DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

PERAMBALUR - 621212

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

B.TECH. CHEMICAL ENGINEERING

CURRICULAM AND SYLLABI

DEPARTMENT OF CHEMICAL ENGINEERING

(Applicable to the students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

Discussed in BOS-4 meeting Dated: 13.09.2024 / CHEMICAL Ratified & Approved in Academic Council

VISION MISSION OF THE INSTITUTION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follow up of global standards by offering UG, PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF CHEMICAL ENGINEERING

ABOUT THE DEPARTMENT

The Department of Chemical Engineering was founded in 2017 and provides B.Tech. in Chemical Engineering with An intake of 120-student for the academic year 2017–2018. To solve industrial related chemical problems, the B.Tech. in Chemical Engineering is a focused programme designed to have a balanced version of theoretical knowledge and practical knowhow in the fields of Basic Science, Physics, Material Science, Chemistry, Chemical Engineering Process and Control System, Industrial Manufacturing, and so on.

Chemical Engineering is a popular discipline of engineering that deals with large-scale manufacturing of chemicals, petrochemicals, biochemicals, food preservation, electronic materials, pharmaceuticals, everyday materials, energy, and the environment, among other things. Workshops, training programmes, and conferences are held by the department on a regular basis in a variety of new thrust areas. Industrial trips, in-plant training, and internships are scheduled on a regular basis to help students obtain technical skills.

Furthermore, the campus offers a diverse range of events, activities, and other extracurricular and co-curricular programmes to complement student's academic experience and help students to develop a well-rounded personality. In order to prepare students for placement, personality development training programmes are offered in the third and final years of study. Competitive tests such as GATE, GRE, TOEFL, UPSC and others receive guidance.

By enrolling in the Department of Chemical Engineering, students will be a part of an illustrious history and an enriching graduate programme that will prepare students for careers in highly sought-after fields like Chemical Engineering. I hope to see students on our campus, which is full of opportunities for a bright future.

VISION OF CHEMICAL ENGINEERING

To strive for the development and transfer of technical competence in academic through formal and non formal education, entrepreneurship and quality research to meet the challenges of an ever expanding and global world..

MISSION OF CHEMICAL ENGINEERING

- Imparting quality technical education to the students in emerging areas of Chemical Engineering
- Integrating industrial training with curricula.
- Enhancing research and Development in the area of Chemical Engineering and allied Fields.
- Non formal education through community Development programs
- To increase interaction with chemical process industry.
- To impart consultancy services to the chemical and allied industrial around the region.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

- Graduates of B. Tech. Chemical Engineering will
- Apply principles of mathematics, science, and engineering to analyze and solve problems encountered in chemical engineering and related areas.
- Think critically and creatively, especially about the use of technology to address local and global problems and become a socially responsible engineer by involving with community and professional organizations.
- Exhibit professional, ethical codes of conduct, team work and continuous learning for catering the ever changing needs of the society.

PROGRAMME OUTCOMES (POS)

PO	GraduateAttribute
PO1	**Engineering knowledge**:Apply the knowledge ofmathematics, science,engineeringfundamentals, and an engineering specialization to the solution of complex engineeringproblems.
PO2	**Problemanalysis**:Identify,formulate,reviewresearchliterature,andanalyzecomplexengineeringproblemsreachingsubstantiatedconclusionsusingfirstprinciplesofmathematics,naturalsciences,and engineeringsciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problemsanddesignsystemcomponentsorprocessesthatmeetthespecifiedneedswithappropriateconsiderationforthe publichealthandsafety,andthecultural,societal,andenvironmentalconsiderations.
PO4	**Conductinvestigationsofcomplexproblems**:Useresearch – basedknowledgeandresearchmethodsincludingdesignofexperiments,analysisandinterpretationofdata,andsynthesis oftheinformation toprovide validconclusions.
PO5	**Moderntoolusage**:Create,select,andapplyappropriatetechniques,resources,andmodern engineeringandITtoolsincludingpredictionandmodelingtocomplexengineeringactivitieswithanunderstandingofthelimitations.
PO6	**Theengineerandsociety**:Applyreasoninginformedbythecontextualknowledgetoassessssocietal,health,safety,legalandculturalissuesandtheconsequentresponsibilitiesrelevanttothe professionalengineeringpractice.
PO7	**Environmentandsustainability**:Understandtheimpactoftheprofessionalengineeringsolutionsinsocietalandenvironmentalcontexts,anddemonstratetheknowledgeof,andneedforsustainabledevelopment.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individualandteamwork**:Functioneffectivelyasanindividual,andasamemberorleaderindiverse teams, andinmultidisciplinarysettings.
PO10	**Communication:**Communicate effectively on complex engineering activities with theengineering community and with society at large, such as, being able to comprehend andwriteeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgive andreceiveclear instructions.
PO11	**Projectmanagementandfinance:**Demonstrateknowledgeandunderstandingofthe engineering and management principles and apply these to one's own work, as a memberandleaderinateam,to manageprojectsandinmultidisciplinary environments.
PO12	**Lifelonglearning**:Recognizetheneedfor,andhavethepreparationandabilityto engageinindependentandlife – longlearninginthebroadestcontextoftechnologicalchange.

