ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2017
B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM

1. Programme Educational Objectives (PEOs)

a) To produce employable graduates with the knowledge and competency in Chemical and Electrochemical Engineering complemented by the appropriate skills and attributes.
b) To produce creative and innovative graduates with design and soft skills to carry out various problem solving tasks.
c) To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities with the right attitudes and ethics.
d) To produce graduates who possess interest in research and lifelong learning, as well as continuously striving for the forefront of technology.
e) To enable the students to set up models for an electrochemical system based on continuity equations and transport equations for relevant variables, and with necessary boundary conditions.

2. Programme Outcomes (POs)

On successful completion of B. Tech. Chemical and Electrochemical Engineering programme, the graduates of this programme would have

1. Ability to apply the knowledge of mathematics, science and engineering to solve domain specific engineering problems.
2. Ability to design and conduct experiments; also have the ability to analyze and interpret experimental results.
3. Ability to implement equations for production and transport of heat in electrochemical systems, and explain the temperature dependence of electrode potentials, electrode kinetics and mass transport properties.
4. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
5. Ability to implement models for current distribution in porous electrodes.

3. PEOs / POs Mapping

PEOs / POs	1	2	3	4	5
a	√	√	√	√	
b			√	√	√
c	√		√	√	
d	√	√			√
e	√		√		√

4. **Semester Course wise POs Mapping**

		Course Title	1	2	3	4	5
Year I	SEMESTER I	Communicative English	√	√			
		Engineering Mathematics I	√	√			
		Engineering Physics	√	√			
		Engineering Chemistry	√	√			
		Problem Solving and Python Programming	√	√			
		Engineering Graphics	√	√			
		Problem Solving and Python Programming Laboratory	√	√			
		Physics and Chemistry Laboratory	√	√			
	SEMESTER II	Technical English	√	√			
		Engineering Mathematics II	√	√			
		Physics of Materials	√	√			
		Chemistry for Technologists	√	√			
		Basic Electrical and Electronics Engineering	√	√			
		Principles of Electrochemistry			√	√	√
		Engineering Practices Laboratory	√	√			
		Computer Aided Drafting and Modeling Laboratory	√	√			
Year II	SEMESTER III	Transforms and Partial Differential Equations	√	√			
		Molecular Physical Chemistry	√	√			
		Organic Chemistry	√	√			
		Inorganic Chemistry	√	√			
		Environmental Science and Engineering	√	√	√		
		Chemical Process Calculations		√	√		√
		Engineering Chemistry Laboratory	√	√			
		Basic Electrical and Electronics Engineering Laboratory	√	√			
	SEMESTER IV	Numerical Methods	√	√			
		Materials Technology			√	√	
		Fluid and Solid Operations			√	√	
		Chemical Engineering Thermodynamics			√	√	
		Heat Transfer and its Applications			√	√	
		Chemical Reaction Engineering			√	√	
		Mechanical Operations Laboratory			√	√	
		Fluid Mechanics Laboratory			√	√	
Year III	SEMESTER V	Corrosion Science and Engineering			√	√	√
		Instrumental Methods of Analysis			√		√
		Mass Transfer I			√		√
		Electrodics and Electrocatalysis			√	√	√
		Electrochemical Reaction Engineering			√	√	√

		Professional Communication	√			√	√
		Heat and Mass Transfer Laboratory			√		√
		Chemical and Electrochemical Reaction Engineering Laboratory			√		√
	SEMESTER VI	Electrochemical Materials Science			√	√	√
		Mass Transfer II			√	√	
		Instrumentation			√	√	
		Electrochemical Process Technology			√	√	
		Process Dynamics and Control			√	√	
		Process Engineering Economics	√	√			
		Equipment Design			√	√	
		Computer Applications in Chemical Engineering Laboratory			√	√	
		Corrosion and Metal Finishing Laboratory			√	√	
Year IV	SEMESTER VII						
		Process Synthesis and Design	√	√		√	√
		Transport Phenomena	√	√	√		
		Electrometallurgy and Thermics		√	√	√	
		Electrochemicals and Electro Metallurgy Laboratory			√	√	√
		Process Dynamics and Control Laboratory			√	√	√
		Internship				√	√
	SEMESTER VIII	Electrochemical Energy Conversion and Storage			√	√	√
		Surface Science			√	√	√
		Project Work	√	√	√	√	√

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I TO VIII SEMESTERS (FULL TIME) CURRICULA AND SYLLABI

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8151	Communicative English	HS	4	4	0	0	4
2	MA8151	Engineering Mathematics I	BS	4	4	0	0	4
3	PH8151	Engineering Physics	BS	3	3	0	0	3
4	CY8151	Engineering Chemistry	BS	3	3	0	0	3
5	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
6	GE8152	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8251	Technical English	HS	4	4	0	0	4
2	MA8251	Engineering Mathematics II	BS	4	4	0	0	4
3	PH8254	Physics of Materials	BS	3	3	0	0	3
4	CY8292	Chemistry for Technologists	BS	3	3	0	0	3
5	BE8251	Basic Electrical and Electronics Engineering	ES	3	3	0	0	3
6	EL8201	Principles of Electrochemistry	PC	3	3	0	0	3
PRACTICALS								
7	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
8	ME8261	Computer Aided Drafting and Modeling Laboratory	ES	4	0	0	4	2
			TOTAL	**28**	**20**	**0**	**8**	**24**

SEMESTER III

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
2	EL8301	Molecular Physical Chemistry	BS	3	3	0	0	3
3	CY8291	Organic Chemistry	BS	3	3	0	0	3
4	EL8302	Inorganic Chemistry	BS	3	3	0	0	3
5	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
6	EL8303	Chemical Process Calculations	PC	3	3	0	0	3
PRACTICALS								
7	EL8311	Engineering Chemistry Laboratory	BS	4	0	0	4	2
8	EE8362	Basic Electrical and Electronics Engineering Laboratory	ES	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER IV

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8491	Numerical Methods	BS	4	4	0	0	4
2	PM8391	Materials Technology	BS	3	3	0	0	3
3	EL8401	Fluid And Solid Operations	PC	3	3	0	0	3
4	PE8491	Chemical Engineering Thermodynamics	PC	3	3	0	0	3
5	EL8402	Heat Transfer and its Applications	PC	3	3	0	0	3
6	PE8091	Chemical Reaction Engineering	PC	3	3	0	0	3
PRACTICALS								
7	CH8581	Mechanical Operations Laboratory	PC	4	0	0	4	2
8	CH8461	Fluid Mechanics Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CH8491	Instrumental Methods of Analysis	PC	3	3	0	0	3
2.	CH8551	Mass Transfer I	PC	3	3	0	0	3
3.	EL8501	Corrosion Science and Engineering	PC	3	3	0	0	3
4.	EL8502	Electrodics and Electrocatalysis	PC	3	3	0	0	3
5.	EL8503	Electrochemical Reaction Engineering	PC	3	3	0	0	3
6.		Open Elective I*	OE	3	3	0	0	3
PRACTICALS								
7.	EL8511	Heat and Mass Transfer Laboratory	PC	4	0	0	4	2
8.	EL8512	Chemical and Electrochemical Reaction Engineering Laboratory	PC	4	0	0	4	2
9.	HS8581	Professional Communication	EEC	2	0	0	2	1
			TOTAL	**28**	**18**	**0**	**10**	**23**

* - Course from the curriculum of the other UG Programmes

SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	EL8601	Electrochemical Materials Science	PC	3	3	0	0	3
2	CH8651	Mass Transfer II	PC	5	3	2	0	4
3	EL8602	Instrumentation	PC	3	3	0	0	3
4	CH8091	Electrochemical Process Technology	PC	3	3	0	0	3
5	EL8603	Process Dynamics and Control	PC	3	3	0	0	3
6	CH8652	Process Engineering Economics	PC	3	3	0	0	3
PRACTICALS								
7	EL8611	Equipment Design	PC	4	0	0	4	2
8	EL8612	Computer Applications in Chemical Engineering Laboratory	PC	4	0	0	4	2
9	EL8613	Corrosion and Metal Finishing Laboratory	PC	4	0	0	4	2
			TOTAL	**32**	**18**	**2**	**12**	**25**

SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	EL8701	Process Synthesis and design	PC	3	3	0	0	3
2	CH8791	Transport Phenomena	PC	3	3	0	0	3
3	EL8702	Electrometallurgy and Thermics	PC	3	3	0	0	3
4		Professional Elective I	PE	3	3	0	0	3
5		Professional Elective II	PE	3	3	0	0	3
6		Open Elective II*	OE	3	3	0	0	3
PRACTICALS								
7	EL8711	Electrochemicals and Electro Metallurgy Laboratory	PC	4	0	0	4	2
8	EL8712	Process Dynamics and Control Laboratory	PC	4	0	0	4	2
9	EL8713	Internship	EEC	0	0	0	0	2
			TOTAL	**26**	**18**	**0**	**8**	**24**

* - Course from the curriculum of the other UG Programmes

SEMESTER VIII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	EL8801	Electrochemical Energy Conversion and Storage	PC	3	3	0	0	3
2	EL8802	Surface Science	PC	3	3	0	0	3
3		Professional Elective III	PE	3	3	0	0	3
PRACTICALS								
4	EL8811	Project Work	EEC	20	0	0	20	10
			TOTAL	**29**	**9**	**0**	**20**	**19**

TOTAL CREDITS:186

PROFESSIONAL ELECTIVES (PE)

PROFESSIONAL ELECTIVE I, SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	CH8074	Optimization of Chemical Processes	PE	3	3	0	0	3
2.	EL8001	Advanced Electrochemical Reaction Engineering	PE	3	3	0	0	3
3.	EL8002	Functional Materials	PE	3	3	0	0	3
4.	GE8074	Human Rights	PE	3	3	0	0	3
5.	CH8077	Process Modeling and Simulation	PE	3	3	0	0	3
6.	EL8003	Nanomaterials Technology	PE	3	3	0	0	3
7.	GE8071	Disaster Management	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE II, SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	EL8004	Chemical Process Technology	PE	3	3	0	0	3
2.	EL8005	Industrial Metal Finishing	PE	3	3	0	0	3
3.	CH8071	Environmental Engineering	PE	3	3	0	0	3
4.	EL8006	Total Quality Management and Engineering Economics	PE	3	3	0	0	3
5.	CH8078	Process Plant Utilities	PE	3	3	0	0	3
6.	CH8092	Energy Technology	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE III, SEMESTER VIII

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	EL8007	Chlor – Alkali Technology	PE	3	3	0	0	3
2.	EL8008	Cathodic Protection and Electrophoretic Coatings	PE	3	3	0	0	3
3.	EL8009	Organic Electrochemistry	PE	3	3	0	0	3
4.	GE8075	Intellectual Property Rights	PE	3	3	0	0	3
5.	CH8073	Industrial Process Plant Safety	PE	3	3	0	0	3
6.	CH8093	Modern Separation Techniques	PE	3	3	0	0	3
7.	CH8094	Polymer Technology	PE	3	3	0	0	3
8.	EL8010	Protective Paint Coatings	PE	3	3	0	0	3
9.	GE8076	Professional Ethics in Engineering	PE	3	3	0	0	3

SUBJECT AREAWISE DETAILS

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	HS8151	Communicative English	HS	4	4	0	0	4
2.	HS8251	Technical English	HS	4	4	0	0	4
3.	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3

BASIC SCIENCES (BS)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	MA8151	Engineering Mathematics I	BS	4	4	0	0	4
2.	PH8151	Engineering Physics	BS	3	3	0	0	3
3.	CY8151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5.	MA8251	Engineering Mathematics II	BS	4	4	0	0	4
6.	PH8254	Physics of Materials	BS	3	3	0	0	3
7.	CY8292	Chemistry for Technologists	BS	3	3	0	0	3

8.	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
9.	EL8301	Molecular Physical Chemistry	BS	3	3	0	0	3
10.	CY8291	Organic Chemistry	BS	3	3	0	0	3
11.	EL8302	Inorganic Chemistry	BS	3	3	0	0	3
12.	EL8311	Engineering Chemistry Laboratory	BS	4	0	0	4	2
13.	MA8491	Numerical Methods	BS	4	4	0	0	4
14.	PM8391	Materials Technology	BS	3	3	0	0	3

ENGINEERING SCIENCES (ES)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
2.	GE8152	Engineering Graphics	ES	6	2	0	4	4
3.	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
4.	BE8251	Basic Electrical and Electronics Engineering	ES	3	3	0	0	3
5.	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
6.	ME8261	Computer Aided Drafting and Modeling Laboratory	ES	4	0	0	4	2
7.	EE8362	Basic Electrical and Electronics Engineering Laboratory	ES	4	0	0	4	2

PROFESSIONAL CORE (PC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	EL8201	Principles of Electrochemistry	PC	3	3	0	0	3
2.	EL8303	Chemical Process Calculations	PC	3	3	0	0	3
3.	EL8401	Fluid and Solid operations	PC	3	3	0	0	3
4.	PE8491	Chemical Engineering Thermodynamics	PC	3	3	0	0	3
5.	EL8402	Heat Transfer and its Applications	PC	3	3	0	0	3
6.	PE8091	Chemical Reaction Engineering	PC	3	3	0	0	3
7.	CH8581	Mechanical Operations Laboratory	PC	4	0	0	4	2
8.	CH8461	Fluid Mechanics Laboratory	PC	4	0	0	4	2
9.	CH8491	Instrumental Methods of Analysis	PC	3	3	0	0	3
10.	CH8551	Mass Transfer I	PC	3	3	0	0	3
11.	EL8501	Corrosion Science and Engineering	PC	3	3	0	0	3
12.	EL8502	Electrodics and Electrocatalysis	PC	3	3	0	0	3
13.	EL8503	Electrochemical Reaction Engineering	PC	3	3	0	0	3
14.	EL8511	Heat and Mass Transfer Laboratory	PC	4	0	0	4	2
15.	EL8512	Chemical and Electrochemical	PC	4	0	0	4	2

		Reaction Engineering Laboratory						
16.	EL8601	Electrochemical Materials Science	PC	3	3	0	0	3
17.	CH8651	Mass Transfer II	PC	5	3	2	0	4
18.	EL8602	Instrumentation	PC	3	3	0	0	3
19.	CH8091	Electrochemical Process Technology	PC	3	3	0	0	3
20.	EL8603	Process Dynamics and Control	PC	3	3	0	0	3
21.	CH8652	Process Engineering Economics	PC	3	3	0	0	3
22.	EL8611	Equipment Design	PC	4	0	0	4	2
23.	EL8612	Computer Applications in Chemical Engineering Laboratory	PC	4	0	0	4	2
24.	EL8613	Corrosion and Metal Finishing Laboratory	PC	4	0	0	4	2
25.	EL8701	Process Synthesis and Design	PC	3	3	0	0	3
26.	CH8791	Transport Phenomena	PC	3	3	0	0	3
27.	EL8702	Electrometallurgy and Thermics	PC	3	3	0	0	3
28.	EL8711	Electrochemicals and Electro Metallurgy Laboratory	PC	4	0	0	4	2
29.	EL8712	Process Dynamics and Control Laboratory	PC	4	0	0	4	2
30.	EL8801	Electrochemical Energy Conversion and Storage	PC	3	3	0	0	3
31.	EL8802	Surface Science	PC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	EL8713	Internship	EEC	0	0	0	0	2
2.	HS8581	Professional Communication	EEC	2	0	0	2	1
3.	EL8811	Project Work	EEC	20	0	0	20	10

SUMMARY

S. No.	Subject Area	Credits Per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	**HS**	4	4	3	-	-	-	-	-	**11**
2	**BS**	12	10	15	7	-	-	-	-	**44**
3	**ES**	9	7	2	-	-	-	-	-	**18**
4	**PC**	-	3	3	16	19	25	13	6	**85**
5	**OE**	-	-	-	-	3	-	3	-	**6**
5	**PE**	-	-	-	-	-	-	6	3	**9**
6	**EEC**	-	-	-	-	1	-	2	10	**13**
Total		**25**	**24**	**23**	**23**	**23**	**25**	**24**	**19**	**186**

HS8151 **COMMUNICATIVE ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS 12

Reading- short comprehension passages, practice in skimming-scanning and predicting- **Writing**- completing sentences - developing hints. **Listening**- short texts- short formal and informal conversations. **Speaking-** introducing oneself - exchanging personal information- **Language development**- Wh- Questions- asking and answering-yes or no questions- parts of speech. **Vocabulary development-**- prefixes- suffixes- articles.- count/ uncount nouns.

UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- **Writing** – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –**Listening**- telephonic conversations. **Speaking –** sharing information of a personal kind—greeting – taking leave- **Language development** – prepositions, conjunctions **Vocabulary development-** guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading- short texts and longer passages (close reading) **Writing-** understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to longer texts and filling up the table- product description- narratives from different sources. **Speaking**- asking about routine actions and expressing opinions. **Language development**- degrees of comparison- pronouns- direct vs indirect questions- **Vocabulary development –** single word substitutes- adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading- comprehension-reading longer texts- reading different types of texts- magazines **Writing**- letter writing, informal or personal letters-e-mails-conventions of personal email- **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking-** speaking about oneself- speaking about one's friend- **Language development-** Tenses- simple present-simple past- present continuous and past continuous- **Vocabulary development**- synonyms-antonyms- phrasal verbs

UNIT V EXTENDED WRITING 12

Reading- longer texts- close reading –**Writing**- brainstorming -writing short essays **–** developing an outline- identifying main and subordinate ideas- dialogue writing-**Listening** – listening to talks- conversations- **Speaking –** participating in conversations- short group conversations-**Language development**-modal verbs- present/ past perfect tense - **Vocabulary development**-collocations- fixed and semi-fixed expressions

TOTAL : 60 PERIODS

OUTCOMES:

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

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. **Using English** A Coursebook for Undergarduate Engineers and Technologists**.** Orient BlackSwan Limited, Hyderabad: 2015**.**
2. Richards, C. Jack. **Interchange Students' Book-2** New Delhi: CUP, 2015.

REFERENCES

1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Comfort, Jeremy, et al. **Speaking Effectively : Developing Speaking Skillsfor BusinessEnglish.** Cambridge University Press, Cambridge: Reprint 2011.
3. Dutt P. Kiranmai and RajeevanGeeta. **Basic Communication Skills,** Foundation Books: 2013.
4. Means,L. Thomas and Elaine Langlois. **English & Communication For Colleges.** CengageLearning ,USA: 2007.
5. Redston, Chris &Gillies Cunningham **Face2Face** (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005.

MA8151 ENGINEERING MATHEMATICS I L T P C
4 0 0 4

OBJECTIVES :

- The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.

PH8151	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – 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 - stress due to bending in beams.

UNIT II WAVES AND FIBER OPTICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers : population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS 9

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 - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV QUANTUM PHYSICS 9

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 – tunnelling (qualitative) - scanning tunnelling microscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course,

- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,

- the students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

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

REFERENCES:

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 Modern Physics'. W.H.Freeman, 2007.

CY8151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water - Reverse Osmosis.

UNIT II SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and

catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, “Engineering Chemistry”, Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.

GE8151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

OUTCOMES:

Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.

- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
6. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd.,, 2015.

GE8152 ENGINEERING GRAPHICS L T P C
2 0 4 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

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 AND FREEHAND SKETCHING 7+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 square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points.

Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12

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 5+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 AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

TOTAL: 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Familiarize with the fundamentals and standards of Engineering graphics
- Perform freehand sketching of basic geometrical constructions and multiple views of objects.
- Project orthographic projections of lines and plane surfaces.
- Draw projections and solids and development of surfaces.
- Visualize and to project isometric and perspective sections of simple solids.

TEXT BOOK:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy And Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size. The examination will be conducted in appropriate sessions on the same day

GE8161	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L T P C 0 0 4 2

OBJECTIVES:

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

LIST OF PROGRAMS

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

OUTCOMES:

Upon completion of the course, students 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.

TOTAL :60 PERIODS

BS8161	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
	(Common to all branches of B.E. / B.Tech Programmes)	0	0	4	2

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

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

TOTAL: 30 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to

- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TOTAL: 30 PERIODS

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)

HS8251	TECHNICAL ENGLISH	L	T	P	C
		4	0	0	4

OBJECTIVES: The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations , participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TECHNICAL ENGLISH 12

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- **Speaking** –Asking for and giving directions- **Reading** – reading short technical texts from journals- newsapapers- **Writing**- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations-**Vocabulary Development**- technical vocabulary **Language Development** –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 12

Listening- Listening to longer technical talks and completing exercises based on them- **Speaking** – describing a process-**Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing- **Writing**- interpreting cgarts, graphs- **Vocabulary Development-**vocabularyused in formal letters/emails and reports **Language Development-** impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talkls on engineering/technology -**Speaking** – introduction to technical presentations- **Reading** – longer texts both general and technical, practice in speed reading; **Writing**-Describing a process, use of sequence words- **Vocabulary Development-** sequence words- Misspelled words. **Language Development-** embedded sentences

UNIT IV REPORT WRITING 12

Listening- Listening to documentaries and making notes. **Speaking** – mechanics of presentations- **Reading** – reading for detailed comprehension- **Writing**- email etiquette- job application – cover letter –Résumé preparation(via email and hard copy)- analytical essays and issue based essays--**Vocabulary Development**- finding suitable synonyms-paraphrasing-. **Language Development-** clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 12

Listening- TED/Ink talks; **Speaking** –participating in a group discussion -**Reading**– reading and understanding technical articles **Writing**– Writing reports- minutes of a meeting- accident and survey-**Vocabulary Development- verbal analogies Language Development-** reported speech

TOTAL : 60 PERIODS

OUTCOMES:

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

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of editors. **Fluency in English A Course book for Engineering and Technology.** Orient Blackswan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. **English for Technical Communication**. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Booth-L. Diana**, Project Work,** Oxford University Press**,** Oxford: 2014.
2. Grussendorf, Marion, **English for Presentations,** Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. **Engineering English**. Orient Blackswan: Hyderabad,2015
4. Means, L. Thomas and Elaine Langlois, **English & Communication For Colleges.** Cengage Learning, USA: 2007
5. Raman, Meenakshi and Sharma, Sangeetha- **Technical Communication Principles and Practice.**Oxford University Press: New Delhi,2014.

MA8251 ENGINEERING MATHEMATICS II L T P C
4 0 0 4

OBJECTIVES :

- This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved

surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c, cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

OUTCOMES :

After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES :

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

PH8254	PHYSICS OF MATERIALS	L	T	P	C
	(Common to courses offered in Faculty of Technology except Fashion Technology)	3	0	0	3

OBJECTIVES:

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

UNIT I PREPARATION OF MATERIALS 9

Phases - phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.

UNIT II CONDUCTING MATERIALS 9

Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law – electrons in metals: particle in a three-dimensional box- degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential (concept only) – electron effective mass – concept of hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III SEMICONDUCTING MATERIALS 9

Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.

UNIT IV DIELECTRIC AND MAGNETIC MATERIALS 9

Dielectric, Paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, magnetoresistance materials.

UNIT V NEW MATERIALS AND APPLICATIONS 9

Metallic glasses – Shape memory alloys: Copper, Nickel and Titanium based alloys – graphene and its properties - Ceramics: types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Biomaterials: hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Bio-sensors – conducting, semiconducting and photoresponsive polymers.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course, the students will able to

- gain knowledge on phase diagrams and various material processing methods,
- acquire knowledge on basics of conducting materials, superconductors and their applications
- get knowledge on the functioning of semiconducting materials and their applications

in LED and solar cells,

- understand the functioning of various dielectric and magnetic materials ,
- have the necessary understanding on various advanced materials.

TEXT BOOKS:

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

REFERENCES

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

CY8292 CHEMISTRY FOR TECHNOLOGISTS L T P C
3 0 0 3

UNIT I UNIT PROCESSES 9

Nitration, Sulphonation, Halogenation, Esterification, Amination, Saponification and Hydrogenation – Role of the above unit processes in such industries as petroleum, drugs, pharmaceuticals and organic synthesis.

UNIT II REACTION MECHANISMS 9

Free radical, substitutions, electrophilic, addition, aromatic electrophilic substitutions, nucleophilic additions, condensation reactions, nucleophilic substitutions in aliphatic and aromatic compounds, cyclo-additions, rearrangements-Beckmann and Fries rearrangement reactions.

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9

Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test. Solid lubricants – graphite and molybdenum disulphide.

UNIT IV CHEMICALS AND AUXILIARIES 9

Preparation, properties and uses of bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide. Estimation of available chlorine in hypochlorite bleach liquor. Determination of strength of hydrogen peroxide.

UNIT V COLORANTS 9

Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Chemistry and synthesis of azo dye (Methyl red, Methyl orange and Congo red)

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Dhara S. S., "A Text Book of Engineering Chemistry", 12th Ed., S. Chand & Co. Ltd., New Delhi, 2016.
2. Jain. P.C. and Monica Jain, "Engineering Chemistry", Dhanpet Rai & Sons, New Delhi, 2012.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

REFERENCES:

1. W.L. McCabe, J.C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill Education, 2005.
2. B.K. Sharma, "Industrial chemistry", Krishna Prakashan Media (P) Ltd, Meerut, 2011.
3. Shore J., "Colourants and Auxiliaries: Volume II Auxiliaries", Wood head Publishing Ltd., 2002.
4. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai, 1995.
5. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.I Publishing Pvt. Ltd., New Delhi, 1994.

BE8251 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 9

Fundamental laws of electric circuits– Steady State Solution of DC Circuits – Introduction to AC Circuits –Sinusoidal steady state analysis– Power and Power factor – Single Phase and Three Phase Balanced Circuits. Classification of instruments – Operating Principles of indicating Instruments

UNIT II ELECTRICAL MACHINES 9

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Introduction - Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

UNIT IV DIGITAL ELECTRONICS 9

Binary Number System – Boolean Algebra theorems– Digital circuits - Introduction to sequential Circuits– Flip-Flops – Registers and Counters – A/D and D/A Conversion –digital processing architecture.

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 9

Introduction – Elements of Communication Systems– Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Digital Communication - Communication Systems: Radio, Antenna, TV, Fax, ISDN, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to identify the electrical components and explain the characteristics of electrical machines.
- Ability to identify electronics components and understand the characteristics

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Electrical Machines "Basic Electrical and Electronics Engineering", McGraw Hill Education(India) Private Limited, Third Reprint ,2016
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson India, 2011
3. Sedha R.S., "Applied Electronics", S. Chand & Co., 2006

REFERENCES:

1. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009
2. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
3. Leonard S Bobrow, " Foundations of Electrical Engineering", Oxford University Press, 2013
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Mehta V K, "Principles of Electronics", S.Chand & Company Ltd, 1994.
6. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.

EL8201 PRINCIPLES OF ELECTROCHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

- To import knowledge on basic principles of electrochemistry and its applications.

UNIT I ION-SOLVENT & ION-ION INTERACTIONS 9

ion-solvent interaction, ExperimentalΔH and ΔIon-solvent interaction – Expression for verification of Born Model, Ion-dipole model of ion-solvent interaction and expression for heat of solvation, Ion-Ion Interaction – True and Potential electrolytes, Debye-Huckel (ion-cloud) theory of ion-ion interactions, Activity coefficients and ion-ion interaction

UNIT II ION TRANSPORT IN SOLUTION 9

Diffusion & Diffusion coefficient, Einstein-Smoluchowski equation, Conduction, Molar & Equivalent conductivity, Kohlrausch's Law, Ionic mobility, Stokes-Einstein relation, NernstEinstein equation, Transport numbers – determination by Hittorf's & Moving Boundary methods – Walden's rule - Debye Huckel-Onsager equation, Non-aqueous solutions

UNIT III POLARISATION AND OVER POTENTIAL 9

Electrolytic polarization, Dissolution and Decomposition potential, Overvoltage – hydrogen and oxygen overvoltage, applications, Polarography – principles, diffusion layer, limiting current density, polarographic circuit, dropping mercury electrode, merits & demerits, supporting electrolyte, current maxima, polarograms, half wave potential, diffusion current, applications

UNIT IV COLLOIDAL ELECTROCHEMISTRY 9

Electrochemical properties of colloids – Charge on colloidal particles, Electrical Double Layer, Cogulation of colloidal sols, Electrokinetic phenomena - Electro-Osmosis – Determination of zeta potential, Electrophoresis – sedimentation potential (Dorn effect), Determination of colloidal particle size, Surfactant, Emulsion, Emulsifiers, gels - Applications

UNIT V ELECTROACTIVE LAYERS AND MODIFIED ELECTRODES 9

Chemically modified electrodes, Types and methods of modification – chemisorption, covalent bond formation, polymer film coatings, inorganic materials, Langmuir-Blodgett (LB) methods, properties of the modified electrodes, electrochemistry at monolayer and multilayer modified electrodes, characterisation of modified electrodes

TOTAL : 45 PERIODS

OUTCOME:

- Upon completion of this course, the students would have knowledge of electrode potentials & Nernst equation, electrode reactions, voltammetry, amperometry, and electrochemical sensors.

TEXT BOOKS:

1. J.O.M.Bockris & A.K.N.Reddy, “Modern Electrochemistry –Vol. I & II” , Plenum Press, New York, 2000.
2. Peter Atkins and Julio de Paula, “Physical Chemistry”, VII Edition, Oxford University Press, New York, 2002.

REFERENCES:

1. A.J. Bard and L.R. Faulkner, “Electrochemical Methods – Fundamentals and applications” 3 rd edition John Wiley & Sons Inc, 2001.
2. Pallab Ghosh,”Colloid and Interface Science”,PHI Ltd,2009.

GE8261 ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

Buildings:

- (a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.

(b) Study of pipe connections requirements for pumps and turbines.

(c) Preparation of plumbing line sketches for water supply and sewage works.

(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.

(b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.

(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning

(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:

(b) Model making – Trays and funnels.

(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.

(b) Foundry operations like mould preparation for gear and step cone pulley.

(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 13

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE 16

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and
- fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

ME8261 COMPUTER AIDED DRAFTING AND MODELING LABORATORY **L T P C 0 0 4 2**

OBJECTIVES:

- To develop skill to use software to create 2D and 3D models.

List of Exercises using software capable of Drafting and Modeling

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg.V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

OUTCOMES:

- ability to use the software packers for drafting and modeling
- ability to create 2D and 3D models of Engineering Components

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Sl.N	Description of Equipment	Quantity
1.	Pentium IV computer or better hardware, with suitable graphics facility	30 No.
2	Licensed software for Drafting and Modeling.	30
3	Laser Printer or Plotter to print / plot drawings	2 No.

MA8353 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
4 0 0 4

OBJECTIVE:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.

- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
3. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
4. James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

EL8301 MOLECULAR PHYSICAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge in the field of electrochemistry, solubility behaviour, chemical reaction kinetics, photochemical reactions and colloidal chemistry towards different applications.

UNIT I QUALITATIVE INTRODUCTION TO QUANTUM THEORY 9

Review of qualitative quantum theory. Schrodinger equation. Born interpretation of wave function. Postulates of quantum theory. Uncertainty principle. Solution to particle in a one dimensional box. Degeneracy and particle in two and three dimensional box. Quantizing vibrational motion. Particle in a ring and rotational motion.

UNIT II ATOMIC STRUCTURE AND SPECTRA 9

Introduction to time dependent and time independent perturbation theories. Structure and spectra of hydrogen atom. Structure of many electron atoms. Spectra of complex atoms.

UNIT III MOLECULAR STRUCTURE AND QUALITATIVE INTRODUCTION TO MOLECULAR SPECTROSCOPY 9

Born – Oppenheimer approximation. Valence bond theory. Molecular orbital theory of diatomic and poly atomic systems. Qualitative introduction to molecular spectroscopy. Origin of selection

rules. Spectral line width and intensities with respect to vibrational, rotational and electronic spectra. Qualitative introduction to NMR.

UNIT IV INTRODUCTION TO STATISTICAL THERMODYNAMICS 9

Distribution of molecular states. Internal energy, enthalpy, free energy and entropy. Statistical ensembles**.** Canonical partition functions.

UNIT V APPLICATIONS OF STATISTICAL THERMODYNAMICS 9

Relationship between macro thermodynamic expressions and partition functions. Applications with respect to heat capacities, equations of state, molecular interaction in liquids. Residual entropies. Equilibrium constants.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the student would be able to define and to explain how thermodynamic laws are applied and incorporated to further our understanding of chemical equilibria, phase equilibria, electrochemical equilibria and biochemical reactions equilibria.

TEXT BOOKS:

1. P.W. Atkins and J.D.Paula**.** "Physical Chemistry" IX Edition, Oxford University Press (India), New Delhi, 2011.
2. Mcquarie, "Physical Chemistry: A molecular Approach". Viva books Private Limited, New Delhi, 2003.

REFERENCES:

1. Stephen Berry. R, Stuart Alan Rice and Ross. J, " Physical Chemistry", II edition, Wiley, New York, 2000.
2. Ira. N.Levine, " Physical Chemistry" V Edition, Mc Graw – Hill, New York, 2007.

CY8291 ORGANIC CHEMISTRY L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to learn the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

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.

TOTAL: 45 PERIODS

OUTCOMES:

- At the end of the course students will have knowledge on various reaction mechanism, preparation of organic compounds and their properties.

TEXTBOOKS:

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", 7th Ed., Prentice Hall Inc. USA, 2010.

REFERENCES:

1. Jonathan Clayden, Nick Greeves, Staurt Warren and Peter Wothers, "Organic Chemistry", Oxford University Press, 2nd Ed., New Delhi, 2013.
2. K.S. Tiwari, N.K. Vishnoi, S.N. Mehrotra, "A Text Book of Organic Chemistry", Vikas Publishing House, 2nd Ed., New Delhi, 2006.

EL8302 INORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVE:

- To introduce certain key aspects of inorganic chemistry, including solid state structures, the chemistry of phosphorus and hydrogen and transition metal chemistry.

UNIT I STRUCTURE AND BONDING IN INORGANIC CHEMISTRY 9

Structure of the atom. Symmetry of orbitals. Periodicity of the elements. Ionic bonding. Covalent bonding. Covalent character in predominant ionic bonding. Multiple bonding.

UNIT II CHEMISTRY IN AQUEOUS AND NON AQUEOUS SOLUTIONS 9

Acid – base chemistry. Acid - base concepts. Measures of acid - base strength. Hard and soft acids and bases. Non - aqueous solvents. Protic solvents and aprotic solvents. Solutions of metals in ammonia. Molten salts. Electro chemistry in non aqueous solvents.

UNIT III COORDINATION CHEMISTRY 9

Coordination number. Effective atomic number rule. Coordination compounds and their structure. Valence bond theory. Crystal field theory. Molecular orbital theory. Isomerisms. Structural equilibriums. Chelate effect. Reactions of coordination compounds.

UNIT IV CHEMISTRY OF TRANSITION METALS 9

Periodic trends among the three transition metal series. Comparison of properties of the oxidation states and electron configuration. General chemistry of heavier transition metals Inorganic chains, rings and cages.

UNIT V ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY 9

Oranometallic chemistry. Synthesis and catalysis of metal carbonyls, metal nitrosyls, metallocenes, aromatic cyclopolyenes, olefin and acetylene complexes. Inorganic chemistry in biological systems. Metalloporphyrins, enzymes, essential and trace elements in biological systems

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students will able to use these concepts in problem solving, describe and place in context the chemistry of main group elements and transition metals

TEXT BOOKS:

1. James E. Huheey, E.A. Keiter and R. L.Keiter “Inorganic Chemistry: Principles of structure and reactivity” IV Edition, Harper & Row, New York, 2004.
2. P.W. Atkins and Shriver. “Inorganic Chemistry” V Edition, Oxford University Press (India), New Delhi, 2011.

REFERENCE:

1. F.A. Cotton and G.Wilkinson “Advanced Inorganic chemistry”, VI edition, Weily India Pvt Ltd., 2008.

GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth‟s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of

biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India PVT LTD, New Delhi, 2007.
2. Erach Bharucha, “Textbook of Environmental Studies”, Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, “Environmental Science”, Cengage Learning India PVT, LTD, Delhi, 2014.

EL8303 CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

OBJECTIVE:

- To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I BASIC CONCEPTS 9

Review of basic concepts. Methods of expressing composition of mixtures and solutions. Use of molal units, partial pressure and pure component volume in calculations. Material balance for non reacting systems like distillation, evaporation, drying etc.

UNIT II MATERIAL BALANCE 9

Material balance for reacting systems. Stoichiometry. Limiting and excess reactants. Degree of completion. Multiple reactions. Recycle, bypass and purging. Material balance for unsteady state processes. Tank hold up and discharge.

UNIT III PSYCHROMETRY & CRYSTALLISATION 9

Psychrometry. Basic definitions. Humidification and dehumidification calculations. Use of psychrometric chart. Solubility and crystallization. Material balance and yield calculations in dissolution and crystallization processes.

UNIT IV ENERGY BALANCE 9

Heat capacity of liquid and gaseous mixtures. Use of mean heat capacities. Evaluation of enthalpy changes for systems with and without phase change. Energy balance for reacting and non reacting systems. Adiabatic reaction temperature. Theoretical flame temperature.

UNIT V FUELS AND COMBUSTION 9

Fuels. Ultimate and proximate analyses. Higher and lower heating values of fuels. Combustion chemistry. Incomplete combustion. Theoretical and excess air. Computations involving flue gas analysis and Orsat analysis. Determination of fuel composition.

TOTAL: 45 PERIODS

OUTCOME:

- The students would be able to understand chemical engineering calculations, establish mathematical methodologies for the computation of material balances, energy balances.

TEXT BOOKS:

1. R.M Felder and R.W. Rousseau, "Elementary principles of Chemical processes" Fifth Edition, Weily, New york, 2004.
2. K. Asokan "Chemical process calculations", First edition, Universities Press, Hyderabad, 2007 &CRC Press, Boca Raton ,U.S.A., 2008.

REFERENCES:

1. D.M. Himmelblau, J.B. Riggs**,** "Basic principles and calculations in chemical engineering" Prentice Hall of India, Revised VII Edition, 2012.
2. O.A. Hougen, K.M. Watson and R.A.Ragatz "Chemical Process Principles, Part I (Material & Energy Balances)",III Edition, Reprinted Indian edition, CBS Publishers & distributors, New Delhi, 2004.
3. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam "Process Calculations" Printice Hall of India, New Delhi, 2011.
4. K.V.Narayanan, B. Lakshmipathy, "Stochiometry and Process Calculation", PHI Learning Ltd.(2013).

EL8311 ENGINEERING CHEMISTRY LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To improve the practical knowledge on the analysis of inorganic/organic compounds, properties and characteristics of solvents and mixtures.

INORGANIC & ORGANIC CHEMISTRY (LIST OF EXPERIMENTS)

1. Analysis of sugars
2. Analysis of soap
3. Preparation of organic compounds:
   i. Hydrolysis – benzoic acid from benzamide
   ii. Acetylation – acetyl salicylic acid from salicylic acid
   iii. Bromination – tribromo aniline from aniline
   iv. Nitration – meta dinitrobenzene from nitrobenzene
   v. Benzoylation – phenyl benzoate from phenol
   vi. Oxidation – benzoic acid from benzaldehyde

OUTCOME:

- The students would be able to prepare organic compounds and analyze the inorganic / organic compounds.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Silica Crucible

2. Heating Mantle
3. Muffle Furnace
4. Hot air oven
5. Desiccators
6. Vacuum pump
7. Condensers

REFERENCE:

1. Laboratory Manual prepared by Faculty

PHYSICAL CHEMISTRY(LIST OF EXPERIMENTS)

1. Determination of partition co-efficient of iodine between two immiscible solvents
2. Determination of partition coefficient of benzoic acid between two immiscible solvents
3. Phase diagram for binary system
4. Verification of Oswald's dilution law
5. Heat of solution
6. Determination of acid value in the given oils
7. Adsorption isotherm
8. Equilibrium constant of $KI + I_2 \dashrightarrow KI_3$

OUTCOME:

- The student would be able to determine the properties and characteristics of solvents and mixtures.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Mechanical Shaker
2. Conducting meter
3. Mantle Heater
4. Hot Plate
5. Bunsen Burners
6. Thermometer
7. Electronic Weighing balance

REFERENCE:

1. Physical Chemistry experiments by Alexander Findley, McGraw-Hill IV Edition, (1976).

TOTAL: 60 PERIODS

EE8362 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To determine characteristics of electrical apparatus and electronic devices by conducting suitable experiments.

LIST OF EXPERIMENTS

1. Verification of Ohm's law and Kirchhoff's laws.
2. Measurement of three phase power
3. Load test on DC shunt motor.

4. Load test on single -phase Transformer
5. Load test on separately excited DC generator
6. Study of half wave and full wave rectifiers.
7. RC coupled transistor amplifier.
8. Study of logic gates and implementation of Boolean functions.
9. Implementation of binary adder/ subtractor.
10. Study of modulation and demodulation principles
11. Study of communication systems
12. Study of ADC and DAC circuits

Minimum of 10 Experiments to be carried out :-

TOTAL : 60 PERIODS

OUTCOMES:

- Understanding the relation between electrical voltage, current and resistance.
- Ability to measure the performance of electrical machine like DC and AC motors.
- Visualizing the usage of logic gates and Microprocessor in motor control systems.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OF THE EQUIPMENT	Qty.
1.	D. C. Motor Generator Set	2
2.	D.C. Shunt Motor	2
3.	Single Phase Induction Motor	2
4.	Ammeter A.C and D.C	20
5.	Voltmeters A.C and D.C	20
6.	Watt meters LPF and UPF	12
7.	Resistors & Breadboards	-
8.	Cathode Ray Oscilloscopes	4
9.	Dual Regulated power supplies	6
10.	A.C. Signal Generators	4
11.	Communication system demonstration kits	2
12.	Modulation and demodulation demo kits	2
13.	ADC and DAC circuit demo kits	2

MA8491 NUMERICAL METHODS L T P C
4 0 0 4

OBJECTIVE:

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

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.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should 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.

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.

REFERENCES:

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, 6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.

4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

PM8391 MATERIALS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To provide students with a strong foundation in materials science with emphasis on the fundamental scientific and engineering principles which underlie the knowledge and implementation of material structure, processing, properties, and performance of all classes of materials used in engineering systems.

UNIT I STRUCTURE OF MATERIALS 9

Introduction-classification of materials, selection of materials, properties of materials, x-ray crystallography, Bragg's law, x-ray diffraction, electron diffraction, neutron diffraction, structure of NaCl and diamond, Crystal defects - point, line, surface and volume defects, alloy formation, solid solution types, solidification of castings, structural examination using microscopy**.**

UNIT II METALLURGICAL PROPERTIES OF MATERIALS 9

Phase diagrams - isomorphous, eutectic, eutectoid and peritectic system. Diffusion - Fick 's laws. Mechanical properties - tension test, hardness test - brinnel, vickers, rockwell, micro hardness test - shore scleroscope. Impact test, fracture - grifiths' theory, fracture toughness, embrittlement phenomena. Fatigue and creep. Strengthening mechanisms

UNIT III TYPES OF MATERIALS 9

Classification of steel, Fe-C phase diagram, heat treatment, TTT curves, ausforming, marforming, annealing types, normalizing, tempering, hardening, effect of alloying elements, tool steels, stainless steel, cast iron - malleable and ductile types and properties. Copper and its alloys - brass, bronze, copper – nickel. Aluminium and its alloys, hardening treatment. Al cladding nickel and its alloys, titanium and its alloys, cermets, welding electric and magnetic materials, nano particles and nano structures.

UNIT IV PHYSICAL CHARACTERISTICS OF MATERIALS 9

Metals, semiconductors, insulators, electron theory, band theory, types of magnetism, domain structures, anisotrophy of materials, and application. Soft and hard magnets. Conductivity of materials, zone refining, crystal growth techniques.

UNIT V NON-METALLIC MATERIALS 9

Ceramic materials - oxides, silicates. Refractories. Glasses, enamels, abrasives, cement and concrete materials. Polymers – classification, reaction, types, mechanisms, deformation of polymers, mechanical, thermal, electrical and chemical behavior. Rubber, silicones, fluoro carbons, composites -FRP, particulates, and laminates.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students will be able to understand various material and its properties and manufacturing methods.

TEXT BOOKS:

1. V.Raghavan, “Materials Science and Engineering: A first course”, V Edition, Prentice Hall of India , 2004.

2. Van Vlack L.H , “Elements of Materials Science and Engineering” (Addision Wesley series in metallurgy and materials engineering), VI Edition, Prentice Hall, 6th Edition, 1989.

REFERENCES:

1. WF.Hosford, “Material Science”, Cambridge Univ. Press, New York, 2006.
2. C.Srinivasan, “ Science of Engineering Materials”, John Wiley, New York, 1987.

EL8401 FLUID AND SOLID OPERATIONS L T P C
3 0 0 3

OBJECTIVE:

- To impart to the student knowledge on fluid properties, fluid static and dynamic characteristics flow metering and transport, particle mechanics, techniques of solid – fluid separation

UNIT I PROPERTIES OF FLUID 9

Newtonian fluids Classification of fluid motion Fluid statics – equilibrium of fluid element – pressure variation in a static fluid – Differential analysis of fluid motion – continuity, Euler’s and Bernoulli equation, Navier-Stokes Equation, Hagen-Poiseuilli flow.

UNIT II FLOW THROUGH PIPES & BOUNDARY LAYER CONCEPTS 9

Reynolds number regimes, Flow through pipes – pressure drop under laminar and turbulent flow conditions; boundary layer concepts; Friction factor, Moody Chart, Flow meters ; different types of flowmeters; Valves, pumps, compressors – characteristics and sizing; Agitation and Mixing;

UNIT III SIZE ANALYSIS 9

General characteristics of solids, techniques of size analysis; Laws of size reduction, quipments for size reduction

UNIT IV FLOW THROUGH FLUIDIZED BEDS 9

Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds. Filtration – batch and continuous, filtration equipments - selection, operation

UNIT V CLASSIFIERS 9

Screening, gravity separation - sedimentation, thickening, elutriation, classifiers - Centrifugal separation - continuous centrifuges, cyclones and hydro cyclones, electrostatic and magnetic separators

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students will be able to understand the principles of fluid mechanics and applications of mechanical operations in process industries.

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Second Edition, McGraw-Hill, (1991).
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.

REFERENCES:

1. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5th Edition“, John Wiley, 2006

2. McCabe W.L, Smith, J C and Harriot. P “Unit operations in Chemical Engineering”, McGraw Hill, V Edition, 2001
3. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

PE8491 CHEMICAL ENGINEERING THERMODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I **9**

Scope of thermodynamics, basic concepts and definitions, Equilibrium state and phase rule, Energy, Work, Temperature and Zeroth Law of Thermodynamics, reversible and irreversible process, Ideal gas- Equation of State involving ideal and real gas, Law of corresponding states, Compressibility chart, First Law of Thermodynamics and its consequences.

UNIT II **9**

Joule’s experiment, internal energy, enthalpy, Application of first Law of Thermodynamics for Flow and non flow processes. Limitations of the first Law , statements of second Law of Thermodynamics and its Applications ,Heat Engine, Heat Pump/Refrigerator, Carnot cycle and Carnot theorem, Thermodynamic Temperature scale, Entropy , Clausius inequality, Third law of thermodynamics.

UNIT III **9**

Refrigeration and liquefaction process, Thermodynamic Potentials, thermodynamic correlation, Maxwell relations, criteria for Equilibria and stability. Clapeyron equation

UNIT IV **9**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, activity and property change of mixing, excess properties of mixtures.

UNIT V **9**

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, ChemicalReaction equilibria, Extent of reaction, equilibrium constant and standard free energy change

TOTAL: 45 PERIODS

OUTCOME:

- The course will help the students to know about engineering thermodynamics and understand the practical implications of thermodynamic law in engineering design.

TEXT BOOKS:

1. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7th Edition, Wiley India, New Delhi, 2009.
2. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics Prentice Hall India, 2004
3. Smith, van Ness and Abbott, “Chemical Engineering Thermodynamics”, 7th Edition, McGraw Hill, New York, 2005

REFERENCES:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006
2. Y V C Rao, “Chemical Engineering Thermodynamics”, Universities Press, Hyderabad 2005.
3. Pradeep ahuja,” Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).
4. GopinathHalder,” Introduction to Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).

EL8402 HEAT TRANSFER AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To enable the students to learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I CONDUCTION 9

Heat transfer by conduction in solids. Fourier’s law. Steady state heat conduction through plane and composite wall. Radial heat conduction through hollow cylinder and hollow sphere. Concepts of thermal conductivity and thermal diffusivity. Unsteady state heat conduction. Heisler charts.

UNIT II CONVECTION 9

Heat flow in fluids. Boundary layers. Parallel, counter current and cross flow heat exchangers. Log mean temperature difference. Overall and individual heat transfer coefficients. Application of dimensional analysis to convection. Natural and forced convection. Convective heat transfer in ducts, flat plates, falling film etc for laminar and turbulent regions. Heat transfer correlations and analogies.

UNIT III CONDENSATION & BOILING 9

Heat transfer from condensing vapors. Drop wise and film type condensation, Nusselt equation for vertical and horizontal plates / tubes. Heat transfer to boiling liquids and molten metals. Mechanisms of boiling. Pool boiling. Convective boiling. Correlations. Design of condensers and vaporizers.

UNIT IV HEAT EXCHANGE EQUIPMENTS 9

Shell and tube heat exchangers. Single pass and multi pass shell and tube heat exchangers. LMTD correction for multipass exchangers. Heat exchanger effectiveness. Fouling factors. Heat transfer units. Plate heat exchangers. Extended surface equipments. Heat transfer in packed and fluidized beds.

UNIT V RADIATION & EVAPORATION 9

Concept of thermal radiation. Black body and gray body concepts. Laws of radiation. Radiation between surfaces. View factors. Radiation shield. Evaporation. Single effect and multiple effect evaporators. Mass and enthalpy balance. Calculation of heat transfer area. Factors affecting the performance of evaporators.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students will have knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments

such as furnace, boilers, heat exchangers evaporation

TEXT BOOKS:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", Fifth Edition, Weily – India, New Delhi, 2009.
2. J.P. Holman, "Heat transfer", Ninth Edition, Tata - McGraw Hill, New Delhi, 2009.

REFERENCES:

1. D.Q. Kern, "Process Heat Transfer", Eighteenth Reprint, McGraw Hill, New York, 2008.
2. J.M.Coulson and J.F. Richardson with J.R.Backhurst and J.H.Harker, "Coulson and Richardson's chemical Engineering", Vol.1, "Fluid Flow, Heat Transfer and Mass Transfer", Butterworth Heinmann, 6th Edition, 2000.

PE8091 CHEMICAL REACTION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I **9**

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II **9**

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, Equal sized CSTRs in series and parallel, Equal sized PFRs in series and parallel,size comparison of reactors.

UNIT III **9**

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV **9**

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V **9**

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students would gain knowledge on the selection of reactor for the required reaction.

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000.
2. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.
3. Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd.,

3rd Edition, 2000.

REFERENCE:

1. Froment. G.F. &K.B.Bischoff, “Chemical Reactor Analysis and Design”, John Wiley and Sons, 1979.

CH8581 MECHANICAL OPERATIONS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

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

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 set up

TOTAL: 60 PERIODS

Minimum 10 experiments shall be offered

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

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

Minimum 10 equipment

OUTCOME:

- Students would gain the practical knowledge and hands on various separation techniques like filtration, sedimentation, screening, elutriation, and centrifugation

CH8461 **FLUID MECHANICS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

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

LIST OF EXPERIMENTS

1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

***Minimum 10 experiments shall be offered**

EQUIPMENT REQUIRED

1.	Viscometer	1 No.
2.	Venturi meter	1 No.
3.	Orifice meter	1 No.
4.	Rotameter	1 No.
5.	Weir and Notches	1 No.
6.	Open drum with orifice	1 No.
7.	Pipes and fittings	1 No.
8.	Helical and spiral coils	1 No.
9.	Centrifugal pump / Gear pump / Reciprocating	1 No
10.	Packed column	1 No.
11.	Fluidized bed	1 No.

Minimum 10 equipment

TOTAL: 60 PERIODS

OUTCOMES:

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

CH8491 **INSTRUMENTAL METHODS OF ANALYSIS** **L T P C**
3 0 0 3

OBJECTIVE:

- To know the principle and importance of various analytical instruments used for the characterization of various materials

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 overlap 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 Performance Liquid Chromatographical methods (principle, mode of separation and technique).

TOTAL: 45 PERIODS

OUTCOME:

- To have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials, intermediates and finished products**.** To know the importance of analytical instrumentation during the purification, compounding and formulating the finished product.

TEXT BOOKS :

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

REFERENCES:

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.
3. Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014
4. John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice-hall of India Pvt. Ltd., 2012

5. Robert M. Silverstein, Francis X. Webstrer, David Kiemle, David L. Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition, 2010.

CH8551 MASS TRANSFER I L T P C
3 0 0 3

OBJECTIVE:

- Students will learn to determine mass transfer rates under laminar and turbulent conditions.

UNIT I **9**

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II **10**

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III **9**

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV **9**

Drying– Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.

UNIT V **8**

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course,

- Students would have knowledge in diffusion and its application in laminar and turbulent conditions.
- Students would apply the mass transfer concepts in the design of humidification columns, dryers and crystallizers.

TEXT BOOKS:

1. Treybal, R.E., “Mass Transfer Operations”, 3rd Edn, McGraw-Hill, 1981.
2. Geankoplis, C.J., “Transport Processes and Unit Operations”, 4th Edition, Prentice Hall Inc., New Jersey, 2003.
3. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edn., McGraw-Hill, 2005.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I and II, 4th Edition, Asian Books Pvt. Ltd., India, 1998.

2. J.D. Seader and E.J. Henley, “Separation Process Principles”, 2nd Ed., John Wiley, 2006.
3. Binay K. Dutta, ”Principles of Mass Transfer and Separation Processes”, PHI Learning Ltd, 2013.

EL8501 CORROSION SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To provide fundamental understanding on aspects of electrochemistry and materials science relevant to corrosion phenomena and Identify practices for the prevention and remediation of corrosion.

UNIT I BASIC ASPECTS OF CORROSION 9

Introduction, classification, economics, emf series, Galvanic series. Corrosion theories: derivation of potential – current relationships of activation controlled and diffusion controlled corrosion processes. Potential – pH diagrams Fe-H_2O system, application and limitations. Passivation-definition, anodic passivation theory of Passivation.

UNIT II FORMS OF CORROSION 9

Definition, factors and control methods of various forms of corrosion: uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement.

UNIT III ATMOSPHERIC CORROSION AND PROTECTIVE COATINGS 9

Atmospheric corrosion – classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods ; organic coating – surface preparation, natural, synthetic resin, paint formulation and applications. Paint testing and evaluation.

UNIT IV IMMERSION CORROSION AND ELECTROCHEMICAL PROTECTION 9

Corrosion in immersed condition: effect of dissolved gases, salts, pH, temperature and flow rates on corrosion; marine corrosion. Underground corrosion – corrosion process in the soil, factors influencing soil corrosion, Biological corrosion definition, mechanism of biological corrosion control of bio corrosion. Electrochemical methods of protection theory of cathodic protection, design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - boiler water system. Corrosion resistant alloys.

UNIT V CORROSION MONITORING 9

Laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by Gravimetric, Tafel polarization, linear polarization, cyclic polarization, impedance spectroscopy, harmonics and NDT techniques- ultrasonics, radiography eddy current.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the student would understand the causes of and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, and various modes of environmentally assisted cracking.

TEXT BOOKS:

1. S.N.Banerjee, “An Introduction to Corrosion Science and Corrosion Inhibition”, Oxonian Press, P.Ltd., New Delhi, 1985.
2. Zaki Ahmad, “Principles of Corrosion Engineering & Corrosion Control”, Butterworth Heinemann, London, 2006

REFERENCES:

1. E.E. Stansbury, R.A. Buchanan, “Fundamentals of electrochemical corrosion”, ASM International, 2000.
2. M.G.Fontana & N.D. Greene, “Corrosion Engineering”, III Edition, McGraw Hill, New York, 1978.

EL8502 ELECTRODICS AND ELECTROCATALYSIS L T P C
3 0 0 3

OBJECTIVE:

- To impart necessary basic knowledge in order to understand, analyze and solve problems related to electrochemical processes.

UNIT I ELECTRICAL DOUBLE LAYER 9

Thermodynamics of ideally polarizable and non-polarizable interfaces- Lipman equation- determination of interfacial tension, charge density, surface excess and double layer capacitance by electro capillary & bridge methods- Helmholtz, Gouy-Chapman and stern models of the double layer with discussion of potential and charge distribution inside the double layer-contact adsorption and its determination.

UNIT II ELECTRODE KINETICS 9

Concepts of equilibrium potential, Nernst equation, overpotential and its different types, equilibrium exchange current density-derivation of Butler-Volmer equation –high field and low field approximations – charge transfer resistance and polarizability of the interface – concepts of rate determining step, Stoichiometric number, reaction order – Determination of kinetics parameters [i_o, $k_{s,}\beta(\alpha)$] by Tafel and linear polarization methods.

UNIT III ELECTROCATALYSIS 9

Chemical catalysis and electro catalysis – comparison of electrocatalysts – electro catalysis in simple redox reactions involving adsorbed species – electronic and geometric factors in electrocatalysts -Discussion on the mechanisms of hydrogen evolution and oxygen reduction reactions.

UNIT IV ELECTROCHEMICAL TECHNIQUES I 9

Ion selective electrodes – Principles of potentiometry and amperometry- determination of dissolved oxygen. Linear sweep voltammetry and cyclic voltammetry derivation of Randles-Sevciks equation – effect of sweep rate-analysis of cyclic voltammograms.

UNIT V ELECTROCHEMICAL TECHNIQUES II 9

Potential step method (chronoamperometry) under diffusion control derivation of Cottrell equation for a planar and spherical electrode- significance of spherical diffusion – derivation of Ilkovic equation.- Chronopotentiometry and analysis of chronopotentiograms-derivation of sands equation for constant current input under linear diffusion- concepts of Faradaic impedance –derivation of kinetic parameters from impedance measurements – Nyquist and

bode plots for simple redox reactions-principles of scanning probe techniques-STM-AFM and SECM – working principles of electrochemistry.

TOTAL: 45 PERIODS

OUTCOME:

- Student will have the knowledge on electrical double layer, Electrocatalysis and different types of Electrochemical techniques.

TEXT BOOKS:

1. J.O.M Bockris& A.K.N. Reddy, "Modern Electrochemistry", Vol.2, Plenum Press (Chapter 7 for unit I: Chapters 8 & 9 for unit II ; chapter 10 for unit III), 1996.
2. A.J.Bard& L.R. Faulkner, "Electrochemical Methods Fundamentals and Applications", John Wiley & Sons. 3nd Edition, 2001.

REFERENCES:

1. Paul Delahay, "Double Layer Structure and Electrode Kinetics", 1965 and publication.
2. James A. Plam Beck , "Electroanalytical Chemistry – Basic Principles and Applications", John Wiley & sons, Wiley Publication, 1982

EL8503 ELECTROCHEMICAL REACTION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To familiarize in the aspects of current-voltage relationships & estimation of mass transfer co-efficient, PFR & CSTR systems model

UNIT I CURRENT-VOLTAGE RELATIONSHIPS & ESTIMATION OF MASS TRANSFER CO-EFFICIENT 9

A general view of electrolytic processes; current-voltage relationships in electrolytic reactors; the limiting current plateau; mass & energy balance, and efficiency in electrochemical reactors. The estimation of mass transport coefficients at commonly occurring electrodes. The estimation of mass transport coefficients under enhanced convection conditions.

UNIT II PLUG FLOW& CSTER SYSTEMS MODEL 9

A general view of plug flow model of electrolytic reactors: plug flow model of electrochemical reactors employing parallel plate reactor; Plug flow model under constant mass flux conditions; PFM analysis with electrolyte recycling PFM and real electrochemical reactors. General view of simple CSTER systems; CSTER in cascades; CSTER analysis of batch electrochemical reactors, CSTER analysis of semi-continuous electrochemical reactors; CSTER analysis of electrolyte recycling; Batch reactor combined with electrolyte recycling.

UNIT III THERMAL BEHAVIOR OF REACTORS 9

General aspects of thermal behavior in electrochemical reactor. Thermal behavior under CSTER conditions. The estimation of heat losses; the thermal behavior under PFR conditions; Thermal behavior of batch electrochemical reactors.

UNIT IV CONVECTIVE DIFFUSION EQUATION & CURRENT DISTRIBUTION 9

Convective diffusion equation and migration effects –derivation of convective diffusion equation theory – scope and limitation – migration effects – Electroneutrality conditions – supporting electrolyte effect – fundamental of Nernst layer model – Estimation of true limiting current

UNIT V DISPERSION MODELS & OPTIMIZATION OF ELECTROCHEMICAL REACTOR **9**

General aspects of dispersion models-tracer input signal/output signal - axial dispersion in electrochemical reactors - axial dispersion and reactor performance - axial dispersion analysis via tank-in-series model - general notions on optimization of electrochemical reactor – elementary process optimization – IBL formula – optimization of electro refining process – Jaskula formula – optimization of a general electrolytic process – The Beck formula.

TOTAL :45 PERIODS

OUTCOME:

- The students will have a practical ability to analyze electrochemical design models, thermal behavior of reactors and electrochemical reactors.

TEXT BOOK:

1. T.Z.Fahidy, “Principles of Electrochemical Reactor Analysis”, Elsevier, 1985.

REFERENCE:

1. K.Scott, “Electrochemical Reaction Engineering”, Academic Press, 1991

EL8511 HEAT AND MASS TRANSFER LABORATORY **L T P C**

(**Any Ten experiments**) **0 0 4 2**

OBJECTIVE:

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

LIST OF EXPERIMENTS

1. Transient state heat conduction
2. Solvent extraction
3. Batch drying
4. Temperature profile of a rod
5. Natural convection
6. Thermal conductivity of composite wall
7. Emissivity measurement
8. Measurement of diffusion coefficient
9. Simple distillation
10. Leaching
11. Adsorption
12. Double pipe heat exchanger

TOTAL: 60 PERIODS

OUTCOME:

- Student would be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena. Students would demonstrate knowledge on the determination of important data for the design and operation of the process equipment’s like distillation, extraction, diffusivity, drying principles which are having wide applications in various industries

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Data Loger
2. Heat Exchanger
3. Condenser

4. Thermal conductivity measurement apparatus
5. Soxlet Extractor
6. Rotating Disc Contactor
7. Controllers of Temperature
8. Convection Apparatus
9. Emissivity measurement apparatus
10. Distillation Apparatus
11. Double pipe heat exchanger
12. Diffusion Apparatus

REFERENCE:

1. Laboratory Manual prepared by Faculty

EL8512 CHEMICAL AND ELECTROCHEMICAL REACTION ENGINEERING LABORATORY **L T P C 0 0 4 2**

CHEMICAL REACTION ENGINEERING

OBJECTIVE:

- Students develop a sound working knowledge on different types of reactors. its also students to experimentally determine the kinetic constant and conversion of a given electrochemical, reactor in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions.

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a PFR followed by a CSTR
5. RTD studies in a PFR
6. RTD studies in a CSTR
7. Study of temperature dependence of rate constant using CSTR.

EQUIPMENT REQUIRED

1. BATCH REACTOR
2. Plug flow reactor
3. CSTR

OUTCOMES:

- Understand rate equation for different types of reactors.
- Design experiments in kinetics to determine conversion and effect of temperature on rate constant.
- Assess the performance of Plug flow Mixed flow and Packed bed by studying the residence time distribution.
- Students would develop a sound working knowledge of electrochemical reaction on different types of reactors

ELECTROCHEMICAL REACTION ENGINEERING

OBJECTIVE:

- To make the students to experimentally determine the kinetic constant and conversion

of a given electrochemical, reaction in a batch reactor, tubular reactor and mixed flow reactor and compare with the theoretically predicted conversions

LIST OF EXPERIMENTS

1. Electrochemical batch reactor-constant current operation / constant potential operation.
2. Factorial design for investigating the current efficiency of copper deposition.
3. Monopolar and bipolar cells.
4. Electrochemical batch reactor – Constant current operations for Copper/Titanium/Stainless steel electrode.
5. Continuous flow stirred tank electrochemical reactor (CSTER)
6. Axial flow electrochemical reactor (PFER) – Single out let
7. Packed bed reactor – Flow through configuration (Copper bed)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Electrochemical batch reactor
2. Chemical Bath
3. CSTER
4. PFER
5. Packed bed reactor

REFERENCE:

1. Laboratory Manual prepared by Faculty

HS8581	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES:

The couse aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully

UNIT I

Introduction to Soft Skills-- Hard skills & soft skills - employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs

UNIT II

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice—– presenting the visuals effectively – 5 minute presentations

UNIT III

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics - brainstorming the topic -– questioning and clarifying –GD strategies- activities to improve GD skills

UNIT IV

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V

Recognizing differences between groups and teams- managing time-managing stress-networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes

TOTLA: 30 PERIODS

OUTCOMES:

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

- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software

1. Globearena
2. Win English

REFERENCES:

1. Butterfield, Jeff **Soft Skills for Everyone.** Cengage Learning: New Delhi, 2015
2. **Interact** English Lab Manual for Undergraduate Students,. OrientBalckSwan: Hyderabad, 2016.
3. E. Suresh Kumar et al. **Communication for Professional Success.** Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma. **Professional Communication**. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. **Soft Skills**. MJP Publishers: Chennai, 2010.

EL8601 ELECTROCHEMICAL MATERIALS SCIENCE L T P C
3 0 0 3

OBJECTIVE:

- This course will give an introduction to basic electrochemistry, principles of electrochemical devices, electroactive materials used in such devices, and case studies of batteries and sensors.

UNIT I THIN FILMS: PHYSICAL METHODS OF PREPARATION 9

Thin films-preparation-vacuum pumps-measurement of vacuum-guages-physical methods-thermal evaporation-electron beam evaporation-sputtering mechanism and methods-ion plating—laser ablation -Epitaxy-Molecular Beam Epitaxy-Hot Wall Epitaxy-Liquid Phase Epitaxy-Atomic layer deposition-Plasma spray

UNIT II THIN FILMS: CHEMICAL METHODS OF PREPARATION 9

Chemical methods-chemical vapor deposition-MOCVD-PECVD--etching process-dry and wet etching-micro contact printing-electrodeposition- templated synthesis- electroless-spray pyrolysis-spin coating-Langmuir Blodgett films-sol-gel synthesis-self assembled monolayers-hydrothermal-screen printing

UNIT III PROPERTIES OF THIN FILMS 9

Thickness measurements-multiple beam interference-quartz crystal-ellipsometric-stylus techniques-optical-reflection-absorbance-transmittance-band gap measurement- electrical (hot probe and four probe techniques) and dielectric behavior of thin films-mechanical properties-testing methods-adhesion-surface and tribological coatings-electrochemical characterization-potentiodynamic polarization-electrochemical impedance spectroscopy

UNIT IV ADVANCED FUNCTIONAL MATERIALS 9

Thin film metallic glasses-preparation-properties and applications- smart materials-piezoelectric materials-thermoelectric materials-self-cleaning materials-chromogenic materials-solar cells-single crystalline siliconsolar cells- amorphous silicon solar cells- thin film polycrystalline solar cells-photoelectrochemical cells- Dye-sensitized solar cells - pervoskite solar cells-supercapacitors.

UNIT V BIOMATERIALS 9

Biomaterials-introduction-different generation of biomaterials-general characteristics-examples and uses-naturally occurring biomaterials-pure metals-alloys-ceramics-polymer-composites-bioactive and biodegradable ceramics-biodegradable polymers-hydrogels-orthopaedic materials-bone composition and properties-biomaterials used in bone and joint replacement-dental materials-biomaterials in opthamology-intracular lens materials-tissue grafts-skin grafts-suture materials-drug delivery: methods and materials

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students would develop a sound knowledge on the integration of electrochemical principles and material science for innovating in the area of modern electrochemical devices.

TEXT BOOKS:

1. K.L. Chopra and S.R. Das, Thin Film Solar Cells, Plenum NewYork, 1983.
2. A.F. Fahrenbruch and R.H. Bube, Fundamentals of Solar Cells, Academic Press, London, 1983.
3. J. Kilner, S. Skinner, S. Irvine, P. Edwards, Functional Materials for Sustainable Energy Applications, Woodhead Publishing Ltd., London, 2012.
4. D.F. Williams, Materials Science and Technology: A comprehensive treatment, Vol 14, Medical and Dental materials, VCH Publishers Inc, New York, 1992.
5. A.J. Bard and L.R. Faulkner, Electrochemical methods: fundamentals and applications, John Wiley and Sons, 2006.

REFERENCES:

1. Vijayamohanan K. Pillai and Meera Parthasarathy, “Functional Materials: A chemist’s perspective”, Universities Press Hyderabad (2012).
2. Milton Ohring, The Materials of Thin Films, Academic press, 2001.
3. Stephen Manne “Biomimetic Materials Chemistry” Wiley-VCH Newyork, 1966.

CH8651 MASS TRANSFER II L T P C

3 2 0 4

OBJECTIVE:

- To provide introduction to physical and thermodynamic principles of mass transfer with an emphasis on how these principles affect the design of equipment and result in specific requirements for quality and capacity.

UNIT I ABSORPTION 12

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 18

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 Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 15

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 12

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), equipments 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 18

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. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL:75 PERIODS

OUTCOME:

After completion of the curse, students will be able to

- Design absorber and stripper, distillation column.
- Design extraction, leaching equipments and adsorber.

TEXT BOOKS:

1. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.
2. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES:

1. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006.
2. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
3. King, C. J., "Separation Processes ", 2nd Edn., Tata McGraw-Hill 1980.

EL8602	INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To enable the students to get knowledge on how to measure process variables, analytical instrumentation, automatic process controls.

UNIT I MEASUREMENTS AND MEASUREMENT SYSTEMS 9

Significance of measurement – methods of measurement – direct and indirect method – instrument and measurement system – classification of instruments – absolute and secondary – static characteristics of instrument – error in measurement – gross error – systematic error – random error – calibration and standards – principles of operation, handling and maintenance of instruments.

UNIT II OPERATIONAL AMPLIFIER/SIGNAL CONDITIONING UNIT 9

Block diagram of operational amplifier – ideal operational amplifier – characteristics- Non-inverting mode – inverting mode – definition of CMPR and gain bandwidth product – OP-AMPS circuits used in instrumentation – ideas – voltage follower- inverter – adder – subtractor - multiplier – divider - integretor – differentiator – comparator – logarithmic converter – current to voltage converter – voltage to current converter – wave form generator – differential amplifier – instrumentation amplifier.

UNIT III INSTRUMENT CONTROL UNIT AND INPUT/OUTPUT UNIT 9

Analog instrument – digital instrument. ADC and DAC concept. Introduction – 8085A architecture - pin configuration, 8085 single board micro computer system. Input/Output unit – displays – recorders, printers – DATA Communication.

UNIT IV PROCESS INSTRUMENTATION 9

Process control principles and system elements - Pressure measurement using bellows and LVDT – Electrical conductivity measurement of solution –p_H measurement using glass electrodes – temperature measurement – monitoring and control (RTD, Thermister and Thermocouple only).

UNIT V ELECTROCHEMICAL INSTRUMENTATION 9

Basic configuration and applications of constant voltage and anodic stripping voltammetry, potentiostat, galvanostat and zero resistance ammeter - computer/microprocessor based instruments, battery life cycle testing – computerized (SCADA) supervisory control systems for anodic / cathodic protection of steel structure.

TOTAL: 45 PERIODS

OUTCOME:

- The students would have knowledge on control equipments used to control the production process of a chemical factory and the mechanism of control through automation and computers.

TEXT BOOKS:

1. A.K.Sawhney, “A course in Electrical and Electronics measurement and instrumentation”, Dhanpat Rai Publication, New Delhi, 1994. (Unit I & II)
2. CurtiesD.Johnson, “Process Control Instrumentation Technology” 5th Edition, Prentice Hall, New Delhi, 1997. (Unit IV)
3. A.J.Bard & L.R. Faulkner, ”Electrochemical Methods Fundamentals and Applications”, 3rd Edition, John Wiley & Sons.New York, 2001 (Unit V)

4. Ramesh S Gaonkar, “Microprocessor Architecture, programming and applications with 8085” Printice Hall of India, New Delhi, 2002. (Unit III)

REFERENCES:

1. Howard A Strobel, Electrochemical Instrumentation, a system approach, Addition weiley publishing company, New York, 1973.
2. Albert Paul Malvino, ” Electronic Principles”, Seventh edition, Tata McGraw - Hill,New Delhi,1998 (Chapter15 to 18).

CH8091 ELECTROCHEMICAL PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To provide an adequate mastery in the principles involved in the electrochemical process and its applications.

UNIT I ELECTRODES AND SEPARATORS 9

Electrodes and separators for the electrolytic production of chemicals – preparation, characteristics and applications of graphite, magnetite, lead dioxide coated anodes, noble metal coated anodes, noble metal oxide coated anodes, spinal anodes, Perovskite platinum and nickel anodes, steel cathodes, coated cathodes, diaphragms and ion exchange membranes.

UNIT II ELECTROLYTIC PRODUCTION OF IN-ORGANIC CHEMICALS 9

Electrolytic production of sodium hypochlorite, sodium and potassium chlorates, bromates and iodates. Sodium, potassium and ammonium perchlorates, perchloric acid. Potassium, and ammonium persulphates, hydrogen peroxide, potassium permanganate, cuprous oxide and maganese dioxide – Basic principles, reaction mechanisms, effect of operating variables, cell design and operating characteristics of industrial cells.

UNIT III ELECTRO ORGANIC CHEMISTRY AND ELECTRODIALYSIS 9

Production of hydrogen by water electrolysis. Electrodialysis and its application to desalination of water electrolysis and waste recovery. Basic principles of Electro organic chemistry, constant current electrolysis, controlled potential electrolysis, material yield, current efficiency, selectivity and energy consumption for electro organic synthesis. Paired synthesis with example.

UNIT IV ELECTROCHEMICAL REDUCTION AND OXIDATION OF FUNCTIONALGROUPS 9

Cathodic reduction of carbonyl compounds, nitro compounds, unsaturated compounds, nitriles and oximes. Electrohydrodimerization and cathodic coupling reactions, cathodic reactions using mediators. Anodic halogenation, oxidation through redox carriers – metal ion, non-metal ion and organic mediators. Anodic coupling reactions. Kolbe synthesis, mechanism and applications. Anodic oxidation of aromatic hydrocarbons and phenol. Anodic substitution reactions: alkoxylation, acetoxylation, cyanation and acetamidation.

UNITV ELECTRO POLYMERIZATION AND ELECTRO ORGANIC PROCESSES 9

Electro polymerization. Anodic and cathodic polymerization. Electrochemical preparation of conducting polymers - polyacetylene, polypyrrole, polythiophene, polyaniline and their applications. Industrial Electro organic processes - adiponitrile from acrylonitrile, dimethyl sebacate from monomethyladipate, tetra alkyl lead from alkyl chloride, perfluorooctanoic acid

from octanoylchloride, aromatic aldehydes from toluenes. Electrochemical fluorination of organic compounds.

TOTAL: 45 PERIODS

OUTCOME:

- Students would have knowledge on basic electrochemical concepts, electrodes and electrodialysis and electropolymerization.

TEXT BOOKS:

1. D.Pletcher and F.C.Walsh, “Industrial Electrochemistry”, II Edition Chapman and Hall, London,1990.
2. M.M.Baizer, “Organic Electrochemistry”, II Edition, Dekker Inc, Newyork, 1983.

REFERENCES:

1. M.R. Rifi and F. H. Covitz, “Introduction to Organic Electrochemistry”, Marcel Dekker Inc. NewYork, 1994.
2. D. Kyriacou, “Modern Electro Organic chemistry” Springer, New York, 1994.

EL8603 PROCESS DYNAMICS AND CONTROL L T P C

3 0 0 3

OBJECTIVE:

- To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

UNIT I MATHEMATICAL TOOLS FOR PROCESS DYNAMICS MODELING 9

Laplace transformation and its application in process control, solution of differential equations by laplace transform techniques, development of transfer functions, state variables, state space methods, transfer function matrix.

UNIT II OPEN LOOP SYSTEMS 9

First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-Ntuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, smith predictor, internal model control, model predictive control, control of distillation towers, introduction to computer control of chemical processes.

TOTAL : 45 PERIODS

OUTCOME:

- Upon completion of this course, the students will understand and discuss the importance ofprocess control in process operation and the role of process control engineers They alsounderstand, develop models and design the modern hardware and instrumentation neededto implement process control.

TEXT BOOKS:

1. Coughanowr, D.R., and LeBlanc, S.E., " Process Systems Analysis and Control ", 3rd Edition., McGraw Hill, New York, 2008.
2. Seborg, D. E., Edgar T. F., and Mellichamp, D. A., "Process Dynamics and Control", Second Edition, Wiley, 2004.

REFERENCES:

1. Marlin, T. E., " Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control",2nd Edn., John Wiley, New York, 1997.
3. Jason L. Speyer, Walter H.Chung, "Stochastic Processes, Estimation, and Control", PHILtd (2013).

CH8652 PROCESS ENGINEERING ECONOMICS L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to understand the various concepts of economics, process development, design consideration and cost estimation in chemical industry.

UNIT I INTEREST AND PLANT COST 9

Time value of money - equivalence, Depreciation, Depletion, estimation of capital 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, economic balance for insulation, evaporation, heat transfer equipments.

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to understand the theory behind Inventory Control, Organization Types and PPC.
- Provides the student with an ability to integrate knowledge about financial statements, Depreciation Accounting and other areas.

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:

1. F.C. Jelen and J.H. Black, "Cost and Optimization Engineering", McGraw Hill, 3rd Edn., 1992

EL8611	**EQUIPMENT DESIGN**	**L T P C**
	(All Tables/Chemical Engineers' Handbook/Data Books are permitted during the Examination.)	**0 0 4 2**

OBJECTIVE:

- To develop skill to design and install process equipments used widely in a chemical industry.

UNIT I **9**

Fundamental principles, equations, general design and drawing considerations of cooling towers, evaporators and driers.

UNIT II **9**

Heat exchangers, condensers and reboilers.

UNIT III **9**

Distillation columns- sieve tray, and bubble cap tray columns and packed column.

UNIT IV **9**

Equipments for absorption and adsorption of gases.

UNIT V **9**

Equipments for liquid-liquid extraction and solid-liquid extraction.

TOTAL:45 PERIODS

OUTCOME:

- Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

TEXT BOOKS:

1. Joshi M.V., Mahajani V.V., and Umerji.S.B.,: "Process Equipement Design", MacMillan, Delhi, 2010.
2. Coulson – Richardson Chemical Engineering Series Vol 6: Ray Sinnott and Gavin Towler "Chemical Engineering Design", Elsevier, Oxford, 2009.

REFERENCES:

1. Brownell, L.E, and Young, E.H.:"Process Equipment Design", Wiley Eastern, New Delhi, 1977.
2. Backhurst, J.R. and Harker, J.H. "Process Plant Design", American Elsevier, New York, 1973.
3. Suresh C. Madigarai,"Chemial Process Equipment Design and Drawing" Vol 1, PHI, 2012

EL8612 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING LABORATORY **L T P C 0 0 4 2**

(Any Ten experiments)

OBJECTIVE:

- To give the students an understanding the fundamentals concepts in mathematics, problems solving and computer programming.

Software Required:

MS Office (EXCEL)	10 user license
MATLAB,	Five user license
ASPEN PLUS/HYSYS	10 user license

Suggested Exercises

1. Equations of state using Newton's method
2. Regression for parameter estimation using a set of data points
3. Equilibrium flash distillation (Multicomponent Ideal)
4. Batch Reactor
5. CSTR in Series Stage wise contacting equipment
6. Solving a simple flow sheet by simultaneous approach
7. Simulation of batch Distillation (binary ideal).
8. Gravity Flow Tank
9. Heat Exchanger
10. Plug Flow Reactor
11. Absorber

Specific examples in ASPEN/HYSYs/MATLAB/EXCEL

1. Solving equation of state, regression of parameters using EXCEL/MATLAB
2. Calculation of Reynolds number, friction factor and pressure drop using EXCEL/MATLAB
3. Calculation of heat transfer coefficient in a Heat Exchanger using EXCEL/MATLAB
4. Calculation of minimum Reflux ratio for binary/tertiary system in a fractionator using EXCEL/MATLAB
5. Calculation of HTU and NTU in a Absorber using EXCEL/MATLAB
6. Calculation of Antoine's coefficient using EXCEL/MATLAB
7. Estimation of settling velocity of solids in liquids using Stoke's law using EXCEL/MATLAB
8. Calculation of minimum number of stages in a distillation column using EXCEL/MATLAB
9. Solving mass and energy balance problems using EXCEL/MATLAB
10. Calculation of Power in Reciprocating compressor using EXCEL/MATLAB
11. Steady state simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
12. Steady state simulation of a CSTR using ASPEN PLUS/ HYSYS
13. Steady state simulation of Flash vessel using ASPEN PLUS/ HYSYS
14. Steady state simulation of Distillation Column using ASPEN PLUS/ HYSYS
15. Steady state simulation of an Absorption column using ASPEN PLUS/ HYSYS
16. Dynamic simulation of Heat Exchanger using ASPEN PLUS/ HYSYS
17. Dynamic simulation of a CSTR using ASPEN PLUS/HYSYS
18. Dynamic simulation of Flash vessel using ASPEN PLUS/ HYSYS
19. Dynamic simulation of Distillation Column using ASPEN PLUS/ HYSYS
20. Dynamic simulation of an Absorption column using ASPEN PLUS/ HYSYS

TOTAL: 60 PERIODS

OUTCOME:

- Students will be equipped with the software applications and the numerical solutions of chemical engineering problems.

Minimum 10 experiments to be offered

TEXT BOOKS:

1. Bequette. B.W, “Process Dynamics”: Modelling, Analysis and Simulation,” Prentice Hall (1998)
2. Himmelblau. D.M. and Bischoff. K.B, “Process Analysis and Simulation”, Wiley, 1988.
3. Strang.G. ,”Introduction to Linear Algebra”, Cambridge Press, 4th edition,2009.
4. William. Luyben, “Process Modelling, simulation and control for Chemical Engineers, 2nd Edn., McGraw Hill International Editions, New York, 1990
5. Chapra.S.C. and Canale.R.P. “Numerical Methods for Engineers”, McGraw Hill, 2001.

EL8613	CORROSION AND METAL FINISHING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To train the students to understand the techniques to measure the corrosion rate and hands-on experience in metal finishing.

LIST OF EXPERIMENTS

CORROSION

1. Determination of efficiency of the given inhibitor by gravimetric method
2. Efficiency of cathodic protection by impressed current method
3. Determination of anode efficiency in sacrificial anode system
4. Standard Test Methods for specific gravity of pigments (3 pigments)
5. Determination of corrosion rate by galvanostatic polarization method [Tafel and linear Polarizationmethods]

METAL FINISHING

(Any Five experiments)

1. Anodizing of Aluminium
2. Electroforming of Metal Foil
3. Hull Cell Studies in Electroplating Bath
4. Throwing Power Studies in Electroplating Bath
5. Nickel Plating & Analysis of nickel plating solution
7. Electrophoretic deposition
8. Electroless Plating

TOTAL: 60 PERIODS

OUTCOME:

- Students would have knowledge on the determination of corrosion rate and techniques for metal finishing

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Electroplating Bath
2. Hull Cell Electroplating Bath
3. Sacrificial anode system
4. Rectifier
5. Galvanostatic polarization apparatus

REFERENCE:

1. Laboratory Manual prepared by Faculty.

EL8701 PROCESS SYNTHESIS AND DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To enable the students to understand the process creation, heuristics and economics.
- To give exposure in the process scheduling, optimization and plant wide control.

UNIT I PROCESS CREATION, HEURISTICS AND ECONOMICS 9

Introduction to process design and process creation, role of process simulation in design, heuristics for process synthesis, introduction to process intensification, cost accounting and capital cost estimation, annual costs, earning and profitability analysis

UNIT II HEAT AND POWER INTEGRATION, SEPARATION TRAIN SYNTHESIS 9

Minimum utility targets, networks for maximum energy recovery, minmum number of heat exchangers, threshold and optimal approach temperature, superstructure for minimization of annual costs, multiple utilities and heat-integrated distillation trains, heat engines and heat pumps, Criteria for selection of separation methods, Sequencying of ordinary distillation columns for separation of nearly ideal and non-ideal fluid mixtures, Separation systems for gas mixtures, Separation sequencing for solid-fluid systems

UNIT III ALGORITHIMIC METHODS 9

Reactor design and reactor network synthesis, Principles of attainable regions, Locating the separation section with respect to the reactor section, Tradeoffs in processes involving recycle, Optimal reactor conversion, Recycle to extinction, Snowball effect and control of processes involving recycle

UNIT IV DESIGN, EQUIPMENT SIZING AND OPTIMIZATION 9

Review of heat exchanger design, heat transfer coefficients and pressure drop, Design of Shell-Tube heat exchanger, Overview of separation tower design Fenske-Underwood-Gilliland Shortcut method for ordinary distillation, Kemser method for absorption and stripping, Plate efficiency and HETP, Tower diameter, Pressure drop and Weeping, Design of pumps, compressors and expanders

UNIT V PROCESS SCHEDULING, OPTIMIZATION, PLANTWIDE CONTROL 9

Optimal design and scheduling of batch processes, Design of reactor-Separator Processes, Design of single and multiproduct processing sequence, general formulation and classification of the process optimization problem, Linear and non-linear programming with a single variable, Conditions for Non-linear programming by gradient methods with two or more design variables, Introduction to optimization algorithm, Introduction to plant-wide control.

TOTAL: 45 PERIODS

OUTCOME:

- Students whould have learnt the process synthesis, algorithm methods and able to design the chemical process.

TEXT BOOK:

1. W. D. Seider, J. D. Seader and D. R. Lewin, " Product and process design principles", 3nd edition, Wiley - India, New Delhi, 2005

REFERENCES:

1. L. T. Biegler, E. I. Grossmann, A. W. Westerberg, “Systematic methods of chemical process design”, Prentice-Hall, Newyork, 1997
2. G. Towler and R. Sinnott, ”Chemical Engineering Design”, Butterworth Heinemann, Maryland Heights, 2012.

CH8791 TRANSPORT PHENOMENA L T P C
3 0 0 3

OBJECTIVE:

- To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Vectors/Tensors, Newton’s law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier’s law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick’s law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity.

UNITII ONE DIMENSIONAL MOMENTUM TRANSPORT 9

Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.

UNIT III ONE DIMENSIONAL HEAT TRANSPORT 9

Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations of change (non-isothermal), equation of motion for forced and free convection, equation of energy (non-isothermal).

UNIT IV ONE DIMENSIONAL MASS TRANSPORT 9

Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalyst and the effectiveness factor, equation of continuity for binary mixtures, equation of change to set up diffusion problems for simultaneous heat and mass transfer.

UNITV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulence 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. Introduction to macroscopic balances for isothermal flow systems, non-isothermal systems and multicomponent systems.

TOTAL: 45 PERIODS

OUTCOME:

- Students would gain the knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes. The students would be able to understand the mechanism of fluids in motion under different conditions.

TEXT BOOKS:

1. R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, 2nd Revised Edition, John Wiley, 2007
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.

REFERENCES:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice-Hall Inc., 4th Edition 2003.
2. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
3. R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.

EL8702 ELECTROMETALLURGY AND THERMICS L T P C
3 0 0 3

OBJECTIVE:

- This course aims to provide the basics of hydrometallurgy and electrometallurgy techniques that are used in the processing of minerals

UNIT I INTRODUCTION 9

Metallurgical industries in India with special reference to electrometallurgical industries. Preparation of cell feed for copper, zinc, aluminium, magnesium and electrolytic cells. Principles of solvent extraction/ ion exchange for the recovery of metallic values. Pollution and control measures adopted/recommended in electrometallurgical Industries like Al, Cr.

UNIT II ELECTROCHEMICAL PRINCIPLES 9

Cell voltage and its components- types of anodes and cathodes-necessity of diaphragms. Physicochemical properties of molten & aqueous electrolytes like conductivity, decomposition potential, density etc. Current and energy efficiency- features of aqueous and molten salt electrolysis distinction between electro winning and refining. Anode effect.

UNIT III AQUEOUS SYSTEM 9

Electro winning of zinc, copper and nickel. Operating conditions for electro winning of copper and Nickel. Electro refining of silver, lead and copper- periodic current reversal technique. Electrolytic metal powders-principles, preparation and characterization. Secondary recovery of metals-Importance and approaches with examples of lead and silver.

UNIT IV MOLTEN SALT ELECTROLYSIS 9

Hall-Heroult cell for electrowinning of Aluminium–composition and structure of cryolite electrolyte, Brief discussion on (anodes and) cathode pot construction, and reactions. Start up and operation of Cell- anode effect. Koope's three layer process. Dow, I.G. and other types cells for production of Magnesium. Interference of impurities like moisture and sludge formation.

Electrowinning of sodium, calcium, misch metal and titanium. Operating data for production of lithium and zirconium.- refining of titanium.

UNIT V THERMICS 9

Modes of electrical heating. Design criteria of arc furnaces. Description of furnaces used and the process for production of calcium carbide. Calcium silicide, Calcium cyanamide, fused alumina, ferroalloys, phosphorous, graphite and Silicon carbide.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students would understand the electrometallurgy techniques that are used in the various Industries.

TEXT BOOKS:

1. K. I. Popov, S. S. Djokic and B. N. Grgur. "Fundamentals of Electrometallurgy", Kluwer Academic Publishing, 2002
2. H.S. Ray, Sridar and K.P. Abraham, "Extraction of Non-ferrous metals", Affiliated East-West press, New Delhi, 1985.

REFERENCES:

1. Grjotheim K and Welch B.J., "Aluminium Smelter Technology", Aluminium Verlag, 1982.
2. Strelets Kh.L., "Electrolytic Production of Magnesium", Israel Program of Scientific Translation 1977.

EL8711 ELECTROCHEMICALS AND ELECTRO METALLURGY LABORATORY L T P C 0 0 4 2

OBJECTIVE:

- To train the students on methodology of the preparation of electrochemicals

LIST OF EXPERIMENTS

ELECTROCHEMICALS (Any Five experiments)

1. Electrochemical preparation of sodium hypochlorite from sodium chloride
2. Electrochemical preparation of potassium chlorate from potassium chloride
3. Electrochemical preparation of potassium permanganate
4. Electrochemical preparation of ammonium persulphate
5. Calcium gluconate from glucose
6. Succinic acid from maleic acid
7. Manganic sulphate from manganoussulphate

ELECTROMETALLURGY (Any Five experiments)

1. Electrowinning of zinc.
2. Recovery of metals from solid wastes / industrial effluents
3. Recovery of metals by ion exchange resins.
4. Cementation reaction between Zn plate and copper sulfate solution
5. Stripping and extraction efficiency of D2EHPA for zinc ion.
6. Electrochemical separation of metals
7. Determination of rate of etching for copper etchant
8. Electrorefining of metals
9. Optimization of potential / current density for electrochemical recovery of metals

TOTAL: 60 PERIODS

OUTCOME:

- Students would have knowledge on the preparation of electrochemicals and electrometallurgy techniques that are used in the various Industries.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Ion exchange apparatus
2. Electrochemical bath
3. Membrane Cell
4. Electrolytic Cell
5. Etching apparatus
6. Hull Cell
7. Packed bed resin column

REFERENCE:

1. Laboratory Manual prepared by Faculty.

EL8712	PROCESS DYNAMICS AND CONTROL LABORATORY	L T P C 0 0 4 2

OBJECTIVE:

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

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

*Minimum 10 experiments shall be offered.

TOTAL:60 PERIODS

OUTCOME:

- Upon completion of this practical course, the students would know development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS:

1. U tube manometer with controller
2. Interacting Tank

3. Non Interacting Tank
4. Open loop control system
5. Closed loop control system
6. ON/OFF controller
7. Control valve characteristics
8. Pressure Tuner
9. Temperature Tuner
10. Proportional Controller
11. Flow Transmitter
12. Level Transmitter
13. Cascade control system

EL8713	INTERNSHIP	L	T	P	C
		0	0	0	2

Students shall undergo training in R&D institutions / Academics / Industries for a minimum period of 15 days. At the end of internship students must submit a report forinternal evaluation.

EL8801	ELECTROCHEMICAL ENERGY CONVERSION AND STORAGE	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To enable the students to gain the knowledge of principle and applications of batteries and fuel cells.

UNIT I FUNDAMENTALS 9

EMF, reversible and irreversible cells, free energy, effect of cell temperature, thermodynamic calculation of the capacity of a battery, calculations of energy density of cells.

UNIT II FACTORS AFFECTING BATTERY PERFORMANCE 9

Factors affecting battery capacity, voltage level, current drain of discharge, types of discharge: continuous, intermittent, constant current, constant load, constant power, service life, voltage regulation, charging methods, battery age & storage condition.

UNIT III STORAGE BATTERIES 9

Principle, design, construction, performance characteristics, advantage and disadvantages. Primary batteries - Zn-MnO_2 carbon-zinc, carbon-zinc chlorides, and zinc-silver oxide. Secondary batteries – lead-acid, nickel-cadmium, nickel-metal hydride, silver oxide-zinc system, lithium-ion, lithium- polymer.

Batteries for electric vehicle applications, Micro batteries.

UNIT IV TESTING & EVALUATION 9

Evaluation of active mass, surface area measurement - BET method. Internal resistance of cells - A.C. methods impedance method. Testing of capacity, retention of charge, vibration, life, efficiency, leakage for sealed cells, High rate discharge, testing of separators.

UNIT V FUEL CELLS & SUPERCAPACITOR 9

Introduction to super capacitors, types of super capacitors. Introduction to fuel cells, types of fuel cells and technology development. Polymer electrolyte and solid oxide fuel cells. Material related challenges. Stack engineering. Microbial fuel cells.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students would know designing of batteries and fuel cells for various applications.

TEXT BOOKS:

1. M. Mench, "Fuel Cell Engines", John Wiley, New York, 2008.
2. B. E. Conway, "Electrochemical Supercapacitors : Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum publishers, New York, 1999.

REFERENCES:

1. Gholam Abbas Nazri, "Lithium Batteries – Science and Technology", Springer, New York, 2009.
2. D.Pavlov, "Lead – Acid Batteries: Science and Technology", Elsevier, Amsterdam, 2011.

EL8802 SURFACE SCIENCE L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, absorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

UNIT III LIQUID INTERFACES 9

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

UNIT IV HETEROGENEOUS CATALYSIS 9

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

TEXT BOOK:

1. K. W. Kolasinski, "Surface Science: Foundations of catalysis and nanoscience" II Edition, John Wiley & Sons, New York, 2008.

REFERENCE:

1. Gabor A. Somorjai and Yimin Li "Introduction to Surface Chemistry and catalysis", II Edition John Wiley & Sons, New York, 2010.

EL8811 PROJECT WORK

L	T	P	C
0	0	20	10

PROJECT REPORT

Each student is required to submit a project report on the research/design and development of Industrial plant selecting the best process with optimum equipment sizes and operating conditions. The project report will be treated as test of ability of the student to tackle a practical problem in the same way as might be expected of him if he were required to report as an Electrochemical Engineer on a new manufacturing proposal.

CH8074 OPTIMIZATION OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVE:

- Students will gain knowledge about process modeling and optimization

UNIT I INTRODUCTION 5

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 13

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.

TOTAL: 45 PERIODS

OUTCOMES:

- 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.

TEXT BOOKS:

1. Rao, S. S., Engineering Optimization - Theory and Practice, Third Edition, John Wiley & Sons, New York, 1996.
2. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes ", McGraw-Hill Book Co., New York, 2003.
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation ", John Wiley, New York, 1980

EL8001	ADVANCED ELECTROCHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To make the students learn the kinetics of electrochemical engineering

UNIT I FUNDAMENTALS OF ELECTROCHEMICAL REACTION KINETICS 9

Fundamentals of reaction kinetics, rate of electrochemical reaction, thermodynamics-heat of reaction and reaction equilibria, electrochemical thermodynamics, practical cell voltage requirements and polarization. Reactor classification, configuration and production capacity, Basic electrode kinetics, Ideal isothermal reactors: single electrochemical reactions, potentiostatic operations of first order reaction and galvanostatic operation of first order reactions. CSTR with general order reactions, Effect of mass transport and side reaction.

UNIT II PLUG FLOW REACTORS WITH AND WITHOUT MASS TRANSPORT 9

Plug flow and recycle reactors, Kinetics of electrochemical reactions: multistep electrochemical reactions, p electrode processes with mass transport, series and parallel reactions, interaction of chemical reaction, electrochemical reactions involving adsorption, electro analytical methods.

UNIT III MULTIPLE ELECTROCHEMICAL REACTIONS 9

Multiple electrochemical reactions with inter-phase mass transport-reaction classification, consecutive reactions, parallel reaction and complex reaction. Potentiostatic and galvanostatic operation of series and parallel electrochemical reactions, reversible reaction. RTD analysis, dispersed plug flow, tank in series model, multi parameter models, reactor dynamics of isothermal CSTR and PFR.

UNIT IV SIMULTANEOUS MASS TRANSFER AND ELECTROCHEMICAL REACTION 9

Simultaneous mass transfer and chemical reaction; mathematical model of interphase mass transport-film model, penetration model, regimes of operation, fast and intermediate chemical

reaction. Multiple chemical reaction, multiple electrochemicals and chemical reaction. Batch recycle and continuous recycle operation, multiple fluid phases at the electrode surface and in the electrolyte phase. Reactor for multiple phase reactions.

UNIT V MIGRATION AND CURRENT DISTRIBUTION 9

Migration effects on mass transport, influence of migration in the reactor design, current and potential distribution, primary current distribution, current and potential distribution arising from polarization, three dimensional electrodes, diaphragm cell reactor models, energy balance, heat transfer and technical optimizations.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the student would be in a position to understand advanced electrochemical reaction, plug flow reactors and migration & current distribution in reactors.

TEXT BOOKS:

1. Scott. K, "Electrochemical Reaction Engineering", Plenum Press, New York, 1991.
2. T.Z Fahidy, "Principles of Electrochemical Reactor Analysis," Elsvier science publishers, New York, 1985.

REFERENCES:

1. New man – J.S., Alyear K.E., "Electrochemcial Systems" JohnWiley, New York, 2004.
2. F.Goodridge and Scott, K.. "Electrochemical Processes Engineering" Springer, New York 1995.

EL8002 FUNCTIONAL MATERIALS L T P C
3 0 0 3

OBJECTIVE:

- The course emphasis on the molecular safe assembly and materials for polymer electronics

UNIT I INTRODUCTION 9

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

UNIT II MOLECULAR SELF ASSEMBLY 9

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

UNIT III BIO-INSPIRED MATERIALS 9

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

UNIT IV SMART OR INTELLIGENT MATERIALS 9

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composities.

UNIT V MATERIALS FOR POLYMER ELECTRONICS 9

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

TOTAL: 45 PERIODS

OUTCOME:

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

TEXT BOOK:

1. Vijayamohanan K. Pillai and MeeraParthasarathy, “Functional Materials: A chemist’s perpective”, Universities Press Hyderabad (2012).

REFERENCE:

1. Stephen Manne “Biomimetic Materials Chemistry” Wiley-VCH Newyork, 1966.

GE8074 HUMAN RIGHTS L T P C

3 0 0 3

OBJECTIVE:

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II 9

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III 9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV 9

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO’s, Media, Educational Institutions, Social Movements.

TOTAL: 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Kapoor S.K., “Human Rights under International law and Indian Laws”, Central Law Agency, Allahabad, 2014.
2. Chandra U., “Human Rights”, Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

CH8077 PROCESS MODELING AND SIMULATION L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I INTRODUCTION 7

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 7

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 13

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.

TOTAL: 45 PERIODS

OUTCOME:

- 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.

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

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", John Wiley, 2000.
2. Franks, R. G. E., "Mathematical Modeling 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, "Chemical Process Modeling and Computer Simulation" 2nd Edn, PHI Learning Ltd,(2012).

EL8003 NANOMATERIALS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To provide students with a solid foundation in synthesis and characterization of novel nanomaterials with multiple application.

UNIT I PROPERTIES OF MATTER 9

Size effects, structure of solids, energy bands, localized particles. Synthesis and properties of: metal, metal oxide, semiconductor and magnetic nanoparticles. Carbon nanostructures – brief notes on synthesis, properties and application.

UNIT II METHODS OF CHARACTERIZATION 9

Nanoparticle characterization: X-ray Diffraction (XRD), Small Angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive Spectrum (EDS), Scanning Probe Microscopy (SPM), and other spectroscopy techniques (UV-Vis, IR and Raman)

UNIT III TYPES OF NANOSTRUCTURES 9

Nanostructures in zeolites cages, quantum wells, wires and dots. Preparation of quantum nanostructures, size and dimensionality effects, single electron tunneling

UNIT IV MAGNETIC PROPERTIES 9

Nanostructured ferromagnetism – basics of ferromagnetism, effect of nanostructuring of bulk magnetic materials, dynamics of nanomagnets, nanopore containment of magnetic particles, nanocarbonferromagnets, giant and colossal magneto-resistance, ferrofluids

UNIT V NANOPARTICLE SYNTHESIS 9

Self assembly – techniques, semiconductor islands – monolayers. Catalysis - nature of catalysis – surface area of nanoparticles – porous materials – pillared clays – colloids.

TOTAL: 45 PERIODS

OUTCOME:

- Students will demonstrate an ability to synthesis and characterize the nanomaterials.

TEXT BOOKS:

1. Catherine Brechignac, PhilipeHoudy, Marcel Lahmani "Nanomaterials and Nanochemistry", Springer.
2. "Nanostructures & Nanomaterials" Synthesis, Properties & Applications by Guozhong Cao, ISBN 1-86094-44809, World Scientific Publishing Company, Jan 2004.

REFERENCES:

1. Taylor & Francis, “Nanomaterials Handbook”, Edited by Yuri Gogotsi, CRC Press, 2006
2. “Handbook of Nanotechnology”, Bhushan Bharat Springer Edition.
3. C.N.R.Rao, “The chemistry of Nanomaterials”, Vol. 1 & 2, Wiley – VCH.

GE8071 DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don’ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj
Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

REFERENCES:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009.

EL8004 CHEMICAL PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory.

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY, FUEL AND INDUSTRIAL GASES 9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries - Phosphorus, Phosphoric acid, Super Phosphate – Potassium chloride, Potassium Sulphate – Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V RUBBERS, POLYMERS AND SYNTHETIC FIBRE 9

Natural and Synthetic rubber, SBR – Silicone rubber – polymer – physical – chemical structure of polymers, Thermosetting and Thermoplastic materials - Polymer manufacturing processes – polyethylene, polystyrene – Resins phenolic and epoxy resins – Synthetic Fibers – Viscose rayon, Polyamides and polyesters.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the student can classify the chemical process industry into industrial categories of base, intermediate end-products and specialty chemicals manufacturers.

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th ed., McGraw-Hill, 1998.
2. SrikumarKoyikkal, "Chemical Process Technology and Simulation",PHI Learning Ltd

EL8005 INDUSTRIAL METAL FINISHING

L	T	P	C
3	0	0	3

OBJECTIVE:

To enable the students

- To differentiate between the electroplating and anodizing process and
- To compare the various engineering aspects and electroplating process.

UNIT I ELECTROPLATING OF METALS 9

Fundamental principles – Faradays laws, mechanism of deposition, surface preparation for electroplating, electroplating of copper, nickel, chromium, zinc, tin and precious metals (gold and silver)

UNIT II EVALUATION & TESTING 9

Measurements of pH, specific gravity, surface tension, conductivity, throwing power and current efficiency of electroplating electrolytes. Testing of Electro deposits for thickness, adhesion, stress, corrosion, porosity, hardness, ductility and solderability. The use of Hull-cell in plating.

UNIT III ELECTROPLATING OF ALLOYS AND OTHER PLATING METHODS 9

Principles of alloy deposition, barrel finishing and plating, electroforming of copper and nickel, electroless deposition of copper and nickel, brush plating, continuous plating, PCB plating.

UNIT IV ENGINEERING ASPECTS 9

Equipment selection, rectifier, pre-treatment equipment-mechanical - chemical, automation, flooring, materials for tanks and linings, ventilation, bus bar, filtration and purification, agitation, heating and cooling arrangement for electrolytes.

UNIT V ANODIZING 9

Anodizing of aluminium, principles, pre-treatment, jigging. Sulphuric acid process, operating conditions for decorative and protective anodizing, effect of impurities, analysis for free acid and aluminium content, chromic acid process, operating conditions, effect of impurities, coloring of anodized aluminium with organic dyes. Sealing in hot water and dichromate solution. Testing of anodic film thickness by Eddy current method and stripping method, coating weight – coating ratio.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students will understand the importance and applications of electroplating techniques and anodizing concepts.

TEXT BOOKS:

1. F.A.Lowenheim, "Modern Electroplating", John Wiley and Sons INC. USA, 3rd Edition, 1974.
2. N.V.Parthasarathy, "Practical Electroplating Handbook", Prentice Hall Inc., 1989

REFERENCES:

1. L.J.Durney, "Electroplating Engineering Handbook", V Edition,Van Nostrand Reinhold, New York, 1984.
2. V.F. Henley, "Anodic Oxidation of Metals", Pergamon ,1st edition, 1982

CH8071 ENVIRONMENTAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To provide technical expertise in Environmental Engineering which will enable them to have a career and professional accomplishment in the public or private sector

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 RECYCLING METHODOLOGY 9

Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

UNIT IV CLEAN TECHNOLOGY 9

Towards Eco- friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

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

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students would understand the importance of environmental audit, concepts behind the methodologies to control pollution, the importance of recycling and concepts behind pollution prevention.

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.

REFERENCES:

1. Coulson, J.M. Richardson, J.F and R.K Sinnott, Chemical Engineering Vol. 6, Pergomon Press, 1989.
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.
5. Paul L Bishop (2000) "Pollution Prevention Fundamentals and Practice", Mc Graw Hill, International.

EL8006 TOTAL QUALITY MANAGEMENT AND ENGINEERING ECONOMICS **L T P C 3 0 0 3**

OBJECTIVE:

- To provide the student with the underlying principles and techniques of Total Quality Management (TQM) with emphasis on their application to technical organizations.

UNIT I QUALITY AND CUSTOMER CONCEPTS **9**

Introduction - definitions of quality, dimensions of quality, historical review of total quality management, customer satisfaction - customer perception of quality, customer complaints, service. Quality, customer retention, continuous process improvement, PDSA cycle, Performance measures:- basic concepts, strategy. The seven tools of quality, concept of six sigma.

UNIT II QUALITY MANAGEMENT TOOLS AND QUALITY SYSTEMS **9**

TQM tools - benchmarking - reasons to benchmark, benchmarking process, Quality function deployment - house of quality, Taguchi quality loss function, total productive maintenance - concept, improvement needs, Quality systems - Need for ISO 9000 and QS 9000: elements, implementation, documentation, Quality auditing- concept, requirements and benefits.

UNIT III VALUE OF MONEY, AMORTIZATION, CAPITAL REQUIREMENTS, COSTS, EARNINGS, PROFITS 9

Value of money – equivalence, equations for economic studies, Amortization - capital recovery, depreciation, interest in depreciation calculations, depreciation accounting, Capital requirements for process plants - cost indices, the Williams six-tenths factor, capital requirements for complete plants, balance sheet, sources of capital, earnings, profits and returns - variable costs, fixed costs.

UNIT IV ECONOMICS OF SELECTING ALTERNATES, RATE OF RETURN & PAYOUT TIME 9

Economics of selecting alternates - annual cost method, present worth method, equivalent alternates, rate-of return method, payout-time method, replacement of existing facilities, irreducible factors in economic analyses.

UNIT V ECONOMIC BALANCE: CYCLIC OPERATIONS – YIELD AND RECOVERY 9

Economic balance - economic balance in evaporation, economic vessel design, economic balance in fluid flow, Economic balance in combined operations – economic balance with one variable and two variable. Economic balance in cyclic operation, batch operations (fixed cycle time), batch operations (variable cycle time), Economic balance in yield and recovery - economic analysis for variable feed and product grades, Economic analysis of a complete process - operating plants, proposed plants, evaluation.

TOTAL: 45 PERIODS

OUTCOME:

- Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality, also quality tools utilized in service and international/environment.

TEXT BOOKS:

1. Dale H. Besterfiled, et al., “Total Quality Management”, Pearson Education Inc, NewJersey, 2003.
2. Schweyer , H.E, “Process Engineering Economics” McGraw Hill, New York, 1955.

REFERENCES:

1. Feigenbaum. A.V. “Total Quality Control” , McGraw Hill, New York, 1991.
2. Oakland.J.S. “Total Quality Management” Butterworth – Hcinemann Ltd., Oxford, 1994.

CH8078 PROCESS PLANT UTILITIES L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to understand the process plant utilities and optimization techniques to optimize various parameters in chemical industries.

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air –Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the students will understand the importance of health, safety and the environment in process industries. Steam, power, water, air are extensively used in process industries and their efficient operation is imperative for economic and safe operation is essential for the survival of industries

TEXT BOOKS:

1. Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 1966.
2. P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 1986.
3. Perry R. H. Green D. W. “Perry’s chemical Engineer’s Handbook”, McGraw Hill, New York, 2007.

REFERENCE:

1. P. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi, 2007.

CH8092 ENERGY TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

- Students will gain knowledge about different energy sources

UNIT I ENERGY 8

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

UNIT II CONVENTIONAL ENERGY 8

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 NON-CONVENTIONAL ENERGY 10

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 BIOMASS ENERGY 10

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 CONSERVATION 9

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

TOTAL: 45 PERIODS

OUTCOME:

- Understand conventional Energy sources, Non- conventional Energy sources, biomass sources and develop design parameters for equipment to be used in Chemical process industries. Understand energy conservation in process industries

TEXT BOOKS:

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. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993

REFERENCES:

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 Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.
4. Handbook of Energy Audit by 7th edition Albert Thumann, P.E., C.E.M & William J Younger C.E.M, Faiment Press 2008

EL8007 CHLOR - ALKALI TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to understand the process of Chlor alkali technology and the unit operations involved in the process.

UNIT I ELECTRODES AND SEPERATORS 9

Anodes, cathodes and separators for chlor – alkali production. Graphite anodes and metal anodes. Steel cathodes, coated cathodes, and gas diffusion cathodes. Asbestos diaphragms and polymer diaphragms. Cation exchange membranes – different types, preparation and characteristics.

UNIT II CONVENTIONAL PROCESSES 9

Diaphragm cell process, different cell designs and deposition of diaphragm. Mercury cell process. Different cell designs. Reasons for hydrogen evolution in the primary cells. Denuder - vertical and horizontal types. Design aspects.

UNIT III MODERN PROCESS 9

Membrane cell process, Different designs of membrane cell, mono polar and bipolar cells. Conversion of mercury and diaphragm cells to membrane cells. Factors affecting the performance of the membrane cells.

UNIT IV UNIT OPERATIONS 9

Unit operations in chlor-alkali industry. Salt washing and saturation. Brine dechlorination. Primary brine purification. Secondary brine purification. Caustic concentration. Separation of salt from diaphragm cell liquor, Handling of hydrogen, chlorine and caustic. Chlorine liquefaction.

UNIT V GENERAL TOPICS 9

Energy conservation in chlor-alkali industry. Chlorine utilization. Materials of construction. Electrode protection devices. Environmental pollution and its control. Analytical techniques. Process control and instrumentation. Safety aspects.

TOTAL: 45 PERIODS

OUTCOME:

- Students would be able to explain the material requirements, chemical reactions and operations carried out in production of Chlor-Alkali industry

TEXT BOOKS:

1. S.Sealey, (Ed) "Modern Chlor – Alkali Technology – Volume 7", Society of Chemical Industry, London, 1998.
2. J.Moorehouse (ED), "Modern Chlor – Alkali Technology – Volume 8" Blackwell Science, London, 2001.

REFERENCES:

1. "Ullmann's Encyclopedia of Industrial Chemistry", Vol.8, Weinheim, Wiley Interscience, New York, pp.92-204, 2012
2. Othmer, "Encyclopedia of Chemical Technology", 5th Edition, Vol: 6, pp 531-622, 2004.

EL8008 CATHODIC PROTECTION AND ELECTROPHORETIC COATINGS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To familiarize the students with the basics of cathodic protection and electrophoretic coatings.

UNIT I BASICS OF CATHODIC PROTECTION 9

Basics of cathodic protection. Electrical basis of cathodic protection. Electrochemical theory of cathodic protection. Definition of cathodic protection using Evans diagram and Pourbiax diagram, derivation of protective potential for steel. Protective potentials for different methods.

UNIT II SACRIFICIAL ANODE SYSTEM & IMPRESSED CURRENT SYSTEM 9

Cathodic protection system, components of galvanic systems, galvanic anodes, fields of application and backfills for sacrificial anodes. Advantages and disadvantages of sacrificial anode system. Impressed current system, impressed current anodes, fields of application and backfills for impressed current anodes.

UNIT III DESIGNING OF CP SYSTEM 9

Design parameters in cathodic protection, soil resistivity measurement, pipe to soil potential data, pH determination, redox potential measurement, coating resistance, stray current measurement and cathodic protection interferences designing of sacrificial anode system - designing of impressed current system - designing of cathodic protection to ship hull

UNIT IV BASIC CONCEPTS OF ELECTRO PHORETIC COATINGS 9

Electrical Constitution of Aqueous Solutions, Dispersions and Suspensions of Paint Binders-Electrokinetic Effects-Electrochemical Parameters of Colloid Particles- Electro-osmosis-Voltage and current Relations in Electro-painting-Throwing power & other factors in Electro-painting- Pretreatment for Electro-painting-Synthetic resins used for Electro-painting.

UNIT V APPLIED ASPECTS OF ELECTRO PHORETIC COATINGS 9

Installations for Electro-painting- Paint bath stability, Control, & Replenishment-Testing of paint bath-Effluent treatment-Process involved in Electro-painting installations-Economics.

TOTAL: 45 PERIODS

OUTCOME:

- Students would be able to design the cathodic protection systems and applied aspects of electrophoretic coatings.

TEXT BOOKS:

1. Zaki Ahmad, “Principles of Corrosion Engineering and Corrosion Control”, Butterworth - Heinemann, London, 2006.
2. Willibald Machu, ”Hand book of Electro Painting Technology” Electrochemical Publications Limited, 1978.

REFERENCE:

1. Peabody A.N and Blanchetti R.L. , “Control of Pipeline Corrosion”, NACE Int., Texas, 2001.

EL8009 ORGANIC ELECTROCHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge of fundamental aspects of electrochemistry, as well as techniques for characterizing surfaces under electrochemical conditions.

UNIT I CATHODIC REACTIONS OF ORGANIC COMPOUNDS 9

Principles and methods, synthetic and mechanistic aspects of cathodic reactions of organic compounds classified by electrophores, hydrocarbons, halogenated organic compounds, nitro and related compounds, carbonyl compounds, azomethine compounds.

UNIT II ANODIC REACTIONS OF ORGANIC COMPOUNDS 9

Synthetic and mechanistic aspects of anodic reactions of organic compounds classified by electrophores, anodic oxidation of hydrocarbon, carboxylic acids, nitrogen-containing compounds, oxygen-containing compounds, sulphur-containing compounds, electrochemistry of certain comprehensive classes of compounds, electrolysis of heterocyclic compounds, natural products and pharmaceuticals, biomass, organoelemental and coordination compounds.

UNIT III CLASSIFICATIONS OF ELECTRODE REACTIONS 9

Electrode reactions classified by reaction type, reductive coupling, oxidative coupling, cleavages and deprotection, anodic substitution, anodic fluorination.

UNIT IV STEREOCHEMISTRY OF ELECTROCHEMICAL PROCESSES 9

Stereochemistry of organic electrode processes, amalgam and related reductions, electrogenerated reagents, electrogenerated acids and bases.

UNIT V INDUSTRIAL APPLICATIONS OF ELECTRO ORGANIC CHEMISTRY 9

Present and future applications, industrial electroorganic chemistry, electrochemical polymerization, chemically modified electrodes and conducting polymers, photoelectron chemistry, paired electro synthesis.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of this course, the students will be able to analyse and answer questions on a number of electrochemical reactions such as metal deposition and electroorganic reactions.

TEXT BOOK:

1. Henning Laud, Manuel M. Baizer, ”Organic Electrochemistry”, Marcel Dekker, INC, New York,1991.

REFERENCES:

1. D.E.Danly “Emerging opportunities for electro organic process”, Marcel Dekker, New York, 1984.
2. S.Torii “Electro organic synthesis”, Kodansha / VCH, Weinheim 1985.

GE8075 INTELLECTUAL PROPERTY RIGHTS L T P C

3 0 0 3

OBJECTIVE:

- To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs 7

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL:45 PERIODS

OUTCOME:

- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002

REFERENCES:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

CH8073 INDUSTRIAL PROCESS PLANT SAFETY L T P C
3 0 0 3

OBJECTIVE:

- Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I 9

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

UNIT II 9

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

UNIT III 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 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-Bopal analysis

UNIT V 9

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse

Hazop study-case studies-pumping system-reactor-mass transfer system.

TOTAL: 45 PERIODS

OUTCOMES:

- Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.
- Exhibit the skill in classifying chemical, fire, explosion hazards and to understand the occupational diseases
- Analyze the bio medical and engineering response to health hazards and to implement the effective process control and instrumentation.

TEXT BOOKS:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
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

REFERENCES:

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., " Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

CH8093 MODERN SEPARATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVE:

- Students will gain knowledge about recent separation methods

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 fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL: 45 PERIODS

OUTCOMES:

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

REFERENCES:

1. King, C. J., “Separation Processes”, Tata McGraw Hill, 1982.
2. Roussel, R. W., “Handbook of Separation Process Technology”, John Wiley, New York, 1987.
3. Nakagawal, O. V., “Membrane Science and Technology”’ Marcel Dekkar, 1992

CH8094 POLYMER TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in 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 ADDITION POLYMERIZATION 12

Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals – 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 POLYMERIZATION 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 – crosslinked polymers by condensation – gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS 9

Difference in molecular weights between simple molecules and polymers – number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering.

UNIT V TRANSITIONS IN POLYMERS 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.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course, the student would be able to demonstrate knowledge and understanding on the principles related to the synthesis and characterization of polymers.

TEXT BOOKS:

1. Billmeyer.F.W.,Jr, Text Book of Polymer Science, Ed. Wiley-Interscience, 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.

REFERENCES:

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 an

EL8010 PROTECTIVE PAINT COATINGS L T P C

3 0 0 3

OBJECTIVE:

- Students learn about the introduction of paint chemistry, testing and evaluation of paints.

UNIT I BINDERS, PIGMENTS AND OTHER RAW MATERIALS FOR PAINTS 9

Variable types of binders used in paint making – natural resins – shellac, rosin, oils and rubber-chemistry and properties; preparation and properties of synthetic resins – alkyds, phenolics, vinyls, amino resins, acrylics, epoxies, urethanes and silicones - Pigments and Extenders – Inorganic, organic and metallic pigments and extenders-corrosion inhibiting pigments-properties and functions.

UNIT II SOLVENTS 9

Solvents, additives, plasticizers and driers used in paints – solvency power, toxicity, auributanol and aniline point values for solvents-various additives and purpose of each considerations in formulation of a paint – concept of Pigment Volume Concentration and volume solids – rheological characteristics of paint – water based paints – composition and properties – factors affecting water dispersibility-Manufacture of paints – ball and pebble mills, attritors, sand and bead mills, three roller mills.

UNIT III TESTING AND EVALUATION OF PAINTS 9

Liquid paints – Instruments involved in each test – fineness of grind, volume solids, specific gravity, viscosity, consistency, wet film thickness, drying time - testing of physical properties –

dry film thickness, holiday detection, adhesion, hardness, flexibility, impact resistance, abrasion resistance - testing of corrosion resistance – electrochemical tests, humidity, salt spray, weather resistance, immersion test and field exposure test. Paint film defects – identification and remedial measures.

UNIT IV SURFACE PREPARATION AND APPLICATION OF PAINTS 9

Methods of surface preparation – chemical and mechanical cleaning. Standards covering them and instruments involved. Conversion coatings-phosphating, chromating of ferrous and non-ferrous metals; application of paints – methods – brushing, dipping, roller coating, air spray, airless spray, electrostatic spray.

UNIT V PAINTS FOR FUNCTIONAL APPLICATION 9

Paints for rural atmospheres, industrially polluted atmospheres, marine atmospheres offshore applications, chemical paints, automobiles and air crafts. Coating for pipelines – coatings for concrete, wood and plastics. ceramic coatings , powder coating- principle, basics and applications.

TOTAL: 45 PERIODS

OUTCOME:

- Upon complete of this course, the student will be able to developed of paint for typical end applications.

TEXT BOOKS:

1. R.Lambourne “Paint and Surface Coatings-Theory and Practice”, Woodhead Publishing Ltd,1999.
2. Surface Coating Association of Australia, “Surface Coatings , Raw materials and their usage” Chapman & Hall. 3rd Edition, 1993.

REFERENCES:

1. GostaWranglen, “An Introduction to Corrosion and Protection of Metals”, ECS Princeton,1972.
2. Parker Dean H, "Principles of surface coating technology” , ECS Princeton, 1965
3. Willibald Machu, “Handbook of Electro-painting Technology”, Electrochemical Publication Limited.1978.

GE8076 PROFESSIONAL ETHICS IN ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

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 – Introduction to Yoga and meditation for professional excellence and stress management.

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.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011.

Web sources:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org