ANNA UNIVERSITY, CHENNAI

NON-AUTONOMOUS COLLEGES AFFILIATED COLLEGES

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

B. TECH. CHEMICAL AND ELECTROCHEMICAL ENGINEERING

1. Programme Educational Objectives (PEOs)

a) To produce employable graduates with the knowledge and competency in Chemical and Electrochemical Engineering
b) To impart problem solving, analytical skills in the contemporary processes.
c) To design and develop eco-friendly sustainable technologies with the aid of computational skills
d) To facilitate the ability to learn, innovate and communicate technical developments for the benefit of humanity
e) To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities
f) To disseminate the knowledge related to intellectual property ownership rights, ethics, professionalism, entrepreneurship, and their societal impact.

2. Programme Outcomes (POs)

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

	Graduate Attribute	Programme Outcome
PO1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design / development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations	Use research-based knowledge and research

	of complex problems	methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The Engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and Sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. PEOs / POs Mapping

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
a	3	3	1	3	1	1	1	-	-	-	-	3
b	2	3	3	1	2	-	2	-	-	-		3
c	2	2	3	-	3	3	3	2	-	-	-	3
d	2	2	3	1	-	3	3	2	-	2	2	3
e	2	1	2	3	2	-	-	1	3	1	1	3
f	-	-	-	-	-	3	3	3	-	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

4. **Semester Course wise POs Mapping**

		Course Title	1	2	3	4	5
Year I	SEMESTER I	Professional English - I	√	√			
		Matrices and Calculus	√	√			
		Engineering Physics	√	√			
		Engineering Chemistry	√	√			
		Problem Solving and Python Programming	√	√			
		Problem Solving and Python Programming Laboratory	√	√			
		Physics and Chemistry Laboratory	√	√			
	SEMESTER II	Professional English - II	√	√			
		Statistics and Numerical Methods	√	√			
		Physics of Materials	√	√			
		Basic Electrical and Electronics Engineering	√	√			
		Engineering Graphics	√	√			
		Introduction to Chemical Engineering	√	√	√		
		Engineering Practices Laboratory	√	√			
		Basic Electrical and Electronics Engineering Laboratory	√	√			
Year II	SEMESTER III	Differential Equations	√	√			
		Chemical Process Calculations		√	√	√	
		Heat Transfer and Its Applications			√	√	
		Fluid and Solid Operations			√	√	
		Principles of Electrochemistry			√	√	
		Instrumental Methods of Analysis			√	√	
		Computer Aided Drafting and Modeling Laboratory	√	√			
		Fluid and Solid Operations Laboratory			√	√	
	SEMESTER IV	Transform Techniques	√	√			
		Mass Transfer			√	√	
		Chemical Reaction Engineering			√	√	
		Chemical Engineering Thermodynamics			√	√	
		Electrodics and Electrocatalysis			√	√	
		Environmental Science and Sustainability	√	√	√		
		Heat and Mass Transfer Laboratory			√	√	
		Electrochemistry Laboratory			√	√	

		Course Title	1	2	3	4	5
Year III	SEMESTER V	Electrochemical Reaction Engineering			√	√	
		Professional Elective - I			√	√	
		Professional Elective - II			√	√	
		Professional Elective - III			√	√	
		Professional Elective - IV			√	√	
		Mandatory Course-I*					
		Life Skills and Soft Skills**					
		Chemical and Electrochemical Reaction Engineering Laboratory			√	√	
		Internship			√	√	√
	SEMESTER VI	Process Dynamics and Control			√	√	
		Open Elective - I					
		Professional Elective - V			√	√	
		Professional Elective - VI			√	√	
		Professional Elective - VII			√	√	
		Professional Elective - VIII			√	√	
		Mandatory Course-I*					
		Process Dynamics and Control Laboratory			√	√	
		Electrochemical Processes Laboratory			√	√	
Year IV	SEMESTER VII	Science and Technology of Lead Acid Battery			√	√	
		Ethics and Human Values					
		Elective - Management					
		Open Elective – II			√	√	
		Open Elective – III			√	√	
		Open Elective – IV			√	√	
		Computer Applications in Chemical Engineering Laboratory			√	√	
		Internship			√	√	√
	VIII	Project Work	√	√	√	√	√

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CHOICE BASED CREDIT SYSTEM

B.TECH. CHEMICAL and ELECTROCHEMICAL ENGINEERING

CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English – I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3172	**அறிவியல் தமிழ் / Scientific Thoughts in Tamil**	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving and Python Programming	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory $	EEC	0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

$ Skill Based Course

SEMESTER II

S. No.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English – II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3258	Physics of Materials	BSC	3	0	0	3	3
4.	BE3252	Basic Electrical, Electronics and Instrumentation	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	CH3251	Introduction to Chemical Engineering	PCC	3	0	0	3	3
7.	GE3252	**தமிழர் மரபு / Heritage of Tamils**	HSMC	1	0	0	1	1
8.		NCC Credit Course Level 1[#]	-	2	0	0	2	2
PRACTICALS								
9.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	2	2
10.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	2	2
11.	GE3272	Communication Laboratory / Foreign Language [$]	EEC	0	0	4	4	2
			TOTAL	**17**	**1**	**16**	**30**	**26**

#NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

$ Skill Based Course

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3356	Differential Equations	BSC	3	1	0	4	4
2.	CH3351	Chemical Process Calculations	PCC	3	0	0	3	3
3.	EL3301	Heat Transfer and Its Applications	PCC	3	0	0	3	3
4.	EL3302	Fluid and Solid Operations	PCC	3	0	0	3	3
5.	EL3303	Principles of Electrochemistry	PCC	3	0	0	3	3
6.	EL3304	Instrumental Methods of Analysis	PCC	3	0	0	3	3
PRACTICALS								
7.	EL3311	Computer Aided Drafting and Modeling Laboratory	ESC	0	0	4	4	2
8.	EL3312	Fluid and Solid Operations Laboratory	PCC	0	0	4	4	2
9.	GE33361	Professional Development[$]	EEC	0	0	2	2	1
			TOTAL	**18**	**1**	**10**	**29**	**24**

$ Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3451	Transform Techniques	BSC	3	1	0	4	4
2.	EL3491	Mass Transfer	PCC	3	0	0	3	3
3.	EL3401	Chemical Reaction Engineering	PCC	3	0	0	3	3
4.	PE3451	Chemical Engineering Thermodynamics	PCC	3	0	0	3	3
5.	EL3402	Electrodics & Electrocatalysis	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2#		3	0	0	3	3 #
PRACTICALS								
8.	EL3411	Heat and Mass Transfer Laboratory	PCC	0	0	4	4	2
9.	EL3412	Electrochemistry Laboratory	PCC	0	0	4	4	2
10.	EL3512	Industrial Training/Internship I*	EEC	-	-	-	-	-
			TOTAL	**17**	**1**	**8**	**26**	**22**

NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
*Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

**** Value Added Course (optional)**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EL3501	Electrochemical Reaction Engineering	PCC	3	0	3	3	3
2.		Professional Elective I	PEC	3	0	0	3	3
3.		Professional Elective II	PEC	3	0	0	3	3
4.		Professional Elective III	PEC	3	0	0	3	3
5.		Professional Elective IV	PEC	3	0	0	3	3
6.		Mandatory Course- I[&]	MC	3	0	0	3	0
PRACTICALS								
7.	EL3511	CRE & ECRE Laboratory	PCC	0	0	4	4	2
8.	EL3512	Industrial Training/Internship I**	EEC	-	-	-	-	2
			TOTAL	**18**	**0**	**7**	**22**	**19**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)
**Four weeks industrial training/internship carries two credits. Industrial training/internship during IV Semester Summer Vacation will be evaluated in V semester

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CH3651	Process Dynamics and Control	PCC	3	0	0	3	3
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Professional Elective VI	PEC	3	0	0	3	3
5.		Professional Elective VII	PEC	3	0	0	3	3
6.		Professional Elective VIII	PEC	3	0	0	3	3
7.		Mandatory Course- II[&]	MC	3	0	0	3	0
8.		NCC Credit Course Level 3#		3	0	0	3	3 #
PRACTICALS								
9.	EL3611	Process Dynamics and Control Laboratory	PCC	0	0	4	2	2
10.	EL3612	Electrochemical Processes Laboratory	PCC	0	0	4	2	2
11.	EL3712	Industrial Training/Internship II[##]	EEC	-	-	-	-	-
			TOTAL	**21**	**0**	**8**	**25**	**22**

Open Elective – I shall be chosen from the emerging technologies.

**Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER VII/VIII[*]

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EL3701	Science and Technology of Lead Acid Battery	PCC	3	0	0	3	3
2.	GE3791	Human values and Ethics	HSMC	2	0	0	2	2
3.		Elective - Management [#]	HSMC	3	0	0	3	3
4.		Open Elective – II**	PCC	3	0	0	3	3
5.		Open Elective – III***	PCC	3	0	0	3	3
6.		Open Elective – IV***	PCC	3	0	0	3	3
PRACTICALS								
7.	EL3711	Computer Applications in Chemical Engineering Laboratory	PCC	0	0	4	4	2
8.	EL3712	Industrial Training/Internship II[##]	EEC	-	-	-	-	2
			TOTAL	**17**	**0**	**4**	**21**	**21**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

****Open Elective – II shall be chosen from the emerging technologies.**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes**

[#] Elective- Management shall be chosen from the Elective Management courses

[##]Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

SEMESTER VIII/ VII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	EL3811	Internship[#]/ Project Work	EEC	0	0	20	20	10
			TOTAL	**0**	**0**	**20**	**20**	**10**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

[#]15 weeks of continuous Internship in an organization carries 10 credits.

TOTAL CREDITS: 166

ELECTIVE – MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

MANDATORY COURSES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

PROFESSIONAL ELECTIVE COURSES
VERTICALS

Vertical I (Advanced Electrochemical Processes)	Vertical II Non vertical
Electrochemical Process Technology	Air Pollution and Control Engineering
Corrosion Science and Engineering	Energy Conservation and Management
Selection of Materials	Design of Experiments
Testing of Materials	Industrial Safety in chemical industries
Industrial Metal Finishing	Electrochemical Energy Conversion and Storage
Cathodic Protection and Electrophoretic Coatings	Advanced Electrochemical Energy Storage Systems
Electrometallurgy and Thermics	Renewable Energy Sources
Electrochemical Materials Science	Control Systems Engineering

Registration of Professional Elective Courses from Verticals:
Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. More details on B.E./B.Tech (Honours) or Minor degree shall be obtained from Regulations 2021 Clause 4.10.

VERTICAL I - ADVANCED ELECTROCHEMICAL PROCESSES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL3001	Electrochemical Process Technology	PEC	3	0	0	3	3
2.	EL3002	Corrosion Science and AdEngineering	PEC	3	0	0	3	3
3.	EL3003	Selection of Materials	PEC	3	0	0	3	3
4.	EL3004	Testing of Materials	PEC	3	0	0	3	3
5.	EL3005	Industrial Metal Finishing	PEC	3	0	0	3	3
6.	EL3006	Cathodic Protection and Electrophoretic Coatings	PEC	3	0	0	3	3
7.	EL3007	Electrometallurgy and Thermics	PEC	3	0	0	3	3
8.	EL3008	Electrochemical Materials Science	PEC	3	0	0	3	3

Vertical II - Non vertical

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EL3009	Air Pollution and Control Engineering	PEC	3	0	0	3	3
2.	CPE334	Energy Conservation and Management	PEC	3	0	0	3	3
3.	EL3010	Design of Experiments	PEC	3	0	0	3	3
4.	EL3011	Industrial Safety in chemical industries	PEC	3	0	0	3	3
5.	EL3012	Electrochemical Energy Conversion and Storage	PEC	3	0	0	3	3
6.	EL3013	Advanced Electrochemical Energy Storage Systems						
7.	EL3014	Renewable Energy Sources	PEC	3	0	0	3	3
8.	EL3015	Control Systems Engineering	PEC	3	0	0	3	3

OPEN ELECTIVES

Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
9.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
10.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
11.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
12.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OIE354	Quality Engineering	OEC	3	0	0	3	3
13.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
20.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
21.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3

22.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
23.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
24.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
25.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
26.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
27.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
28.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
29.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
30.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
31.	OEC351	Signals and Systems	OEC	3	0	0	3	3
32.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
33.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
34.	OBM352	Assistive Technology	OEC	3	0	0	3	3
35.	OMA352	Operations Research	OEC	3	0	0	3	3
36.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
37.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3

13.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
20.	OMR353	Sensors	OEC	3	0	0	3	3
21.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
22.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
23.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
24.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
25.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
26.	OAE353	Drone Technologies	OEC	3	0	0	3	3
27.	OGI352	Geographical Information System	OEC	3	0	0	3	3
28.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
29.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
30.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
31.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
32.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
33.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
34.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
35.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
36.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
37.	OTT355	Fibre Science	OEC	3	0	0	3	3
38.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
39.	OPE353	Industrial safety	OEC	3	0	0	3	3
40.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
41.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
42.	OEC353	VLSI Design	OEC	3	0	0	3	3
43.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
44.	OBM353	Wearable devices	OEC	3	0	0	3	3
45.	OBM354	Medical Informatics	OEC	3	0	0	3	3

SUMMARY

Name of the Programme										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VIII	VIII/VII	
1	HSMC	4	3					5		12
2	BSC	12	7	4	6					29
3	ESC	5	11	2						18
4	PCC		3	17	16	5	7	14		62
5	PEC					12	12			24
6	OEC						3			3
7	EEC	1	2	1		2		2	10	18
8	Non-Credit /(Mandatory)					√	√			
Total		22	26	24	22	19	22	21	10	166

Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also. Complete details are available in clause 4.10 of Regulations 2021.

Verticals FOR MINOR DEGREE (IN ADDITIONS TO ALL THE VERTICALS OF OTHER PROGRAMMES)

Vertical I Fintech and Block Chain	**Vertical II Entrepreneurship**	**Vertical III Public Administration**	**Vertical IV Business Data Analytics**	**Vertical V Environment and Sustainability**
Financial Management	Foundations of Entrepreneruship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneruship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

MA3356 **DIFFERENTIAL EQUATIONS** **L T P C**
3 1 0 4

OBJECTIVES

- To acquaint the students with Differential Equations which are significantly used in engineering problems
- To introduce the basic concepts of PDE for solving standard partial differential equations.
- 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.
- To understand the finite methods for time dependent partial differential equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Higher order linear differential equations with constant coefficients – Particular integrals: Operator methods, Method of variation of parameters, Methods of undetermined coefficients– Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT II PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

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 III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Explicit Adams-Bashforth Techniques, Implicit Adams-Moulton Techniques, Predictor-Corrector Techniques, Finite difference methods for solving two-point linear boundary value problems, Orthogonal Collocation method.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9 + 3

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes.

UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 9 + 3

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – First order hyperbolic equations – method of characteristics, different explicit and implicit methods; Wave equation: Explicit scheme- Stability of above schemes.

TOTAL: 60 PERIODS

OUTCOMES

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

- Apply various methods of solving differential equation which arise in many application problems.
- Understand how to solve the given standard partial differential equations.
- 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.
- Familiar with various methods to solve time dependent partial differential equations.

TEXT BOOKS

1. Grewal. B.S, “Higher Engineering Mathematics”, 44th Edition, Khanna Publications, New Delhi, 2018.
2. Gupta S.K., “Numerical Methods for Engineers” (Third Edition), New Age Publishers, New Delhi , 2015.
3. M K Jain , S R K Iyengar , R K Jain, “Computational Methods for Partial Differential Equations”, New Age Publishers, New Delhi , 1994.

REFERENCES

1. Glyn James, “Advanced Modern Engineering Mathematics”, 3rd Edition, Pearson Education, 2012.
2. Peter V. O’Neil,” Advanced Engineering Mathematics”, 7th Edition, Cengage learning, 2012.
3. Saumyen Guha and Rajesh Srivastava, “Numerical methods for Engineering and Science”, Oxford Higher Education, New Delhi, 2010.
4. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, Cengage Learning, India Edition, New Delhi, 2009. Publishers,1993.
5. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”, Cambridge University press, Cambridge, 2002.

CH3351 CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

OBJECTIVE:

- To acquire knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I **9**

Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II **9**

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

UNIT III **9**

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

UNIT IV **9**

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction -Energy balance for systems with and without chemical reaction - Unsteady state energy balances

UNIT V **9**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the fundamentals of units and stoichiometric equations.
- Write material balance for different chemical process.
- Understand the fundamentals of ideal gas behavior and phase equilbria. Write energy balance for different chemical process.

TEXT BOOKS:

1. Bhatt, B.L., Vora, S.M., "Stoichiometry ", 4th Edition, Tata McGraw-Hill (2004)
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Eighth Edition, Prentice Hall Inc., 2012
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",5th Edn., John Wiley & Sons, New York, 2005.

REFERENCE:

1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers ,Second edition,2004.

EL3301 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.

EL3302 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.

EL3303 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.

EL3304 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.

EL3311 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.

EL3312 FLUID AND SOLID 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 and to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Characteristics of batch Sedimentation
4. Reduction ratio in Jaw Crusher / Pulverizer/ Hammer Mill
5. Reduction ratio in Ball mill
6. Reduction ratio of Roll Crusher
7. Size separation using Sub-Sieving

8. Viscosity measurement of non Newtonian fluids
9. Flow through annular pipe
10. Flow through helical coil and spiral coil
11. Pressure drop studies in packed column
12. Hydrodynamics of fluidized bed

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. Sedimentation Jar	1 No.
4. Jaw Crusher	1 No.
5. Ball Mill / Pulverizer / Hammer Mill	Any one mill
6. Cyclone Separator	1 No.
7. Roll Crusher	1 No.
8. Test Sieves.	1 No.
9. Viscometer	1 No.
10. Helical and spiral coils	1 No.
11. Packed column	1 No.
12. Fluidized bed	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
- 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

MA3451 TRANSFORM TECHNIQUES L T P C
3 1 0 4

OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- 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 transform techniques used in wide variety of situations.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.
- 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 VECTOR CALCULUS 9 + 3

Gradient and directional derivative – Divergence and curl - 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 applications in evaluating line, surface and volume integrals.

UNIT II FOURIER SERIES 9 + 3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value - Parseval's identity – Harmonic analysis.

UNIT III FOURIER TRANSFORMS 9 + 3

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

UNIT IV LAPLACE TRANSFORMS 9 + 3

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.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3

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

TOTAL:60 PERIODS

OUTCOMES

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- 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.
- Understand the mathematical principles on Laplace transforms and 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", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

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", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

EL3491 MASS TRANSFER L T P C
3 0 0 3

UNIT I 9

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

UNIT II 9

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.

UNIT III ABSORPTION 9

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

UNIT IV DISTILLATION 9

Vapour liquid equilibria - Raoult's law, Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method, Total reflux, minimum reflux ratio, optimum reflux ratio.

UNIT V LEACHING & EXTRACTION 9

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for single stage extraction, multi-stage cross current extraction, multi-stage counter current operation. Solid-liquid equilibria- equilibrium diagram for leaching, single stage leaching, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K Asokan, Mass Transfer concepts, University Press
2. Robert Ewald Treybal, "Mass Transfer Operations" McGraw Hill Education India

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.

EL3401 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.

PE3451 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 PVT RELATIONS AND FIRST LAW OF THERMODYNAMICS **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 SECOND LAW AND THERMODYNAMIC CORRELATIONS **9**

Application of first Law of Thermodynamics for Flow and non-flow processes. Limitations of the first Law, statements of second Law of Thermodynamics, Thermodynamic Temperature scale, Entropy, Third law of thermodynamics. Thermodynamic Potentials, thermodynamic correlation, Maxwell relations. Clapeyron equation.

UNIT III SOLUTION THERMODYNAMICS **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. Activity coefficient-composition models.

UNIT IV PHASE EQUILIBRIA **9**

Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry's law, fugacity, Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation,

thermodynamic consistency test of VLE data, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium.

UNIT V REACTION EQUILIBRIA 9

Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions.

TOTAL: 45 PERIODS

OUTCOME:

1. Understand the fundamentals of system of units, apply ideal gas law to solve problems in pure components and mixtures.
2. Apply stoichiometric principles to solve problems and write material balance for different process equipments.
3. Understand and apply basics of humidity to solve problems in humidification and other processes.
4. Understand and apply the basics of energy balance concepts to solve to different chemical processes.
5. Understand the basics of fuels and combustion, to solve problems on combustion of various fuels and also to find excess air.
6. Apply the above knowledge to process flow sheeting in industries.

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. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

EL3402 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

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C
2 0 0 2

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, 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.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY . 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCE BOOKS :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

EL3411 **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 - 1 No.
2. Heat Exchanger - 1 No.
3. Condenser - 1 No.
4. Thermal conductivity measurement apparatus - 1 No.
5. Soxlet Extractor - 1 No.
6. Rotating Disc Contactor - 1 No.
7. Controllers of Temperature - 1 No.
8. Convection Apparatus - 1 No.
9. Emissivity measurement apparatus - 1 No.
10. Distillation Apparatus - 1 No.
11. Double pipe heat exchanger - 1 No.
12. Diffusion Apparatus - 1 No.

REFERENCE:

1. Laboratory Manual prepared by Faculty

EL3412 ELECTROCHEMISTRY LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- Enable the students to develop a sound working knowledge on different types of electrochemical techniques and electrochemical parameter calculations.

LIST OF EXPERIMENTS

1. Fabrication of Reference electrode (Ag/AgCl) and its validation
2. Fabrication of modified electrodes and calculation of surface excess
3. Potentiometric titration of redox couple (Fe/Ce ions)
4. Estimation of equilibrium potential of quinhydrone electrode(pH dependence)
5. Determination of formal potential and diffusion coefficient for a reversible process using ferricyanide and ferrocyanide
6. Distinguish between inner and outer sphere processes using Pt and glassy carbon electrode
7. Effect of dissolved oxygen in electrochemical reduction of nitrophenol
8. Amperometric method for sensing hydrogen peroxide
9. Determination of dihydroxy phenols using cyclic voltammetry
10. Investigation of electrochromism using electropolymerisation on a ITO substrate
11. Double-layer capacitance measurement using cyclic voltammetry
12. Electrode surface area measurement using a redox probe.

TOTAL: 60 PERIODS

OUTCOME:

- Student would be able to calculate electrochemical parameters from various electrochemical techniques. Students will understand the standard procedures to carry out an electrochemical experiment.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Electrochemical analyzer- 1 No.
2. Potentiometer- 3 No.
3. Glassy carbon electrode- 15 No.
4. ITO electrode–15 No.
5. Reference electrode- 15No.
6. Pt electrode- 15 No.