PEO's – PO's & PSO's MAPPING:

PEO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
I.	3	3	2	2	2	2	-	-	-	-	-	3	3	2	3
II.	3	3	3	2	2	-	-	-	2	1	2	3	3	3	3
III.	3	2	3	3	2	-	-	-	2	2	-	3	3	3	3
IV.	3	3	3	2	2	-	-	2	-	-	-	2	2	2	2

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS)

PERAMBALUR – 621 212

REGULATIONS 2023

B.TECH CHEMICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

CURRICULAM AND SYLLABI FOR SEMESTERS I TO VIII

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IP3151	Induction Program	-				-	0
2.	U23HST11	Communicative English	HSMC	3	0	0	3	3
3.	U23MAT12	Matrices and Calculus	BSC	3	1	0	4	4
4.	U23PHT13	Physics for Engineers and Technologists	BSC	3	0	0	3	3
5.	U23CYT14	Chemistry for Engineering and Technology	BSC	3	0	0	3	3
6.	U23GET16	Engineering Graphics	ESC	3	1	0	4	4
7.	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	U23BSP11	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
9.	U23HSP12	English Laboratory	EEC	0	0	4	4	1
10.	U23GEP14	Engineering Practices Laboratory	ESC	0	0	2	2	2
TOTAL								**23**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23HST21	Professional English	HSMC	2	0	0	3	2
2.	U23MAT22	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	U23GET15	Problem Solving and Python Programming	ESC	3	0	0	3	3
4.	U23EET25	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
5.	U23CHT21	Introduction to Chemical Engineering	PCC	3	0	0	3	3
6.	U23PHT26	Physics of Materials	BSC	3	0	0	3	3
7.		NCC Credit Course Level 1	-	2	0	0	2*	2*
8.	GE3252	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
PRACTICALS								
1.	U23EEP24	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
2.	U23HSP22	Communication Laboratory	EEC	0	0	4	4	2
3.	U23GEP13	Problem Solving and Python Programming Laboratory	ESC	2	0	0	4	2
TOTAL								**25**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23MAT31	Transforms And Partial Differential Equations	BSC	3	1	0	4	4
2.	U23CHT31	Basic mechanical Engineering	ESC	3	0	0	3	3
3.	U23CHT32	Industrial and Engineering Chemistry	ESC	3	0	0	3	3
4.	U23CHT33	Chemical Process Calculation	PCC	3	0	0	3	3
5.	U23CHT34	Fluid mechanics for Chemical Engineers	PCC	3	0	0	3	3
6.	U23CHT35	Chemical Process Industries	PCC	3	0	0	3	3
PRACTICALS								
7.	U23CHP31	Basic Mechanical Engineering Laboratory	ESC	0	0	3	3	1.5
8.	U23CHP32	Technical Analysis Laboratory	PCC	0	0	3	3	1.5
TOTAL								**22**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHT41	Instrumental methods of chemical analysis	PCC	3	0	0	3	3
2.	U23CHT42	Mass Transfer I	PCC	3	0	0	3	3
3.	U23CHT43	Mechanical Operations	PCC	3	0	0	3	3
4.	U23CHT44	Chemical Engineering Thermodynamics	PCC	3	1	0	4	3
5.	U23CHT45	Heat Transfer	PCC	3	1	0	4	3
6.	U23GET41	Environmental Science and Engineering	BSC	2	0	0	3	2
PRACTICALS								
7.	U23CHP41	Fluid Mechanics Laboratory For chemical Engineers	PCC	0	0	3	3	1.5
8.	U23CHP42	Mechanical Operation Laboratory	PCC	0	0	3	3	1.5
TOTAL								**20**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHT51	Process instrumentation dynamics and control	PCC	3	0	0	3	3
2.	U23CHT52	Mass Transfer- II	PCC	3	1	0	4	3
3.	U23CHT53	Chemical Reaction Engineering - I	PCC	3	0	0	3	3
4.	U23CHT54	Fertilizer Technology	ESC	3	0	0	3	3
5.		Professional Elective –I	PEC	3	0	0	3	3
6.		Open Elective -I	OEC	3	0	0	3	3
PRACTICALS								
7.	U23CHP51	Mass transfer Laboratory	PCC	0	0	3	3	1.5
8.	U23CHP52	Heat Transfer Laboratory For chemical engineers	PCC	0	0	3	3	1.5
TOTAL								**21**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHT61	Chemical Process Economics	PCC	3	0	0	3	3
2.	U23CHT62	Chemical Reaction Engineering II	PCC	3	1	0	4	3
3.	U23GET61	Human values and ethics	HSMC	3	0	0	3	2
4.		Open Elective II	OEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
7.	U23CHP61	Chemical Reaction Engineering Laboratory	PCC	0	0	3	3	1.5
8.	U23CHP62	Process Control and Instrumentation Laboratory	PCC	0	0	3	3.	1.5
9.	U23GE3361	Professional Development	EEC	0	0	2	2	1
TOTAL								**21**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHT71	Transport Phenomena	PCC	3	0	0	3	3
2.	U23CHT72	Process Equipment design for chemical Engineers	PCC	3	0	0	3	3
3.		Open Elective III	OEC	3	0	0	3	3
4.		Open Elective IV	OEC	3	0	0	3	3
5.		Professional Elective –IV	PEC	3	0	0	3	3
6.		Professional Elective –V	PEC	3	0	0	3	3

7.		Professional Elective –VI	PEC	3	0	0	3	3
PRACTICALS								
8.	U23CHP71	Process Equipment design & Drawing Laboratory	PCC	0	0	3	3	1.5
9.	U23CHP72	Computational chemical Engineering Laboratory	PCC	0	0	3	3	1.5
10.	U23CHP73	Internship	EEC	-	-	-	-	1
TOTAL								**25**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHP81	Project Work	EEC	0	0	20	20	10
TOTAL								**10**

TOTAL COURSES & CREDITS – SEMESTER WISE

SEMESTER	I	II	III	IV	V	VI	VII	VIII	TOTAL
NO. OF COURSES	10	11	8	8	8	9	10	1	65
CREDITS	23	25	22	20	21	21	25	10	167

SUMMARY

B.TECH CHEMICAL ENGINEERING											
S. No.	SUBJECT AREA	CREDITS PER SEMESTER								CREDIT TOTAL	PERCENTAGE %
		I	II	III	IV	V	VI	VII	VIII		
1.	**Humanities Sciences and Management Science Course(HSMC)**	4	3				2			**9**	**5.35**
2.	**Basic Sciences Course (BSC)**	12	7	4	2					**26**	**15.47**
3.	**Engineering Sciences Course (ESC)**	6	10	7.5		3				**26.5**	**15.77**
4.	**Professional Core Course (PCC)**		3	10.5	18	12	9	9		**61.5**	**36.60**
5.	**Professional Elective Course (PEC)**					3	6	9		**18**	**10.71**
6.	**Open Elective Course (OEC)**					3	3	6		**12**	**7.14**
7.	**Employability Enhancement Course (EEC)**	1	2				1	1	10	**15**	**8.92**
TOTAL		**23**	**25**	**22**	**20**	**21**	**21**	**25**	**10**	**167**	**100**

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Environmental and Safety Engineering	Vertical IV Computational Chemical Engineering	Vertical V Chemical Plant Design	Vertical VI Elective management courses
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Air Pollution Engineering	Computational Techniques	Chemical Plant Design	Principles of management
Primary Refining Technology	Renewable Energy Resources	Industrial Waste Water Treatment	Optimization of Chemical Processes	Plant Layout	Total quality management
Secondary Refining Technology	Pinch Technology	Solid waste Management	Process Modeling and Simulation	Design Safety	Engineering economics and financial accounting
Refinery Advancements and Environmental Regulations	Hydrogen And Fuel Cell Technology	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection	Human resources management
Petroleum Equipment Design	Power Plant Engineering	Process Safety Management	Chemical Process Flow sheeting	Statutory Requirements and Customer Care	Knowledge management
Polymer science and technology	Non Renewable Energy Sources	Risk and HAZOP Analysis	Computational Fluid Dynamics	Process Plant Utilities	Industrial management

VERTICALS - I: PETROLEUM PROCESS TECHNOLOGY

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHV11	Petroleum Chemistry and Refining Fundamentals	PEC	3	0	0	3	3
2.	U23CHV12	Primary Refining Technology	PEC	3	0	0	3	3
3.	U23CHV13	Secondary Refining Technology	PEC	3	0	0	3	3
4.	U23CHV14	Refinery Advancements and Environmental Regulations	PEC	3	0	0	3	3
5.	U23CHV15	Petroleum Equipment Design	PEC	3	0	0	3	3
6.	U23CHV16	Polymer science and technology	PEC	3	0	0	3	3

VERTICALS - II: ENERGY ENGINEERING

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHV21	Bioenergy	PEC	3	0	0	3	3
2.	U23MEV36	Renewable Energy Resources	PEC	3	0	0	3	3
3.	U23CHV23	Pinch Technology	PEC	3	0	0	3	3
4.	U23CHV24	Hydrogen And Fuel Cell Technology	PEC	3	0	0	3	3
5.	U23MET73	Power Plant Engineering	PEC	3	0	0	3	3
6.	U23CHV26	Non Renewable Energy Sources	PEC	3	0	0	3	3

VERTICALS - III: ENVIRONMENTAL AND SAFETY ENGINEERING

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHV41	Air Pollution Engineering	PEC	3	0	0	3	3
2.	U23CHV42	Industrial Waste Water Treatment	PEC	3	0	0	3	3
3.	U23CHV43	Solid waste Management	PEC	3	0	0	3	3
4.	U23CEV33	Environmental Impact Assessment	PEC	3	0	0	3	3
5.	U23CHV45	Process Safety Management	PEC	3	0	0	3	3
6.	U23CHV46	Risk and HAZOP Analysis	PEC	3	0	0	3	3

VERTICALS - IV: CHEMICAL PLANT DESIGN

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHV41	Computational Techniques	PEC	3	0	0	3	3
2.	U23CHV42	Optimization of Chemical Processes	PEC	3	0	0	3	3
3.	U23CHV43	Process Modeling and Simulation	PEC	3	0	0	3	3
4.	U23CHV44	Pinch Analysis and Heat Exchange Network Design	PEC	3	0	0	3	3
5.	U23CHV45	Chemical Process Flow sheeting	PEC	3	0	0	3	3
6.	U23AET72	Computational Fluid Dynamics	PEC	3	0	0	3	3

VERTICALS – V: CHEMICAL PLANT DESIGN

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHV51	Chemical Plant Design	PEC	3	0	0	3	3
2.	U23CHV52	Plant Layout	PEC	3	0	0	3	3
3.	U23CHV53	Design Safety	PEC	3	0	0	3	3
4.	U23CHV54	Material Selection	PEC	3	0	0	3	3
5.	U23CHV55	Statutory Requirements and Customer Care	PEC	3	0	0	3	3
6.	U23CHV56	Process Plant Utilities	PEC	3	0	0	3	3

VERTICALS – VI: ELECTIVE MANAGEMENT

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23GET71	Principles of management	PEC	3	0	0	3	3
2.	U23GET72	Total Quality management	PEC	3	0	0	3	3
3.	U23GET73	Engineering economics and financial accounting	PEC	3	0	0	3	3
4.	U23GET74	Human resource management	PEC	3	0	0	3	3
5.	U23GET75	Knowledge management	PEC	3	0	0	3	3
6.	U23GET76	Industrial management	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 ,II,III,IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23CHO01	Energy Engineering	OEC	3	0	0	3	3
2.	U23CHO02	Corrosion Engineering	OEC	3	0	0	3	3
3.	U23CHO03	Introduction to Industrial Safety	OEC	3	0	0	3	3
4	U23CHO04	Advances in Pollution Control	OEC	3	0	0	3	3
5	U23CHV32	Industrial waste water Treatment	OEC	3	0	0	3	3
6	U23CHO05	Waste to Energy	OEC	3	0	0	3	3
7	U23CHV24	Hydrogen And Fuel Cell Technology	OEC	3	0	0	3	3
8	U23CHV16	Polymer science and technology	OEC	3	0	0	3	3
9	U23CHV31	Air Pollution Engineering	OEC	3	0	0	3	3
10	U23CHO06	Paper technology	OEC	3	0	0	3	3
11	U23CHO07	Sugar technology	OEC	3	0	0	3	3
12	U23CHV35	Process safety management	OEC	3	0	0	3	3

IP3151 INDUCTION PROGRAMME

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution.

Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts.

Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself

and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked

to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

U23HST11	**COMMUNICATIVE ENGLISH**	**L**	**T**	**P**	**C**
	(COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To enhance students listening ability for academic and Professional purposes.
2. To learn to use basic grammatical structures in suitable contexts
3. To help students acquire the ability to speak effectively in English in real -life situations.
4. To help learners use language effectively in professional contexts.
5. To develop student's ability to read and write complex texts, summaries, articles, definitions, Paragraph user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.

Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.

Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II READING QUEST 9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** –Edison of India-GD Naidu "The Great Inventor". **Writing-** Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT 9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV LANGUAGE IN LIFE SKILL 9

Listening- Listening to speech of Great Scholars. Speaking- mechanics of presentation. **Reading** – Newspaper articles, power point presentation. **Writing** – Checklist, Jumbled sentences-Rearrange the sentences in correct order, WH-Questions-Form questions by using statements, Prefixes and Suffixes.

UNITV IMPROVING SPEAKING &READING 9

Listening- listening to situational based dialogues; **Speaking-** Stating intention to do something-Expressing opinion-asking people to repeat themselves**. Reading** – Summary of O.Henry's "The last Leaf". **Writing** – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 : Remember appropriate words in a situational conversation.
CO2 : Gain understanding of basic grammatical structures and use them in right context.
CO3 : Read and infer the denotative and connotative meanings of technical texts.
CO4 : Write Dialogue, Letter and paragraphs on various topics.
CO5 : Make the students prepare effective notes for main sources available.
CO6 : Enhance them to give operational talk.

TEXT BOOKS:

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. The Gift of the Magi by O.Henry, McClure,Philips and company.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman &Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By AyshaViswamohan, Mcgraw Hill Education.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5 Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

U23MAT12	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables.
4. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5. To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.

UNIT I MATRICES 12

Introduction – Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of Eigen values and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS 12

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III MULTIVARIABLE CALCULUS 12

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

UNIT IV MULTIPLE INTEGRAL AND THEIR APPLICATIONS 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.

UNITV ORDINARY 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

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Use the matrix algebra methods for solving practical problems.

CO2 : Use both the limit definition and rules of differentiation to differentiate functions.

CO3 : Apply differential calculus tools in solving various application problems.

CO4 : Able to use differential calculus ideas on several variable functions.

CO5 : Apply multiple integral ideas in solving areas, volumes and other practical problems.

CO6 : Solve the ordinary differential equations using different techniques for that model engineering problems.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., “Higher Engineering Mathematics”,Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - 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].

REFERENCE BOOKS:

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, 5th Edition,2016.
3. Narayanan. S. and Manicavachagom Pillai. T. K.,“Calculus" Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt.Ltd, New Delhi, 2016.
5. Thomas. G. B., Hass. J, and Weir. M.D,"Thomas Calculus", 14th, Pearson India, 2018.

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2. To understand the students to know the application of the sound waves in different fields.
3. To motivate the students towards the applications of photo electric phenomena.
4. To know the physical principle of LASER, the working of LASER applications.
5. To understand the propagation of light in optical fibers and its applications.

UNIT I ELASTICITY 9

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Modulii of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting ouple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II ULTRASONICS 9

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III MODERN PHYSICS 9

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process – Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV LASERS 9

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process - Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light By Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo And Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNIT V FIBER OPTICS AND APPLICATIONS 9

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression For Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method - Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Differentiate the elastic and plastic nature of the materials.

CO2 : Know the experimental techniques in both production and applications of ultrasonic waves.

CO3: Gain knowledge in the basics of quantum mechanics concepts.

CO4: Develop new devices based on LASER source.

CO5: Understand the advantages of optical fiber than metal wire.

CO6: Demonstrate the some useful experiments based on optical fibre

TEXT BOOKS:

1. Dr. P.Mani, “Engineering Physics”, Dhanam Publications, 2013.
2. Dr. G. Senthilkumar, “Engineering Physics”, VRB Publishers, 2017.
3. K. Thyagarajan, Ajoy Ghatak, “Lasers Fundamentals and Applications” II nd Edition, Springer, 2010.
4. D.K. Bhattacharya, Poonam Tandon,” Engineering Physics”, Oxford HED Publishers, 2017.

REFERENCE BOOKS:

1. Marikani, “Engineering Physics”, PHI, New Delhi, 2013.
2. Bhattacharya & Bhaskaran, “Engineering Physics”, Oxford Publications, 2012.
3. R Murugeshan, Kiruthiga, Sivaprasath S, “Modern Physics”, Chand Publishing, 2021.
4. S. Rajivgandhi & A. Ravikumar, “ Engineering Physics I”, RK Publications, 2023
5. Sathyaprakash, “Quantum Mechanics”, Pragati Prakashan, Meerut, 2016.

U23CYT14	CHEMISTRY FOR ENGINEERING & TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To inculcate sound understanding of water quality parameters and water treatment techniques.
2. Impart knowledge on the basic principles and preparatory methods of nanomaterial.
3. To introduce the basic concepts and applications of phase rule and composites.
4. To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5. Tofamiliarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I Water Treatment 9

Water: Sources , impurities, Parameters. Types of water Hardness of water -types – expression of hardness – units – Estimationof hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

UNIT II Electro and Nano chemistry 9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes -types–Calomel electrode - electrolysis of water.

Nanomaterials:Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulkmaterials. Preparation of nanomaterials- laser ablation method and Chemical VapourDeposition(CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III Phase Rule and Composites 9

Phase rule terms with examples. water system; Reduced phase rule Two component system: lead-silver system – Composites , Need , Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV Fuels & Combustion 9

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; 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. CO_2 emission and carbon foot print.

UNITV Energy Sources and Storage devices 9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2 : Apply the basic knowledge of Corrosion and various electrodes.

CO3 : Know the economically and new methods of synthesis nano materials.

CO4 : Apply the knowledge of phase rule and composites for material selection requirements.

CO5 : Understand the concepts of suitable fuels for engineering processes and applications.

CO6 : Have the knowledge of different forms of energy resources and apply them for suitable applications in energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, “A text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018.
4. J.Manivel , “Engineering Chemistry” R.K.Publishers, 1st Edition 2022.

REFERENCE BOOKS:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, “Text book of nanoscience and nanotechnology”, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

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

UNIT I PLANE CURVES AND ORTHOGRAPHIC PROJECTION 6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimension. 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 (polygonal and circular surfaces) inclined to both the planes.

UNIT III PROJECTION OF SOLIDS 6+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 6+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 solids – Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC PROJECTION 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.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Familiarize with the fundamentals and standards of Engineering graphics

CO2 : Perform freehand sketching of basic geometrical constructions and multiple views of objects.

CO3 : Project orthographic projections of lines and plane surfaces.

CO4 : Draw projections and solids and development of surfaces.

CO5 : Visualize and to project isometric and perspective sections of simple solids.

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. 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.

GE3152	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNITV CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

		L	T	P	C
GE3152	**தமிழர்மரபு**	**1**	**0**	**0**	**1**

அலகு I மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL: 15 PERIOD

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L 0	T 0	P 3	C 2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the proper use of various kinds of physics laboratory equipment.
2. To learn how data can be collected, presented and interpreted in a clear and concise manner.
3. To learn problem solving skills related to physics principles and interpretation of experimental data.
4. To determine error in experimental measurements and techniques used to minimize such error.
5. To make the student as an active participant in each part of all lab exercises.
6. To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7. To Induce the students to analyze the hardness of water
8. To induce the students to familiarize with electro analytical techniques such as, pH metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1. Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2. Non - Uniform bending–Determination of Young's modulus.
3. Laser – (i) Determination of the wavelength of the laser using grating.
   (ii) Determination of size of the particles using laser source.
4. Air wedge – Determination of thickness of a thin sheet/wire.
5. Determination of Band gap of a semiconductor using PN junction kit.
6. To study the V-I Characteristics of Light Dependent Resistor (LDR).
7. Determination of types and amount of alkalinity in water sample.
8. Determination of total, temporary & permanent hardness of water by EDTA method.
9. Determination of chloride content of water sample by Argentometric method.
10. Determination of strength of given hydrochloric acid using pH meter.
11. Determination of strength of acids in a mixture of acids using conductivity meter.
12. Conduct metric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl No	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**
3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand With Meter Scale)	**5**
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**
6.	Light Dependent Resistor (Power Suppy, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**
8.	Conductivity meter	**10**
9.	Common Apparatus(Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand the functioning of various physics laboratory equipment.

CO2 : Observe and tabulate experimental data.

CO3: Solve problems individually and collaboratively.

CO4: Analyse the quality of water samples with respect to their acidity, alkalinity

CO5: Determine the amount of hardness in the water

CO6: Analyse quantitatively the impurities in solution by electro analytical techniques

U23HSP12 **ENGLISH LABORATORY** **L T P C**

(COMMON TO ALL B.E. / B.TECH. PROGRAMMES) **0 0 2 1**

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
5. To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1	Listening for general information-specific details.
2	Conversation: Introduction to classmates.
3	Speaking - making telephone calls-Self Introduction.
4	Talking about current and temporary situations & permanent and regular situations.
5	Listening to podcasts, anecdotes / stories / event narration.
6	Event narration; documentaries and interviews with celebrities.
7	Events-Talking about current and temporary situations & permanent and regular situations.
8	Engaging in small talk.
9	Describing requirements and abilities- Picture description.
10	Discussing and making plans.
11	Talking about tasks- progress- positions -directions of movement.
12	Talking about travel preparations and transportation.
13	Listening to debates/ discussions.
14	Making prediction talking about a given topic.
15	Describing processes.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Identify and comprehend complex academic texts.

CO2 : Interpret accurately and fluently in formal and informal communicative contexts.

CO3: Demonstrate their opinions effectively in both oral and written medium of communication.

CO4: Plan travelogue and construct paragraphs on various aspects.

CO5: Develop journal reading skills and small talk.

CO6: Utilizing technical terms and making power point presentations.

U23GEP14	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. awing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common house hold wood work.
2. iring various electrical joints in common household electrical wire work.
3. elding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

LIST OF EXPERIMENTS

GROUP – A (CIVIL AND MECHANICAL)

PART I : CIVIL ENGINEERING PRACTICES

PLUMBING WORK:

1. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2. Preparing plumbing line sketches.
3. Laying pipe connection to the suction side of a pump
4. Laying pipe connection to the delivery side of a pump.
5. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WELDING WORK:

1. Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
2. Practicing gas welding.

BASIC MACHINING WORK:

1. Turning
2. Drilling
3. Tapping

ASSEMBLY WORK:

1. Assembling a centrifugal pump.
2. Assembling a household mixer.

SHEET METAL WORK:

1. Making of a square tray

WOOD WORK:

1. Sawing,
2. Planing and
3. Making joints like T-Joint Mortise joint and Tenon joint and Dovetail joint.

PART II: ELECTRICAL & ELECTRONICS:

ELECTRICAL:

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.

ELECTRONICS:

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.

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

CO2 : Wire various electrical joints in common household electrical wire work.

CO3: Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

CO4: Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

U23HST21	PROFESSIONAL ENGLISH (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To engage learners in meaningful language activities to improve their reading and writing skills.
2. To learn various reading strategies and apply in comprehending documents in professional context.
3. To help learners understand the purpose, audience, contexts of different types of writing.
4. To enable students write letters and reports effectively in formal and business situations.
5. To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I PREPARATORY DOCUMENTATIONS 9

Listening- Listening to formal conversations and Participating**. Speaking-** speaking about one's family. **Reading –** Summary of W.W Jacobs "The monkey's paw". **Writing –** Subject verb Agreement, Numerical -Adjectives, Kinds of sentences**,** Writing reviews (book / film), writing Instructions, Writing Recommendation.

UNIT II LECTURA ENRICHMENT AND PASSAGE COMPOSE 9

Listening- listening to lectures on academic topics; **Speaking-** Asking for and giving directions. **Reading -** Reading longer technical texts; **Writing -** Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III ANALYTICAL SKILL 9

Listening- Watching videos/documentaries and responding to questions based on them. **Speaking –**Speaking about ones favourite place**. Reading –** Summary of the poem – John keats "Ode to a Nightingale". **Writing-** Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV REPORT WRITING 9

Listening- Listening to class room lectures/talks on engineering/technology. **Speaking–** Introduction to technical presentations. **Reading –** Newspaper articles; **Writing –** Comparative Adjectives Direct and Indirect speech**.** Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNIT V ENABLING LINGUA IDEALITY & INFORMATION 9

Listening- TED/Ink talks. **Speaking –** Making presentation on a given topic. **Reading –**Company profiles, Statement of Purpose, (SOP), **Writing –** Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Compare and contrast products and ideas in technical texts.

CO2 : Identify cause and effects in events, industrial processes through technical texts.

CO3: Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.

CO4: Motivate students to write reports and winning job applications.

CO5: Recall and comprehend different discourses and genres of texts.

CO6: Making the students to become virtuous presenters.

TEXT BOOKS:

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, MeeraBannerji- Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2. To acquaint the knowledge of classifications of design of experiments in the field of agriculture.
3. To introduce the basic concepts of solving algebraic and transcendental equations.
4. To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
5. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 12

Introduction – Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of a matrices by power method and jacobi's method for Symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNITV NUMERICAL SOLUTION OF 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 differential equations – Multi step methods : Milne's and Adams Bashforth predictor corrector methods for solving first order differential equations.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO2 : Apply the basic concepts of classifications of design of experiments in the field of agriculture.

CO3: Solve the algebraic and transcendental equations.

CO4: Understand the knowledge of numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

CO5: Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

CO6: Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson , R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCE BOOKS:

1. Burden,R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi , 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi,12th Edition, 2020.
5. Spiegel.M.R.,Schiller.J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

U23GET15	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -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 TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 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: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNITV FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop algorithmic solutions to simple computational problems.

CO2 : Develop and execute simple Python programs.

CO3 : Write simple Python programs using conditionals and loops for solving problems.

CO4 : Decompose a Python program into functions.

CO5 : Represent compound data using Python lists, tuples, dictionaries etc.

CO6 : Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
3. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.

REFERENCE BOOKS:

1. John V Guttag, "Introduction to Computation and Programming Using Python'", Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
4. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.

U23EET25	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. the basics of electric circuits and analysis
2. The impart knowledge in domestic wiring
3. The impart knowledge in the basics of working principles and application of electrical machines
4. Analog devices and their characteristics
5. The functional elements and working of sensors and transducers

UNIT I ELECTRICAL CIRCUITS 9

Basic circuit components -Ohms Law Kirchhoff's Law – Instantaneous Power –Inductors - Capacitors– Independent and Dependent Sources-steady state solution of DC circuits-Nodal analysis, Mesh analysis-Thevinin's Theorem, Norton's Theorem, Maximum Power transfer theorem- Linearity and Superposition Theorem.

UNIT II AC CIRCUITS 9

Introduction to AC circuits–waveforms and RMS value–power and power factor, single phase and three-phase balanced circuits–Three phase loads-housing wiring, industrial wiring, and materials of wiring. safety precautions and First Aid.

UNIT III ELECTRICAL MACHINES 9

Construction and Working principle- DC Separately Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Synchronous motor and Three Phase Induction Motor.

UNIT IV ANALOG ELECTRONICS 9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

UNITV SENSORS AND TRANSDUCERS 9

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Compute the electric circuit parameters for simple problems.

CO2 : Explain the concepts of domestics wiring.

CO3: Explain the concepts of protective devices.

CO4: Explain the working principle and applications of electrical machines.

CO5: Analyze the characteristics of analog electronic devices.

CO6: Explain the types and operating principles of sensors and transducers

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020.
2. A.K. Sawhney, PuneetSawhney 'A Course in Electrical & Electronic Measurements &Instrumentation', DhanpatRai and Co, 2015.
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits, Wiley,2018

REFERENCE BOOKS:

1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition.,Cengage India,2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.

U23CHT21	INTRODUCTION TO CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basic concepts of chemical process industries
2. To learn the fundamentals of mechanical operations and their significance in chemical industries.
3. To gain exposure over fluid properties and types of fluids.
4. To understand the heat transfer mechanisms and the types of heat exchange equipments.
5. To have a basic idea on process calculations carried out in chemical industries

UNIT I BASICS OF CHEMICAL PROCESS INDUSTRIES 9

Unit process and unit operations concepts-Outlines of unit process- Calcination, carbonylation, combustion, hydration, dehydration, hydrolysis, nitration, sulfonation, Polymerization

UNIT II FUNDAMENTALS OF MECHANICAL OPERATIONS 9

Size reduction-Crushing and grinding, Equipments and Uses- Solidfluid separations, Equipment and industrial uses, Gas-solid separations-Equipment and industrial uses. Solid handling-conveyors types and uses.

UNIT III FUNDAMENTALS OF FLUID MECHANICS 9

Definition of fluids-compressible and incompressible fluids-Physical properties of fluids-density, specific weight, specific volume, viscosity-Compressible fluids and incompressible fluids-ideal and real fluids- Pressure Measurement Manometers-U-tube manometer

UNIT IV BASICS OF HEAT TRANSFER 9

Heat Transfer –Modes of heat transfer-Principles of conduction, convection and radiation Various types of heat exchange equipment cooler, condenser, chiller, exchanger-heater, reboiler- evaporator

UNITV BASICS OF PROCESS CALCULATIONS 9

Basic concepts: Units and Dimensions, systems of units, conversion and conversion factors of units, concept of mole, weight percent, mole percent, simple problems, Field study of unit operations in chemical industry

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end ofthe course the students would be able to

CO1 :	Understand the concepts of unit operations and unit processes.
CO2 :	Apply the principles of size reduction, separation and transportation for handling solids in Chemical process industries.
CO3:	Comprehend the importance of fluid properties, types of fluids and select the manometers for pressure measurement.
CO4:	Familiarize with modes of heat transfer and acquire knowledge on types of heat exchangers.
CO5:	Understand and apply the concepts of units and dimensions, mole, weight percentage, mole percentage in process calculations
CO6:	Understand the concepts of Compressible fluids and incompressible fluids

TEXT BOOKS:

1. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, 2nd edition, Affiliated East-West press, 1993.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, 1997.
3. D.C. Sikdar ," Chemical Process Calculations", PHI Learning Private Limited, 2013

REFERENCE BOOKS:

1. J.M.Coulson and J.F.Richordson, "Chemical Engineering Vol-1 & II", Sixth Edition Butterworth, New Delhi, 2000.
2. G.G. Brown, "Unit Operations", Wiley International Edition, 1960.
3. W.L. McCabe and J.C .Smith. "Unit operations of chemical Engineering", 6th edition, McGraw Hill Book.co.Singapore-2001.
4. Randolph Norris Shreve, George T. Austin, "Shreve's Chemical Process Industries", 5th edition, McGraw Hill, 1984.
5. S.Pushpavanam, "Introduction to Chemical Engineering", PHI Learning Private Limited, 2012

		L	T	P	C
U23PHT26	PHYSICS OF MATERIALS (COMMON TO AGRI, BME, BIOTECH, CHEM, FOOD PHARMA PROGRAMMES)	3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To expand their knowledge in applications of magnetic and superconducting materials in small scale industries.
3. To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.

UNIT I CONDENSED MATTER PHYSICS 9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II MAGNETIC AND SUPER CONDUCTING MATERIALS 9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials- Applications.

Super Conducting Materials: Properties – Type I and Type II Super Conductors – London equations – Applications: Magnetic Levitated Train – Magnetic Resonance Imaging.

UNIT III MODERN ENGINEERING MATERIALS 9

Shape Memory Alloys – Structures – Properties – Applications. Metallic Glasses – Preparation and Applications. Ceramics – Types - Properties and Applications.

Nano Materials – Types – Properties and Applications – Preparation Techniques: Electrodeposition – Pulsed Laser Deposition. CNT – Structure – Types – Properties - Applications

UNIT IV INSTRUMENTATION PHYSICS 9

X – rays – Production – Diffraction of X – rays – Laue'e experiment – Bragg's law – Bragg's X – ray Spectrometer – Diffraction methods – Laue method – Rotating Crystal method – Powder Crystal method.

Optical microscope – Electron microscope – Scanning electron microscope – Transmission electron microscope – EDAX – FTIR.

UNIT V RADIOACTIVE MATERIALS 9

Nucleus: Classification, Properties – Radioactivity – Alpha, Beta and Gamma rays – Properties – Laws of disintegration – Half-life period – Mean life -Neutron and its properties.

Artificial radioactivity – Applications and hazards of nuclear radiations – Detectors of Nuclear radiations: Solid State detectors – Proportional Counter – Geiger-Muller Counter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Know basics of crystallography and its importance for varied materials properties.

CO2 : Gain knowledge on the magnetic and superconductor properties of materials and their applications.

CO3: Illustrate the SMA and metallic glasses.

CO4: Gain knowledge in the development of instruments.

CO5: Get knowledge about radioactive materials.

CO6: Understand the concept of detectors and counters.

TEXT BOOKS:

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019
2. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
3. Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
4. Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.

REFERENCE BOOKS:

1. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
2. S. Rajivgandhi, Dr. I. Cicil Ignatius & A. Ravikumar, “ Engineering Physics II”, RK Publications, 2023
3. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.
4. Dr. G. Senthilkumar, A. Ravikumar & S. Rajivgandhi, “ Engineering Physics II”, VRB Publishers, 2023

NCC Credit Course Level 1		L	T	P	C
		2	0	0	2
(NAVAL WING) NCC Credit Course Level - I					
NCC GENERAL					**6**
NCC 1	Aims, Objectives & Organization of NCC				1
NCC 2	Incentives				2
NCC 3	Duties of NCC Cadet				1
NCC 4	NCC Camps: Types & Conduct				2
NATIONAL INTEGRATION AND AWARENESS					**4**
NI 1	National Integration: Importance & Necessity				1
NI 2	Factors Affecting National Integration				1
NI 3	Unity in Diversity & Role of NCC in Nation Building				1
NI 4	Threats to National Security				1
PERSONALITY DEVELOPMENT					**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving				2
PD 2	Communication Skills				3
PD 3	Group Discussion: Stress & Emotions				2
LEADERSHIP					**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code				3
L 2	Case Studies: Shivaji, Jhasi Ki Rani				2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT					**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth				3
SS 2	Protection of Children and Women Safety				1
SS 3	Road / Rail Travel Safety				1
SS 4	New Initiatives				2
SS 5	Cyber and Mobile Security Awareness				1

GE3252	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

Prerequisite: Tamil language, Unicode, NLP, Tamil computing tools, machine translation, speech recognition.

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3252 **L T P C**

தமிழரும் தொழில்நுட்பமும் 1 0 0 1

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III <u>உற்பத்தித் தொழில் நுட்பம்</u>: 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV <u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>: 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V <u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>: 3

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL:15PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

WEB RESOURCE:

1. http://www.tamilvu.org/

U23EEP24	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Conducting load tests electrical machines
2. Practical experience in experimentally obtaining the characteristics of electronic devices
3. experimentally obtaining the characteristics of rectifiers
4. To train the students to measure three phase power
5. To train the students to measure three phase displacement

LIST OF EXPERIMENTS

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	DC Regulated Power supply (0 - 30 V)	1
2.	Three Phase Variable Load	1
3.	DC Shunt Motor	1
4.	DC Shunt Motor coupled with DC shunt Generator	1
5.	Single phase Induction motor	1
6.	PN Diode andZener diode	1
7.	Transistor, SCR and MOSFET	1
8.	Diodes	1
9.	LVDT Kit	1
10.	Ammeters	As Required
11.	Voltmeters	As Required
12.	Rheostat	As Required
13.	Tachometer	As Required
14.	Connecting wires	As Required

COURSE OUTCOMES:

At the end ofthe course thestudentswouldbeableto

CO1 : Use experimental methods to verify the Ohm's law

CO2 : Use experimental methods to verify the Kirchhoff's Law

CO3: Use experimental methods to measure threephase power

CO4: Analyze experimentally the load characteristics of electrical machines

CO5: Analyze the characteristics of basic electronic devices

CO6: Use LVDT to measure displacement

U23HSP22	COMMUNICATION LABORATORY	L	T	P	C
	(COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	0	0	2	2

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2. To be able to communicate effectively through writing.
3. Encouraging plan designing and decision making.
4. Understanding and writing technical instruction.
5. To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1. Speaking-Role Play Exercises Based on Workplace Contexts.
2. Talking about competition.
3. Discussing progress toward goals-talking about experiences.
4. Discussing likes and dislikes.
5. Discussing feelings about experiences.
6. Discussing imaginary scenarios.
7. Writing short essays.
8. Speaking about the natural environment.
9. Describing communication system.
10. Describing position and movement- explaining rules.
11. Understanding technical instructions-Writing: writing instructions.
12. Speaking: describing things relatively-describing clothing.
13. Discussing safety issues (making recommendations) talking about electrical devices.
14. Describing controlling actions.
15. Writing a job application (Cover letter + Resume).

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 : Distinguish their technical competency through language skill.

CO2 : Predict context effectively in-group discussions held in a formal / semi-formal discussions.

CO3: Understanding candidates' key characteristics.

CO4: Finding personality traits by sharing and comparing thoughts and ability.

CO5: Understanding the value of ethics.(rules and regulations).

CO6: Construct emails and effective job applications**.**

U23GEP13	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. understand the problem solving approaches.
2. learn the basic programming constructs in Python.
3. practice various computing strategies for Python-based solutions to real world problems.
4. use Python data structures - lists, tuples, dictionaries.
5. To do input/output with files in Python.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)

9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Intel Desktop System With Suitable software	30

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop algorithmic solutions to simple computational problems

CO2 : Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems.

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

U23MAT31	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

1. To introduce the basic concepts of PDE for solving standard partial differential equations.
2. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4. To acquaint the student with Fourier, transform techniques used in wide variety of situations.
5. 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 9+3

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- 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 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 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

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 (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORM 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 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

COURSE OUTCOMES:

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

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

4. 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.
5. 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", 44thEdition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018.

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, 2021.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, 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 EducationPvt. Ltd, 6th Edition, New Delhi, 2012.

U23CHT31	BASIC MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines.

UNIT I FIRST LAWS OF THERMODYNAMICS 9

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II SECOND LAWS OF THERMODYNAMICS 9

Joule's experiment, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator,