, Dryers		
UNIT III	**MASS TRANSFER EQUIPMENTS – II**	**9**
Absorption column, Distillation Column, Extraction Column, Adsorption column		
UNIT IV	**REACTORS**	**9**
Packed bed Reactors, Pressure Vessel, Storage Vessel		
UNIT V	**DESIGN OF LAYOUT**	**9**
Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of Construction and Selection of process equipments.		

Text Books:

1.	Green D. W., "Perry's Chemical Engineer's Handbook", 8th Edition McGraw Hill, 2007, should be permitted for the end semester examination

Reference Books:

1.	Baranan, C.R., "Rules of Thumb for Chemical Engineers", Gulf Publishing Co, Texas, 1996.
2.	R. K. Sinnott, "Coulson & Richardson's Chemical Engineering", Vol. 6, Butterworth Heinermann, Oxford, 1996
3.	Dawande, S. D., "Process Design of Equiments", 4th Edition, Central Techno Publications, Nagpure, 2005.

Chairman BoS
Dept. of Chemical Engg. / ESEC

4.	Coulsion and Richardson's., "Chemical Engineering Design - Volume 6", Pergamon; 2nd edition, 1993.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019		SEMESTER VII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH703	PROCESS ENGINEERING ECONOMICS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand the various concepts of economics.
- Know the development concept of process.
- How to consider the best design.
- Understand the cost estimation in chemical industry.
- Know the concepts of management.

Course Outcome: At the end of this course, learners will be able to

- Understand the theory behind Inventory Control.
- Work on production plant control.
- Apply the concepts of management.
- Integrate knowledge about financial statements.
- Understand the concept of depreciation, Accounting and other areas.

UNIT I	INTEREST AND PLANT COST	9

Time value of money - equivalence, Depreciation, Depletion, estimation of capital cost, Total Annualized cost, Capital requirement for complete plant, cost indices, capital recovery.

UNIT II	PROJECT PROFITABILTY AND FINANCIAL RATIOS	9

Estimation of project profitability, Investment alternatives, income statement and financial ratios, balance sheet preparation- problems.

UNIT III	ECONOMIC BALANCE IN EQUIPMENTS	9

Essentials of economic balance, economic balance in batch operations, cyclic operations, economicbalance for insulation, evaporation, heat transfer equipments, Discounted Cash flow.

UNIT IV	PRINCIPLES OF MANAGEMENT	9

Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS).

UNIT V	PRODUCTION PLANNING CONTROL	9

Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory and control, role of control charts in production and quality control.

Text Books:

1.	Peters and Timmerhaus, Plant design and Economics for Chemical Engineers, McGraw Hill 5th Edition, 2004.
2.	Ahuja K.K, Industrial management, Khanna publishers, New Delhi, 1985.
3.	Schweyer. H.E, "Process Engineering Economics", Mc Graw Hill, 1969

Reference Books:

1.	F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill,1992.

Chairman BOS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R 2019	Semester VI	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19HS601	RESEARCH METHODOLOGY	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- impart scientific, statistical and analytical knowledge for carrying out research work effectively.

Course Outcomes: At the end of this course, learners will be able to:

1. Get knowledge about the purpose, need and techniques of research.
2. Get knowledge about the experimental design concepts.
3. Get knowledge about the various method of data collection.
4. Get knowledge about the statistical techniques.
5. Get knowledge about the report writing of research work.

UNIT I	INTRODUCTION TO RESEARCH	9

The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

UNIT II	EXPERIMENTAL DESIGN	9

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

UNIT III	DATA COLLECTION METHODS	9

Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size

UNIT IV	MULTIVARIATE STATISTICAL TECHNIQUES	9

Data Analysis – Factor Analysis – Culster Analysis -Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical(SPSS) Software Package in Research.

UNIT V	RESEARCH REPORT	9

Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

REFERENCE(S):

1. C.R.Kothari, Research Methodology, Wishva Prakashan, New Delhi, 2001.

Chairman - BoS
Dept. of Chemical Engg - ESEC

2.	Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002
REFERENCE(S):	
1.	Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
2.	G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
3.	Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
4.	Raymond-Alain Thie'tart, et.al., Doing Management Research, Sage Publications, London, 1999

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER VII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CH704	PROJECT-PHASE – I	0	0	2	1	30	100

Course Objectives: The purpose of learning this course is to

- Make use of the knowledge gained by the student at various stages of the degree course.

Course Outcomes: At the end of this course, learners will be able to

- Identify the recent research activities.
- Identify the industrial difficulties and challenges.
- Acquire a knowledge on finding the solution for the challenges

METHOD OF EVALUATION

- Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry. Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH705	COMPREHENSIVE REVIEW	0	0	2	0	60	100	

Course Objectives: The purpose of learning this course is to

- Comprehend the knowledge acquired from the first Semester to seventh Semester of B.TECH Degree Course through periodic exercise.

Course Outcomes: At the end of this course, learners will be able to

- Prepare and present technological developments.

METHOD OF EVALUATION:

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics.

Chairman - BoS
Dept. of Chemical Engg. ESEC

SEMESTER VIII

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VIII	PC
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CH801	PROJECT- PHASE – II	0	0	12	6	180	100	

Course Objectives: The purpose of learning this course is to

- Make use of the knowledge gained by the student at various stages of the degree course.

Course Outcomes: At the end of this course, learners will be able to

- Identify the recent research activities.
- Identify the industrial difficulties and challenges.
- Acquire a knowledge on finding the solution for the challenges

METHOD OF EVALUATION

- Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry. Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

PROFESSIONAL ELECTIVE

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX01	POLYMER TECHNOLOGY	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

Course Outcome: At the end of this course, learners will be able to

- Demonstrate knowledge and understanding on the principles related to the synthesis and characterization of polymers.

UNIT I	INTRODUCTION	6

History of Macromolecules – structure of natural products like cellulose, rubber, proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT II	POLYMERIZATION	12

ChemistryofOlefinsandDienes–doublebonds–Chemistryoffreeradicals–monomers–functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization –coordination polymerization– industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Kinetics – Copolymerization concepts.

UNIT III	CONDENSATION	9

Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of poly condensation- Carother's equation – Linear polymersbypolycondensation–Interfacialpolymerization–crosslinkedpolymersbycondensation–gel point.

UNIT IV	POLYCONDENSATION	9

Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation- Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – cross linked polymers by condensation – gel point.

UNIT V	CRYSTALLIZATION	9

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure.

TEXT BOOK(S):

1. Billmeyer.F.W. Jr, "Text Book of Polymer Science", Ed. Wiley-Inter science, 1984
2. Seymour. R.B., and Carraher.C.E., Jr., "Polymer Chemistry", 2nd Ed., Marcel Dekker, 1988.
3. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., "Polymer Science", Wiley Eastern Ltd., 1988.

REFERENCE BOOK(S):

1. Joel,R.F; "Polymer Science and Technology", Eastern Economy Edition, 1999
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., "Principles of Polymer Systems", 5th edition, Taylor and fransis.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHX02	CHEMICAL PROCESS OPTIMIZATION	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Gain knowledge about process modeling and optimization

Course Outcome: At the end of this course, learners will be able to

- Design experiments and formulate models of chemical processes/equipment.
- Understand different search methods and linear programming methods for solution of chemical process problems like optimization of process variables to get maximum yield/conversion, product mix pattern product distribution etc.,
- Understand the non-linear programming methods for application in R & D work.

UNIT I	INTRODUCTION	9
Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems.		
UNIT II	**SINGLE VARIABLE OPTIMIZATION**	**9**
Necessary and sufficient conditions for optimum; region elimination methods; interpolation methods; direct root methods.		
UNIT III	**MULTIVARIABLE OPTIMIZATION WITHOUT AND WITH CONSTRAINTS**	**9**
Necessary and sufficient conditions for optimum; direct search methods; indirect search methods.		
UNIT IV	**OTHER OPTIMIZATION METHODS**	**9**
Introduction to geometric, dynamic and integer programming and genetic algorithms		
UNIT V	**APPLICATIONS OF OPTIMIZATION**	**9**
Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, resource allocation and inventory control.		

TEXT BOOK(S):

1. Rao, S. S., "Engineering Optimization - Theory and Practice", Third Edition, John Wiley &Sons,New York, 1996.

REFERENCE BOOK(S):

1. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes", McGraw-Hill Book Co.,New York, 2003.

Chairman - BOS
Dept. of Chemical Engg. -ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX03	CORROSION ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Study the principles of different forms of corrosion
- Study the testing procedures and protection systems of corrosive materials
- Acquire knowledge regarding predicting corrosion behavior and designing process.

Course Outcome: At the end of this course, learners will be able to

- Learn the principles of Corrosion and understand the environmental effects.
- Differentiate possible types of corrosion in a particular situation.
- Apply different corrosion testing methods for a system.
- Adopt different corrosion prevention methods.
- Design and apply modern protection coatings.

UNIT I	INTRODUCTION	9
Corrosion principles - electro-chemical aspects, environmental effects, economical, metallurgical and other aspects		
UNIT II	**FORMS OF CORROSION**	**9**
Forms of corrosion uniform attack, galvanic, crevice, pitting, Inter granular, selective, leaching, erosion and stress corrosion		
UNIT III	**CORROSION TESTING**	**9**
Classification - purpose - materials and specimens - Surface Preparation - Exposure Techniques - Standard Expression for Corrosion Rate - Huey Test for Stainless Steel - Streicher Test for Stainless Steel - Warren Test - NACE Test Methods - Slow - Strain - Rate Tests.		
UNIT IV	**CORROSION PREVENTION**	**9**
Material Selection - Alteration of Environment - Design - Cathodic and Anodic Protection – Coatings		
UNIT V	**DESIGNING PROTECTION**	**9**
Modern Theory - Principles - Thermodynamics and Electrode Kinetics. Modern Theory Applications - Predicting Corrosion Behavior - Corrosion Prevention -Corrosion Rate Measurement.		

TEXT BOOK(S):

1.	Fontana, M.G., "Corrosion engineering", McGraw Hill, 3rdEd., 2005.
2.	Pierre R. Roberge, "Corrosion Engineering Principles and Practice", McGraw Hill, 1stEdition, 2008

REFERENCE BOOK(S):

1.	R. Winston Revie, "Uhlig's Handbook of Corrosion", Wiley, 3rdedition, 2011.
2.	Zaki Ahmad, "Principles of Corrosion Engineering and Corrosion Control",Butterworth Heinemann,2006.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX04	ENERGY ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Gain knowledge about different energy sources

Course Outcome: At the end of this course, learners will be able to

- Understand conventional Energy sources, Non- conventional Energy sources, biomass sources anddevelopdesignparametersforequipmenttobeusedinChemicalprocessindustries.Understand energy conservation in process industries

UNIT I	INTRODUCTION	9

Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.

UNIT II	ENERGY RESOURCES	9

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III	SOLAR, WIND AND TITAL ENERGY	9

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy

UNIT IV	BIOFUELS	9

Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

UNIT V	ENERGY AUDIT	9

Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.

TEXT BOOK(S):

1.	Rao, S. and Parulekar, B.B., "Energy Technology", Khanna Publishers, 2005.
2.	Rai, G.D., "Non-conventional Energy Sources", Khanna Publishers, New Delhi, 1984.
3.	Nagpal, G.R., "Power Plant Engineering", Khanna Publishers, 2008.
4.	Paul W, O'Callaghan, "Energy Management", McGraw – Hill, 1993.

REFERENCE BOOK(S):

1.	Nejat Vezirog, "Alternate Energy Sources", IT, McGraw Hill, New York.
2.	El. Wakil, "Power Plant Technology", Tata McGraw Hill, New York, 2002
3.	Sukhatme. S.P., "Solar Energy - Thermal Collection and Storage", Tata McGraw hill, New Delhi, 1981.
4.	Albert, Thumann, P.E., C.E.M & William J, Younger C.E.M, "Handbook of Energy Audit"7th edition, Faiment Press 2008.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX05	CHEMICAL PROCESS FLOW SHEETING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand importance of Flow sheets for Specific Processes
- Understand the methods to generate and develop process alternatives, and how to evaluate and screen them quickly.
- Simulate the steady-state behavior of process flow sheets using a suitable simulation software

Course Outcome: At the end of this course, learners will be able to

- Know the basic concepts of flow sheeting on symbols and their presentation, the calculations involving constraints prevention
- Apply the sequential method for modular approach
- Gain the ability to solve complex problems using Equation modular approach
- Suitably apply P&ID methods for any process
- Understand various applications for Chemical Process plant Safety.

UNIT I	FLOW SHEETING	9
Introduction, Symbols, Flowsheet presentation with examples, Manual flowsheet calculation, Constrains and their applications in flowsheet calculations, Types of flow sheets, Synthesis of steady state flow sheet		
UNIT II	**SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING**	**9**
Solution, partitioning and tearing a flowsheet, convergence of tear streams with example.		
UNIT III	**FLOWSHEETING BY EQUATION SOLVING METHODS**	**9**
Selection, decision and tearing of variables in a flowsheet with simple and complex examples		
UNIT IV	**DEVELOPMENT OF FLOWSHEET**	**9**
Piping & Instrumentation Diagram (P&ID) development, typical stages and Applications of P&ID in design. – Construction stage - Commissioning stage - Operating stage -Revamping stage		
UNIT V	**FLOWSHEET APPLICATIONS**	**9**
Flows heeting software, Applications of P&ID in HAZOPS and Risk analysis in Pharma industries. Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.		

TEXT BOOK(S):

1.	Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants",Vol.I Gulf Publishing Company, Houston, 1989..
2.	Max. S. Peters and K. D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc., New York, 1991.

REFERENCE BOOK(S):

1.	Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill publishing Company Limited, New Delhi 1981.
2.	A.N. Westerberg, "Process Flowsheeting", Cambridge University Press, 1979.
3.	Paul Benedek, "Steady state flow sheeting of Chemical Plants", Elsevier.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX06	ENZYME ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Develop skills of the students in the area of Enzyme Engineering with emphasis on reactor operation and design.

Course Outcome: At the end of this course, learners will be able to

- Learnt about classification of enzymes, immobilization, extraction and purification of enzymes and biosensors.

UNIT I	INTRODUCTION	9

General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Metallo enzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. Isozymes, Abzymes, Synzyme

UNIT II	ENZYME CATALYSIS AND INHIBITION	9

Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases-Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).

Reversible Inhibition- Competitive, Non-Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide and DIPF.

UNIT III	ENZYME KINETICS	9

Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.

UNIT IV	ENZYME REGULATION	9

Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Organisation of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples.

UNIT V	INDUSTRIAL AND CLINICAL USES OF ENZYMES (APPLIED ENZYMOLOGY)	9

Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes.

Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflamatory agents, strptokinasae, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases. Immobilization of enzymes, ELIZA. Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes

TEXT BOOKS:

1.	Butter worth, "Technological Applications of Bio-catalysts", BIOTOL series, 1995.
2.	Cornish. A, Bowden, "Analysis of Enzyme Kinetic Data", Oxford University Press, 1996.

Chairman - BoS
Dept. of Chemical Engg. ESEC

REFERENCE BOOKS:	
1.	Wiseman.AandBlakeborough N and Dunnill P, "Enzymic and nonenzymic catalysis", Ex. Vol.5 Ellis and Harwood, U.K. (1981).
2.	2. Wiseman A (Ed.), "Topics in enzyme and fermentation Bio-technology", Ellis and Harwood, U.K. Vol-5.
3.	Nicholas Price & Lewis Stevens, "Fundamentals of Enzymology",
4.	Trevor Palmer, "Enzymes: Biochemistry, Biotechnology and Clinical Chemistry".

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX07	FOOD TECHNOLOGY	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Learn to design processing equipment for Food Industries.

Course Outcome: At the end of this course, learners will be able to

- Get the exposure on use of different chemical additives in foods during food processing and preservation.

UNIT I	**AN OVERVIEW**	**9**
General aspects of food industry; world food needs and Indian situation.		
UNIT II	**FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS**	**9**
Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control.		
UNIT III	**GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS**	**9**
Preliminary processing methods; conversion and preservation operations.		
UNIT IV	**FOOD PRESERVATION METHODS**	**9**
Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.		
UNIT V	**PRODUCTION AND UTILISATION OF FOOD PRODUCTS**	**9**
Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.		

TEXT BOOK(S):

1. Heid J.L. Joslyn M.A., "Fundamentals of Food Processing Operation", The AVI publishing Co., West port 1967.
2. Potter N.N., "Food Science", The AVI publishing Co., Westport, 1963.

REFERENCE BOOK(S):

1. Heldman D.R., "Food Process Engineering", The AVI publishing co., 1975.
2. Charm S.E., "The Fundamentals of Foods Engineering", The AVI Publishing Co., Westport, 1963.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER V	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX08	PLASTICS ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand the structure property relationship of various plastics.
- Understand the structure property relationship and applications of engineering plastics and high-performance polymers.
- Understand the design factors involved in plastic products.

Course Outcome: At the end of this course, learners will be able to

- Classify the different types of plastics and demonstrate an idea about structure property relation of different plastics and its uses.
- Understand different methods of preparation of plastic materials.
- Understand engineering of plastics.
- Understand the preparation, properties and applications of high-performance plastics.
- Design various plastic products.

UNIT I	INTRODUCTION TO PLASTICS	9

Brief history of plastics - Advantages and disadvantages Plastics – Classification – Structure – Property relationship (effect on thermal, mechanical, optical, chemical, electrical properties).

UNIT II	PREPARATION, PROPERTIES AND APPLICATIONS OF PLASTIC MATERIALS	9

Thermoplastics and thermosets. Manufacture of monomers - polymerization - structure - properties - processing and applications of polyethylene, cross-linked polyethylene, chlorinated polyethylene and polypropylene. Preparation, properties and applications of polytetrafluoroethylene, tetra fluoro ethylene copolymers, polyvinyl fluoride and poly vinylidene fluoride.

UNIT III	ENGINEERING PLASTICS	9

Polyamides, (nylons), modified polyamides, polyesters – PET, PBT, Polyacetals, PC and its blends – Preparation, properties & applications, LCP's

UNIT IV	HIGH TEMPERATURE PLASTICS	9

Fluorine containing Plastics– Preparation, properties & uses of PTFE, PCTFE, PVDF, other high-performance plastics like PPO, PPS, polysulphones, PEEK, Polyimides, Polybenzimidazoles, aromatic polyamides – Kevlar, Nomex – Preparation, properties & applications.

UNIT V	CONCEPT OF PLASTIC PRODUCT DESIGN	9

Plastics for designer- Selection of Plastics - Product Design, Development and Manufacture –Checklist forms – Versatility of Design and assembly with Polymers– Property considerationsn designing of Plastics parts –Mechanical properties of plastics – Creep curves of Plastics.Product design consideration—Stress strain curves.

TEXT BOOK(S):

1. J.A.Brydson, "Plastics Materials", 7th edition Elsevier Publication, 1999.
2. James M. Margolis "Engineering. Plastics Handbook" McGraw – Hill, 2006.

REFERENCE BOOK(S):

1. Engineering. "Plastics", Vol.2, ASM International 1988.
2. R.J Crawford "Plastics Engineering", 3 rd Edition, Elsevier publications.

Chairman - BoS
Dept. of Chemical Engg. / ESEC

Department	CHEMICAL ENGINEERING				R2019	SEMESTER VI	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHX09	FLUIDIZATION ENGINEERING	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Study the phenomena and factors affecting the Fluidization in the fluidized beds.
- Do the pressure drop calculations in the Fluidized beds.

Course Outcome: At the end of this course, learners will be able to

- Understand the properties of Fluidized bed.
- Learn different type of Fluidization processes.
- Acquire knowledge on design aspects of fluidization equipment.
- Acquire knowledge on heat and mass transfer in Fluidized Beds and types of fluidization.
- Acquire the knowledge of single and multi-stage continuous fluidization equipment.

UNIT I	BASICS OF FLUIDIZATION	9

History of Macromolecules – structure of natural products like cellulose, rubber, proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT II	FLUIDIZED BED TYPES	9

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT III	DESIGN ASPECTS	9

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidization. Design aspects of fluidized bed systems

UNIT IV	HEAT AND MASS TRANSFER IN FLUIDIZED BEDS	9

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT V	TYPES OF FLUIDIZATION	9

Single stage and multi stage continuous fluidization its flow of solids by gravity and collection of fineusing cyclones

TEXT BOOK(S):

1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth –Heinmann, 1991.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book",7th Edition, McGraw Hill – International, 1997.

REFERENCE BOOK(S):

1. Liang-Shih Fan, "Gas-Liquid-Solid Fluidization Engineering", Butter Worths, 1989.
2. Monsoon Kwauk, "Fluidization idealized and Bubbleless with Applications",SciencePress, 1992.
3. Wen-Ching Yang, "Handbook of Fluidization and Fluid-Particle Systems",Marcel DekkerInc, 2003.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX10	MODERN SEPARATION TECHNIQUES	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Compare the conventional treatment methods and modern separation techniques.
- Explain about the membrane separation processes.
- Explain about the basics of adsorption and types of adsorption.
- Give a brief about the inorganic separation processes.
- Study the different cases with advanced separation techniques.

Course Outcome: At the end of this course, learners will be able to

- Create the understanding of separation processes for selecting optimal process for new and innovative applications.
- Exhibit the skill to develop membrane processes, adsorption process and inorganic separation process.
- Apply the latest concepts like super critical fluid extraction, pervaporation, lyophilization etc., in Chemical process industries.
- Understand Innovative techniques of controlling and managing oil spills.
- Understand the different cases with advanced separation techniques.

UNIT I	BASICS OF SEPARATION PROCESS	9

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid–liquid separations involving a second liquid

UNIT II	MEMBRANE SEPARATIONS	9

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic Hybrid process and Biological Membranes.

UNIT III	SEPARATION BY ADSORPTION	9

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV	INORGANIC SEPARATIONS	9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V	OTHER TECHNIQUES	9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluidExtraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques

TEXT BOOK(S):

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.

REFERENCE BOOK(S):

1. Nakagawal, O. V., "Membrane Science and Technology", Marcel Dekkar, 1992.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX11	INDUSTRIAL SAFETY	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Learn about safety procedures.
- Understand risk analysis and assessment.
- Learn hazard identification
- Know about standards and regulations.
- Impart knowledge through case studies.

Course Outcomes: At the end of this course, learners will be able to

- Gain knowledge on safety procedures.
- Assess risk &analyse the risk.
- Identify hazards.
- Apply standards and regulations.

UNIT I	INTRODUCTION	9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II	SAFETY PROCEDURES	9

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT III	RISK ASSESSMENT	9

Overall risk analysis--emergency planning-on site &off-site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV	SAFETY ANALYSIS	9

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag-Bhopal analysis.

UNIT V	CASE STUDY	9

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

TEXT BOOK(S):

1.	Taylor, J.R., "Risk analysis for process plant, pipelines and transport", Chapman andHall, London,1994
2.	Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation",Wiley Interscience,1965.
3.	Marcel, V.C., "Major Chemical Hazard", Ellis Harwood Ltd., Chi Chester, UK,1987.
4.	Hyatt, N., "Guidelines for process hazards analysis, hazards identification & risk analysis", Dyadem Press,2004.

REFERENCE BOOK(S):

Chairman - BoS
Dept. of Chemical Engg. - ESEC

1.	Handley, W., "Industrial Safety Hand Book", 2nd Edition. McGraw-Hill Book Company, 1969.
2.	Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw- Hill Book Co., 1980.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VI	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX12	RENEWABLE ENERGY TECHNOLOGIES	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Get exposure on solar radiation and its environmental impact of power.
- Know about the various collectors used for storing solar energy.
- Know about the various applications in solar energy.
- Learn about the wind energy and biomass and its economic aspects.
- Know about geothermal energy with other energy sources.

Course Outcome: By the end of the course students will be able to

- Understanding the physics of solar radiation.
- Ability to classify the solar energy collectors and methodologies of storing solar energy.
- Knowledge in applying solar energy in a useful way.
- Knowledge in wind energy and biomass with its economic aspects.
- Knowledge in capturing and applying other forms of energy sources like wind, biogas and geo- thermal energies.

UNIT I	PRINCIPLES OF SOLAR RADIATION	9

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II	SOLAR ENERGY COLLECTIONS	9

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT III	SOLAR ENERGY STORAGE AND ITS APPLICATIONS	9

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT IV	WIND ENERGY	9

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT V	GEOTHERMAL ENERGY	9

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.

TEXT BOOK(S):

1. Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers,2011.
2. Twidell& Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis),2011.

REFERENCE BOOK(S):

Chairman - BoS
Dept. of Chemical Engg. - ESEC

1.	Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House,2007.
2.	Ramesh R & Kumar K.U, "Renewable Energy Technologies",Nervosa Publishing House, 2004.
3.	Mittal K M, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003.
4.	Kothari D.P, Singhal., K.C., "Renewable energy sources and emerging technologies", P.H.I, New Delhi, 2010.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX13	PETROLEUM REFINERY ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Gain knowledge about petroleum refining process and production of petrochemical products.

Course Outcome: At the end of this course, learners will be able to

- Understand the classification, composition and testing methods of crude petroleum/ product
- Develop innovative refining process and develop quality control and assurance techniques.
- Apply the knowledge of treatment processes to develop the manufacture of petroleum products.

UNIT I	TESTING OF PETROLEUM PRODUCTS	9

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum Atmospheric and Vacuum Distillation.

UNIT II	CRACKING	9

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen.

UNIT III	TREATMENT TECHNIQUES	9

Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance, Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining.

UNIT IV	CATALYTIC REFORMING	9

Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, Catalytic Reforming of Petroleum Feed Stocks and Extraction of Aromatics.

UNIT V	PRODUCTION OF PETROCHEMICALS	9

Production of Petrochemicals like Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black

Text Books:

1.	Nelson, W. L., "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York, 1985.
2.	Bhaskara Rao, B. K., "Modern Petroleum Refining Processes", 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.

Reference Books:

1.	Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., Khanna Publishers, New Delhi, 1987.
2.	Wiseman. P., Petrochemicals, UMIST Series in Science and Technology. 5. H. Steiner, Introduction to petrochemicals Industry', Pergamon, 1961.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX15	HETEROGENEOUS CATALYSIS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Gain knowledge about different types of heterogeneous catalysts, their structures, synthesis processes, characterisation and solid state chemistry associated with these catalyst
- Understand the mechanism and kinetics of heterogeneous catalytic reactions
- Overview selected applications of heterogeneous catalysis.

Course Outcome: At the end of this course, learners will be able to

- Apply the knowledge of heterogeneous catalytic reactions in industry
- Develop mechanism and kinetics of heterogeneous catalytic reactions
- Prepare and characterize various catalysts
- Consider the mass & heat transfer and other effects in design
- Design reactors for heterogeneous catalytic reactions

UNIT I	INTRODUCTION	9

Heterogeneous catalytic processes, types of heterogeneous reactions.Introduction and basic concept of green catalysis. Adsorption, adsorption isotherms, rates of adsorption, Physisorption and chemisorptions. Solid catalysis, types of catalysts, catalyst formulations and preparation methods. Environmental catalysis.

UNIT II	CataLYST PREPARATION AND CHARACTERIZATION	9

Fundamentals of solid state chemistry, structure of solids. Selection, design and preparation of catalysts. Optimal distribution of catalyst in a pellet of different geometry.Structure-property relationship and analysis: BET surface area and pore volume analysis, X-ray diffraction, scanning electron microscopy, infrared spectroscopy.

UNIT III	CATALYST DEACTIVATION	9

Reactor design, catalyst applications and deactivation kinetics: Applications of heterogeneous catalysts in different fields, various deactivation models of solid catalysts.

UNIT IV	KINETIC MODELING AND INTERPRETATION OF HETEROGENEOUS DATA ANALYSIS	9

Mechanisms of solid catalyzed reactions: Rates of adsorption, desorption, surface reactions, rate determining steps, development of reaction mechanism. Deducing a rate law from the experimental data, Evaluation of Rate law parameters. Kinetic modeling and parameter estimations. Effect of external and internal transport processes on observed rate of reactions, Heat and Mass transfer effects in heterogeneous catalysis, internal and external mass transfer limitations.

UNIT V	INDUSTRIAL CATALYTIC REACTORS AND LATEST DEVELOPMENTS	9

Commercial Catalytic Reactors (Adiabatic, packed and fluidized bed, trickle bed and slurry reactors). Industrially important catalysts and processes such as oxidation, regeneration, New development in solid catalysis, monolith catalysts, nanocatalysts, Fuel cell catalysts, Environmental catalysts, Insitu characterization.

Text Books:

1. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th ed., PHI, 2005.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2.	J. M. Smith, "Chemical Engineering Kinetics", 3 rd ed., MGH, 1981.
3.	R.A Sheldon, I. Arends, U. Hanefeld 'Green Chemistry and Catalysis', Wiley-VCH 2007.
Reference Books:	
1.	Lann D. Schmidt, "The Engineering of Chemical Reactions", 2nd Edition, Oxford University Press, 2007.
2.	J.J. Carberry , "Chemical and catalytic reaction Engineering", Dover Publications, 2001.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX14	PLANT WIDE CONTROL	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understand the fundamentals of process control, multi variable control and advanced control strategies
- Know the control strategies for heat exchangers and separation units
- Explain the concepts of control for reactors
- Explain the control fundamentals for recycle processes
- Discuss the plant wide control ideas for various cases.

Course Outcome: By the end of the course students will be able to

- Describe the fundamentals of process control, multi variable control and advanced control strategies
- Explain the control strategies for heat exchangers and separation units.
- Explain the concepts of control for reactors.
- Explain the control fundamentals for recycle processes.
- Discuss the plant wide control ideas for various cases.

UNIT I	ESSENTIALS OF PROCESS CONTROL	9

Process dynamics, Laplace transform models and identification. 2. Concept of feedback control, block diagram representation, PID control algorithm and tuning.

UNIT II	CONTROL STRUCTURES	9

Multivariable control: Niederlinski Index, Relative Gain Array, SVD. Decoupling, Decentralized controller tuning, dynamic matrix control.

UNIT III	CONTROL STRUCTURES FOR COMMON UNIT OPERATIONS	9

Advanced control structures: Feedforward control, ratio control, cascade control, override control and optimizing control.Control structures for simple distillation columns: LV, LB, DV, DB. Single ended and dual ended temperature inferential control, criteria for temperature control tray selection.

UNIT IV	PLANT-WIDE CONTROL FUNDAMENTALS	9

Control of complex column configurations: Side draw columns, side rectifier/side stripper columns, heat integrated columns. Petlyuk and Kaibel columns, homogenous and heterogenous azeotropic distillation. Reactive distillation, Do's and dont's of distillation control. CSTR control: Reaction heat removal and corresponding control schemes. Multiple steady states and stability analysis, heat integration. PBR control: Adiabatic operation, Reaction heat removal schemes and control structures, heat integration. Control of heat exchangers.

UNIT V	PLANT-WIDE CONTROL FOR IMPROVED ECONOMICS	9

Degrees of freedom: control dof, steady state performance dof, dynamic dof. Rigorous dof analysis for example processes. Plant-wide implications of material (energy) recycle: The snowball effect, effect on process time constant, component inventory balancing. Through-put manipulation and its relation to local inventory control loops. Consistent and inconsistent control structures for a simple recycle process. Plant-wide regulatory Control Structure Design Case Studies: Recycle process with side reaction, cumene manufacture process, hydrodealkylation of toluene, vinyl chloride process

Text Books:

Chairman - BoS
Dept. of Chemical Engg. - ESEC

1.	Gade Pandu Rangaiah , Vinay Kariwala, "Plantwide Control: Recent Developments and Applications",2012.
Reference Books:	
1.	Luyben, W.L., Tyreus, B.D. and Luyben, M.L. "Plantwide Process Control" McGraw Hill: New York, 1998.

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX16	PROCESS MODELING AND SIMULATION	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- give an overview of various methods of process modeling, different computational techniques for simulation.

Course Outcome: At the end of this course, learners will be able to

- Upon completing the course, the student should have understood the development of process models based on conservation principles and process data and computational techniques to solve the process models.

UNIT I	INTRODUCTION	9

Introduction to modeling and simulation, classification of mathematical models,conservation equations and auxiliary relations.

UNIT II	STEADY STATE LUMPED SYSTEMS	9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III	UNSTEADY STATE LUMPED SYSTEMS	9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV	STEADY STATE DISTRIBUTED SYSTEM	9

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V	UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES	9

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

Text Books:

1. Ramirez, W.; "Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co., 1990

Reference Books:

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., "Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Edn, PHI Learning Ltd (2012).
4. Amiya K. Jana, "ChemicalProcess Modelling and Computer Simulation" 2nd Edn,PHI Learning Ltd,(2012).

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VIII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX17	DRUGS AND PHARMACEUTICAL ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Understanding of the polytechnical nature of engineering and drugdiscovery in the pharmaceutical industry involving Chemical Engineering.

Course Outcome: At the end of this course, learners will be able to

- Transform raw materials into usefulpharmaceutical and fine chemical products with commercial interest through systematic use of engineering concepts and methods

UNIT I	INTRODUCTION	9
Development of drugs and pharmaceutical industry; organic therapeutic agent's uses and economics.		
UNIT II	**DRUG METABOLISM AND PHARMACO KINETICS&MICROBIOLOGICAL AND ANIMAL PRODUCTS**	**9**
Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies. Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones..		
UNIT III	**IMPORTANT UNIT PROCESSES AND THEIR APPLICATION**	**9**
Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complexchemicalconversions fermentation..		
UNIT IV	**MANUFACTURING PRINCIPLES & PACKING AND QUALITY CONTROL**	**9**
Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.		
UNIT V	**PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS**	**9**
Vitamins; cold remedies; laxatives; analgesics; nonsteroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals– spectroscopy, chromatography, fluorimetry, polarimetry, refractometry, pHmetry.		

Text Books:

1. Rawlines, E.A.; "Bentleys Text book of Pharmaceutics", III Edition, Bailliere Tindall, London,1977.

Reference Books:

1. Yalkonsky, S.H.; Swarbick. J. "Drug and Pharamaceutical Sciences", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences", Mack Publishing Co., 1975.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VIII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX18	BIOCHEMICAL ENGINEERING	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Provide the knowledge on the role of enzymes and microbes in biotechnology sectors.

Course Outcome: At the end of this course, learners will be able to

- Design novel bioprocesses for their research in various areas.
- Find solutions to the problems which occur when materials and processes interact with the environment.

UNIT I	INTRODUCTION	9

Industrial biochemical processes with typical examples, comparing chemical and biochemicalprocesses, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.

UNIT II	KINETICS OF ENZYME ACTION	9

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance

UNIT III	KINETICS OF MICROBIAL GROWTH	9

Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured, structured and cybernetic models, medium formulation. Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation, Design and analysis of biological reactors.

UNIT IV	TRANSPORT PHENOMENA	9

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer

UNIT V	DOWN STREAM PROCESSING	9

Down stream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultrafiltration and reverse osmosis),chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying

Text Books:

1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd ed, 1986, McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and FikretKargi, 2nd edition, Pearson education.

Reference Books:

1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997

Chairman BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VIII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX19	PROFESSIONAL ETHICS	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Create awareness on professional ethics and human values.
- Provide basic familiarity about engineers as responsible experimenters, research ethics, codes of ethics, industrial standards.
- Inculcate knowledge and exposure on different safety aspects of a process and intellectual property rights.

Course Outcomes: At the end of this course, learners will be able to

- Implement awareness of professional ethics and human values.
- Pursue career with professional ethics by adopting ethical theories
- Work with more responsibility by understanding various social issues by adopting various industrial standards.
- Adopt various safety procedures in the professional environment and safe guard IPR.
- Judge role in various global issues and apply ethical principles to resolve situations.

UNIT I	HUMAN VALUES	9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality.

UNIT II	ENGINEERING ETHICS	9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III	ENGINEERING AS SOCIAL EXPERIMENTATION	9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law – The NASA's Challenger Case Study.

UNIT IV	SAFETY, RESPONSIBILITIES AND RIGHTS	9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – The Three Mile Island and Chernobyl Case Studies Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V	GLOBAL ISSUES	9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample Code of Conduct.

Text Books:

1.	Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2.	John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

Reference Books:

1.	Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New

Chairman BOS
Dept. of Chemical Engg. ESEC

	Jersey, 2004.
2.	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Thompson Wadsworth, A Division of Thomson Learning Inc., United States, 2000
3.	Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	SEMESTER VIII	PE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CHX20	PROGRAMMING USING MATLAB	3	0	0	3	45	100	

Course Objectives: The purpose of learning this course is to

- Give a complete programming knowledge about MATLAB
- Acquireknowledge with the basic concepts of MATLAB, variables, arrays and functions of MATLAB.

Course Outcome: At the end of this course, learners will be able to

- Apply MATLAB basics in solving complex problems
- Find the solution for Problems related to chemical engineering
- Implement algorithms to find solutions using arrays, functions and statements
- Implement concepts of MATLAB in various field of Chemical Engineering.
- Find the solutions for multidisciplinary problems

UNIT I	INTRODUCTION TO MATLAB	9

Introduction to MATLAB- Creating Variables- Some useful MATLAB functions- Data types- Script files – video lecture on plotting, Introduction to arrays, Graphing, Exercises- Graphing Functions Using MATLAB.

UNIT II	PROGRAMMING PRACTICES	9

Planning Code-Creating Code- Video Lectures on Input Statements, Output Statements Exercises: Input/OutputStatements.

UNIT III	CONDITIONAL STATEMENTS AND LOOPS	9

Conditional Statements: Logical Operators, if, else, and elseif, Switch, Exercises- conditional statement. Loops: Repetition Structure: Introduction to Loops, For Loops, While Loops.

UNIT IV	NESTED LOOPS	9

Nested Loops Breaks - Video Lecture: Repetition Structures: Nested Loops and the Break Statement.

UNIT V	ARRAYS AND ARRAY FUNCTIONS	9

Arrays-Exercises: Arrays, Video Lecture: Some Useful Functions for Arrays-Exercises: Array Functions.

Text Books:

1. MATLAB: A Practical Introduction to Programming and Problem Solving, 3rd edition, Stormy Attaway, Elsevier, 2013.
2. Chemical Engineering Computational with MATLAB, Yeong Koo Yeo, Hanyang University, CRC Press, Inc., 2018.

Reference Books:

1. Problem Solving in Chemical and Biochemical Engineering with POLYMATH, Excel, and MATLAB 2nd Edition,MichealB.Cutlip, Mordechai Shacham, 2007.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

OPEN ELECTIVES

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY01	ELECTROCHEMICAL ENGINEERING	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Impart knowledge on basic electrochemical concepts.
- Impart knowledge on basic thermal balance.
- Acquire knowledge on basic transport properties & potential theory in electrochemical processes.

Course Outcome: By the end of the course students will be able to

- Understand the basic concepts involved in electrochemical processes.
- Learn different types of electrodes used for processes.
- Apply the concepts of potential theory for design of advanced electrodes.
- Apply the concept of transport properties.
- Learn different types of potential properties.

Unit I	BASIC ELECTROCHEMICAL CONCEPTS	9

Introduction - electrode potential - phase equilibrium, chemical and electrochemical potentials, cells with solution of uniform concentration, transport processes in junction regions, electrolyte concentration cells. The electric potential-the electrostatic potential, intermolecular forces, outer and inner potential, potentials of reference electrode, the electric potential in thermodynamics. Activity coefficients-ionic distributions in dilute solutions, electrical contribution to the free energy, measurement of activity coefficients

Unit II	REFERENCE ELECTRODE AND ELECTRICAL DOUBLE LAYER	9

Reference electrode-criteria of reference electrodes, hydrogen electrode, the calomel electrode and other mercury and mercurous salt electrodes, silver-silver halide electrodes. Potentials of cells with junction- the Nernst equation, types of liquid junctions, cells with liquid junction, potentials across membranes. Structure of the electric double layer- qualitative description of double layers, the Gibbs adsorption isotherm, the Lippmann equation, the diffused part of the double layer. Electrode kinetics, electro kinetic phenomena, Electro capillary phenomena.

Unit III	INFINITELY DILUTE SOLUTIONS AND THERMAL BALANCE	9

Infinitely dilute solutions-transport laws, conductivity, diffusional potential and transference numbers, conservation of charge, binary electrolyte, supporting electrolyte, multicomponent diffusion by elimination of the electric field. Mobilities and diffusion coefficients-Neutrality and Laplace's equation. Concentrated solutions-liquid junction potentials. Thermal effects-thermal diffusion, heat generation, conservation and transfer, Thermo galvanic cells.

Unit IV	TRANSPORT PROPERTIES	9

Transport properties- single and multicomponent solutions. Fluid mechanics stress in a Newtonian fluid, magnitude of electrical forces. Transport in dilute solutions, simplification for convective transport, the Graetz problem, two dimensional diffusion layer in laminar force convection, axisymmetric diffusion layers in forced convection

Unit V	POTENTIAL THEORY	9

Application of potential theory- primary and secondary current distribution. Numerical solution. Effect of migration on limiting currents-Correction factors for limiting currents. Concentration variation of supporting electrolyte, limiting currents for free convection. Concentration over potential- binary electrolyte, supporting electrolyte. Currents below the limiting current

Text Books:

1. Prentice, G, Electrochemical Engineering Principles, Englewood Cliffs, Prentice Hall, NJ,

Chairman - BoS
Dept. of Chemical Engg. - ESEC

	1986.
Reference Books:	
1.	1. Newman. J, Electrochemical Systems, Englewood Cliffs, Prentice Hall, NJ, 1991.
2.	Rousar. I, Micka, K and Kimla, A., Electrochemical Engineering, Vol. I & II,Elsevier, 1986..

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY02	ADVANCES IN POLLUTION CONTROL	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Provide exposure to the pollution control techniques.
- Generate awareness about the environmental pollution.
- Understand the concept of pollution prevention.
- Understand about the clean technology.
- Provide knowledge on -which will enable the students to have a career and professional accomplishment in the public or private sector.

Course Outcome: By the end of the course students will be able to

- Aware of past, present and future environment.
- Understand the importance of chemical engineering processes.
- Apply the concept of environmental audit.
- Understand the concepts behind the methodologies to control pollution.
- Apply recycling concepts behind pollution prevention.

Unit I	ENVIRONMENT AWARENESS	9

Environment – friendly Chemical Process; Hazard and risk analysis; Environmental Audit.

Unit II	CHEMICAL ENGINEERING PROCESSES	9

Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

Unit III	ADVANCED WASTEWATER TREATMENT	9

Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

Unit IV	CLEAN TECHNOLOGY	9

Towards Eco- friendly products of chemical industry. Handling emerging pollutants in industrial effluents

Unit V	POLLUTION PREVENTION	9

Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

Text Books:

1. Rao, C.S Environmental Pollution control Engineering, Wiley- Eastern Ltd. 1991.
2. Peavy H.S. Rowe D.R., and George Technologious, Environmental Engineering, Mc Graw Hill Book Company, Ny, 1985.
3. Rao M.N and H.V.N. Rao. "Air pollution" ,Tata McGraw Hill Publishing Co. Ltd.1989
4. Theodore L and Buomlore A.J Air pollution control equipments. Prentice Hall Inc, NY. 1982.

Reference Books:

1. Coulson, J.M. Richardson, J.F and R.K Sinnott, Chemical Engineering Vol. 6, Pergomon Press, 1989.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2.	Gilbert M.Mastrs, Introduction to Environmental Engineering and Science, Prentice - Hall of India, New Delhi, 1994.
3.	Wahi S.K., Agnihotri A.K and Sharmma J.S (Editors) Environmental Management in Petroleum Industry, Wiley Eastern Ltd., New Delhi 1996.
4.	Smith, R., "Chemical Process Design", McGraw Hill, New York, 1995

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY03	INDUSTRIAL WASTEWATER TREATMENT	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Focus on the wastewater treatment.
- Analyze the process.
- Understand the theory chemical unit processes.
- Study the biological treatment processes.
- Provide knowledge on advanced treatment processes.

Course Outcome: At the end of this course, learners will be able to

- Have knowledge on physical/chemical/biological characteristics.
- Understand the general treatment process.
- Apply the concepts of chemical unit processes.
- Study the biological treatment processes.
- Apply the knowledge on advanced treatment processes.

Unit I	**Waste water treatment an overview**	**9**

Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water inorganic – Organic and metallic constituents.

Unit II	**Process analysis and selection**	**9**

Components of waste water flows – Analysis of Data – Reactors used in waste water treatment – Mass Balance Analysis – Modeling of ideal and non ideal flow in Reactors – Process Selection.

Unit III	**Chemical unit processes**	**9**

Role of unit processes in waste water treatment chemical coagulation –Chemical precipitation for improved plant performance chemical oxidation –Neutralization – Chemical Storage.

Unit IV	**Biological treatment**	**9**

Overview of biological Treatment – Microbial metabolism – Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors – Combined aerobic processes – Activated sludge film packing.

Unit V	**Advanced waste water treatment**	**9**

Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

Text Books:

1.	Waste water Engineering Treatment and Reuse. Mc Graw Hill, G. Tchobanoglous, FL Biston, 2002.
2.	Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.

Reference Books:

1.	Unit Operations of Chemical Engineering, Warren, L., McCabe, Julian C.Smith, Peter
2.	Separation Process Principles, J D Seader and E J Henly, John Wiley & sons, NY 1998.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY04	TOTAL QUALITY MANAGEMENT	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Facilitate the basic concepts of TQM.
- Understand of TQM principles.
- Study the TQM tools.
- Understand the legislations and standards.
- Study the Quality Management principles and process

Course Outcome: At the end of this course, learners will be able to

- Apply the TQM concepts in industries.
- Utilize the TQM tools.
- Apply the TQM techniques of quality management.
- Apply the legislations and standards in chemical process industries.
- Utilize the quality systems in industry.

Unit I	Introduction	9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

Unit II	TQM principles	9

Leadership - Strategic quality planning, Quality Councils – Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

Unit III	TQM tools and techniques I	9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA -Stages, Types.

Unit IV	TQM tools and techniques II	9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Unit V	Quality systems	9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

Text Books:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall

Chairman - BoS
Dept. of Chemical Engg - MSEC

	(India) Pvt. Ltd., 2006

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY05	NANO SCIENCE AND NANOTECHNOLOGY	3	0	0	3	45	100

Course Objective(s): The purpose of learning this course is to

- Understand the description of nanotechnology, its technological development and different applications.
- Get exposure to the general preparation methods of nano-materials and different techniques in their preparation.

Course Outcome(s): At the end of this course, learners will be able to:

- Learn and understand the purpose of Nanotechnology.
- Understand application of carbon nanotubes and process the involved, learn micro fabrication.
- Understanding different types of NEMS, MEMS and learn principles of microscopes
- Understand material aspects of NEMS, MEMs and their applications
- Understand the principle and applications of Microscopy.

Unit I	Introduction	9

Background and Definition of Nanotechnology. Why Nano? Applications in Different Fields, Chemical Approaches to Nanostructured Materials, Molecular Switches and Logic Gates, Solid State Devices

Unit II	Phase iagrams and phase transformations	12

Carbon Nanotubes - Structure of Carbon Nanotubes, Synthesis of Carbon Nanotubes, Growth Mechanisms of Carbon Nanotubes, Properties of Carbon Nanotubes, Carbon Nanotube-Based Nano-Objects, Applications of Carbon Nanotubes, Nano wires – Synthesis, Characterization and Physical Properties of Nanowires, Applications

Unit III	Elastic behavior of materials plastic deformation	8

Basic Microfabrication Techniques, MEMS Fabrication Techniques, Nanofabrication techniques, Stamping techniques - High Resolution Stamps, Microcontact Printing, Nanotransfer Printing, Applications

Unit IV	Composite materials	8

Material aspects of NEMS and MEMS – Silicon, Germanium-Based Materials, Metals, GaAs, InP, and Related III-V Materials, MEMS Devices and Applications - Pressure Sensor, Inertial Sensor, Optical MEMS, RF MEMS, NEMS Devices and Applications, Current Challenges and Future Trends.

Unit V	Introduction to nanotechnology	8

Microscopy - Scanning Tunneling Microscope, Atomic Force Microscope, Scanning Electron Microscopy, FESEM, TEM, Principles of Noncontact Atomic Force Microscope (NCAFM).

Text Books:

1. B. Bhushan, (in Eds.) "Springer handbook of nanotechnology", 3rd Edition, Springer – Verlag, 2010.

Reference Books:

1. Charles P. Poole; Frank K. J Owens, "Introduction to Nanotechnology", A John Wiley and Sons , Inc, Publication 2003.

Chairman - BOS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY06	PIPING ENGINEERING	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Impart knowledge on piping technology and instrumentation on pipelines.

Course Outcome: At the end of this course, learners will be able to

- Gain knowledge on fundamentals of piping engineering.
- Understand the concept of pipe hydraulics.
- Concepts behind choosing the size.
- Study the piping supports.
- Understand the role of instrumentation.

Unit I	Fundamentals of piping engineering	9

Definitions, Piping Components their introduction, applications. Piping MOC, Budget Codes and Standards, Fabrication and Installations of piping

Unit II	Pipe hydraulics and sizing	9

Pipe sizing based on velocity and pressure drop consideration cost, least annual cost approach, pipe drawing basics, development of piping general arrangement drawing, dimensions and drawing of piping.

Unit III	Plot plan	9

Development of plot plan for different types of fluid storage, equipment layout, process piping layout, utility piping layout. Stress analysis -Different types of stresses and its impact on piping, methods of calculation, dynamic analysis, flexibility analysis.

Unit IV	Piping support	9

Different types of support based on requirement and its calculation

Unit V	Instrumentation	9

Final Control Elements; measuring devices, instrumentation symbols introduction to process flow diagram (PFD) and piping & instrumentation diagram (P&ID).

Text Books:

1. Piping Handbook, 6 th edition, M.L. Nayyar, P.E., Mc Graw-Hill, Inc.

Reference Books:

1. Piping Design Handbook edited by Johan J McKetta, CRC Press, 1992.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY07	NON CONVENTIONAL ENERGY SOURCES	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- Analyze the solar radiation and its environmental impact to power
- Interpret the various collectors used for storing solar energy.
- Find out the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects.
- Summarize about geothermal energy with other energy sources.

Course Outcomes: At the end of this course, learners will be able to:

- Understanding the physics of solar radiation.
- Ability to classify the solar energy collectors and methodologies of storing solar energy.
- Knowledge in applying solar energy in a useful way.
- Analyze the wind energy and biomass with its economic aspects.
- Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

Unit I	PRINCIPLES OF SOLAR RADIATION	10

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Unit II	SOLAR ENERGY COLLECTION	8

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

Unit III	SOLAR ENERGY STORAGE AND APPLICATIONS	8

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

Unit IV	WIND ENERGY	10

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, IC engine operation and economic aspects.

Unit V	GEO THERMAL ENERGY	9

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.

REFERENCE(S):

1. ari and Ghosal, "Renewable energy resources", Narosa Publishing House,2007
2. nesh R & Kumar K.U, "Renewable Energy Technologies",Nervosa Publishing House, 2004.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

3.	tal K M, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003.
4.	hari D.P, Singhal., K.C., "Renewable energy sources and emerging technologies", P.H.I, New Delhi, 2010.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R2019	OE
Course Code	Course Name	Hours/week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19CHY08	FUEL AND COMBUSTION TECHNOLOGIES	3	0	0	3	45	100

Course Objectives: The purpose of learning this course is to

- Have knowledge on the fluid properties.
- Characteristics while static, during flow through ducts pipes and other channels.
- Acquire knowledge on several machineries used to transport the fluid and their performance are assessed.

Course Outcome: At the end of this course, learners will be able to

- Understand different characterization methods of fuel.
- Understand classification and purification methods of solid and liquid fuels.
- Understand classification and purification methods of gaseous fuels.
- Determine the kinetics and mechanism of combustion process.
- Design equipment for combustion process.

Unit I	Characterization	9

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis – Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation – Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

Unit II	Solid Fuels and Liquid Fuels	9

Solid Fuels: Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking of Coals - Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels – Manufactured Solid Fuels. Liquid Fuels: Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Cloud point, Pour Point & Smoke point - Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

Unit III	Gaseous Fuels	9

Classification - Composition & Properties - Estimation of Calorific Value – Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non -Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

Unit IV	Combustion: Stoichiometry & Kinetics	9

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes – Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual - Ignition Limits - Limits of Inflammability.

Unit V	Combustion Equipments	9

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing – Fixed Bed & Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers - Sprinkler Stokers, Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners – Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

Text Books:

Chairman BOS
Dept. of Chemical Engg. - ESEC

1.	Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2.	Bhatt, Vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984
3.	Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn,1988
Reference Books:	
1.	Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966

Chairman - BoS
Dept. of Chemical Engg. - ESEC

LANGUAGE ELECTIVE

Department	CHEMICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX201	ENGLISH FOR ENGINEERS	3	0	0	3	45	100	

Course Objective (s):

- To acquire the usage of grammar in English language.
- To develop listening skills which will enable to listen lectures and comprehend different types of texts.
- To enhance the reading skill to comprehend technical writings.
- To improve writing skills to express thoughts freely.
- To develop speaking skills to speak fluently in real contexts.

Course Outcomes: At the end of this course, learners will be able to:

- Improve their language usage in LSRW skills.
- Develop listening skills to understand sentence stress and into nations.
- Acquire the ability to understand different written texts.
- Enhance the writing skills to express the ideas of the learners.
- Communicate fluently in pair /team.

UNIT I	LANGUAGE FOCUS	9

Voice(Active & Passive) - Reported speech - Conditionals - Collocations - Discourse markers - One word substitution - Phrasal verbs - Error identification

UNIT II	LISTENING	9

Listening for specific information – Identifying sentence stress - Rhythm – Intonation

UNIT III	READING	9

Reading graphs and charts - Skimming and scanning texts – Identifying topic sentences - Understanding the structure of a text

UNIT IV	WRITING	9

Job Application, Letter and Resume - Recommendations - Report writing (accident and survey) - Writing review (book and movie) - Transcoding (interpreting charts & diagrams)

UNIT V	SPEAKING	9

Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging - Language Functions: suggesting - comparing and contrasting - Expressing - finding out facts, attitudes and Opinions

TEXT BOOK(S):

1. Communicative English by KN Shoba, Lourdes Joavani Rayen Published by Cambridge university Revised Edition2018

REFERENCE(S):

1. Jeremy Comfort, Pamela Rogerson, Trish Stott, and Derek Utley, Speaking Effectively and Developing Speaking Skills for Business English, Cambridge: Cambridge University Press, 2002.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

2	Eric H. Glendinning and Beverly Holmstrom, Study Reading: A Course In Reading for Academic Purposes. United Kingdom: Cambridge University Press, 2004.
3	Murphy, Raymond. English Grammar in Use – A Self-Study Reference and Practice Book forInter learners of English. Ived. United Kingdom: Cambridge University Press. 2012.
4	Seely, John. Oxford Guide to Effective Writing and Speaking. Indian ed. New Delhi: Oxford University Press. 2005.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX202	HINDI	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Help students to acquire the basics of Hindi
- Teach them how to converse in Hindi on various occasions
- Help learners acquire the ability to understand a simple technical text in Hindi

Course Outcomes: At the end of this course, learners will be able to

- Communicate effectively with: (a) Improved fluency in Hindi (b) Clarity on the basic sounds of the Hindi language (c) Proper vocabulary

Unit I	HINDI ALPHABET	9

Genders (Masculine & Feminine Nouns ending in a, e,i,o, u,)- Masculine & Feminine - Reading Exercises. Introduction-Vowels-Consonants-Plosives-Fricatives-Nasalsounds-VowelSigns-ChandraBindu &Visarg -Table of Alphabet -Vocabulary.

Unit II	NOUNS IN HINDI	9

Genders (Masculine & Feminine Nouns ending in a ,e, i, o, u,)- Masculine & Feminine - Reading Exercises.

Unit III	PRONOUNS AND TENSES	9

Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

Unit IV	CLASSIFIED VOCABULARY	9

Parts of body - Relatives - Spices- Eatables- Fruit & Vegetables - Clothes - Directions-Seasons - Professions.

Unit V	SPEAKING	9

Model Sentences - Speaking practice for various occasions.

TEXT BOOK(S):

1. Elementary Hindi: Learn to Communicate in Everyday Situations by Richard DelacyTuttle Publication 2013
2. Colloquial Hindi: The Complete Course for Beginners by Tej K. Bhatia

REFERENCE(S):

1. B. R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Syed, PrayojanMulak Hindi, Rahamathullah Vani Prakasan, New Delhi, 2002.
3. Ramdev, Vyakaran Pradeep, Saraswathi Prakasan, Varanasi, 2004.

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX203	JAPANESE	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Help students acquire the basics of Japanese language
- Teach them how to converse in Japanese in various occasions
- Teach the students the Japanese cultural facets and social etiquette

Course Outcomes: At the end of this course, learners will be able to communicate effectively with

1. Improved fluency in Japanese
2. Clarity on the basic sounds of the Japanese language
3. Proper vocabulary

UNIT I	INTRODUCTION	9

Introduction to Japanese - Japanese script - Pronunciation of Japanese(Hiragana) - Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. N1 wa N2 des - N1 wa N2 ja arimasen - S ka - N1mo - N1 no N2 - .san - Kanji - Technical Japanese Vocabulary (25 Numbers) - Phonetic and semantic resemblances between Tamil and Japanese

UNIT II	VOCABULARY AND GRAMMER	9

Introduction - Kore - Sore - are - Kono N1 - Sono N1 - ano N1 - so des - so ja arimasen - S1 ka - S2 ka - N1 no N1 - so des ka ' koko - soko - asoko - kochira - sochira - achira - N1 wa N2 (Place) des - dhoko- N1 no N2 - Kanji-10 - ima-.ji-fun des - Introduction of verb - V mas - V masen - V mashitha-V masendeshitha - N1(Time) ne V - N1 kara N2 des - N1 tho N2 / S ne Kanji-10 - Technical Japanese Vocabulary (25 Numbers) - Dictionary Usage.

UNIT III	NOUNS AND TYPES	9

N1(Place) ye ikimas - ki mas - kayerimasu - Dhoko ye moikimasen - ikimasendheshitha - N1(vehicle) de ikimasu - kimasu - kayerimasu - N1(Personal or Animal) tho V ithsu - S yo. - N1 wo V (Transitive) - N1 wo shimus - Nani wo shimasu ka - Nan & Nani - N1(Place) de V - V masen ka - V masho - Oo. Kanji-10, N1(tool - means) de V - Word / Sentence wa go nan des ka - N1(Person) ne agemus - N1(Person) ne moraimus - mo V shimashitha - , Kanji-10 - Japanese Typewriting using JWPCE Software, Technical Japanese Vocabulary (25 Numbers).

UNIT IV	VOCABULARY AND GRAMMER	9

Introduction to Adjectives - N1wanaadj des. N1 wa ii adj des - naadjna N1 - ii adj ii N1 - Thothemo - amari - N1 wadho des ka - N1 wadhonna N2 des ka - S1 ka S2 - dhore - N1 gaarimasu - wakarimasu - N1gasukimasu-N1gakiraimasu-jozudes-hethades-dhonnaN1-Usagesofyoku-dhaithai-thakusan-sukoshi-amari-zenzen-S1karaS2-dhoshithe,N1gaarimasu-imasuN1(Place)neN2

Chairman - BoS
Dept. of Chemical Engg. - ESEC

gaarimasu - iimasu - N1 wa N2(Place) ne arimasu - iimasu - N1(Person,Place,or Thing) no N2 (Position)- N1 ya N2, Kanji-10 - Japanese Dictionary usage using JWPCE Software, Technical Japanese Vocabulary (25 Numbers).		
UNIT V	**ROOT WORD AND VOCABUALRY**	**9**
Saying Numbers , Counter Suffixes , Usages of Quantifiers -Interrogatives - Dhonokurai - gurai - Quantifier- (Period) ne -.kai V - Quantifier dhake / N1 dhake Kanji - Past tense of Noun sentences and na Adjective sentences - Past tense of ii-adj sentences - N1 wa N2 yoriadj des - N1 tho N2 thoDhochiragaadj des ka and its answering method - N1 [no naka] de {nani/dhoko/dhare/ithsu} ga ichiban adj des ka - answering -N1 gahoshi des - V1 mas form dhake mas - N1 (Place) ye V masu form ne ikimasu/kimasu/kayerimasu - N1 ne V/N1 wo V - Dhokoka - Nanika - gojumo - Technical Japanese Vocabulary (25 Numbers).		
TEXT BOOK(S):		
1.	Modern Japanese Vocabulary: A Guide for 21st Century Students | Edward P. Trimnell Publisher: Beechmont Crest Publishing.	
2	Japanese Verbs & Essentials of Grammar" | Rita Lampkin Passport Books , 2013	
REFERENCE(S):		
1	Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.	
2	Japanese for Everyone: Elementary Main Textbook 1-2, Goyal Publishers and Distributors Pvt. Ltd.,Delhi, 2007.	

Chairman - BoS
Dept. of Chemical Engg. - ESEC

Department	CHEMICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX204	FRENCH	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Help students acquire the basics of French language
- Teach them how to converse in French in various occasions

Course Outcomes: At the end of this course, learners will be able to

- Familiar with the basics of French language and start conversing in French.

UNIT I	Alphabet Français	6

AlphabetFrançais(alphabets)-LesAccentsFrançais(theaccentsinFrench)-aigu-grave-circonflexe-rémacédille - écrire son nom dans le français (spellingone -sname in French) - Les noms de jours de la semaine (Days of theweek).

UNIT II		6

Les noms de mois de l'année (Months) - Numéro 1 à 100 (Numbers 1 to 100) GRAMMAIRE :Conjugaison.

UNIT III		10

Moyens de transport (Transport) - Noms de Professions (Professions) - Nomsd'endroitscommuns(Places) - Nationalités (Nationalities) ECOUTER : (Listening) Écouter l - alphabet associéà des prénomsfrançais - Écouter et répondre PARLER (Speaking)Présntation - même /Présentez - Vous (Introducingoneself)LIRE :Lireles phrases simples.

UNIT IV		12

Pronoms (Pronouns) - Nomscommunsmasculins et de femme (Common masculine and Femininenouns) - Verbescommuns (Common verbs)COUTER :couter et crier les prnoms - Observer les dessins et couter les dialogues LIRE : Lire les profilsd'utilisateursd'interlingua (alter ego)PARLER :Parler de saville - Parlerde sa profession.

UNIT V		11

Narration de son nom et l'endroitoù on vit - Son âge et date de naissance - Numéro detéléphoneet'dresse- Narration du temps - La France en Europe PARLER: Conversation entre deux amis - Jouer la scène ÉCOUTER: Ecouter les conversations (CD alter ego) ÉCRIRE: Écrireune cartepostale.

TEXT BOOK(S):	
1.	Le Bon Usage by M. Grevisse Publisher- Duculot 14 edition (25 January 2001)
2	Advanced French by Monique L'Huillier, Cambridge University Press,2013

REFERENCE(S):	
1	Alter ego+ Niveau a1
2	Grammaire Progressive du Français
3	Collins Easy Learning French Verbs& Practice
4	FrançaisLinguaphone
5	FrançaisI.Harrisonburg: The Rosetta Stone: Fairfield Language Technologies

Chairman - BoS
Dept. of Chemical Engg. - ESEC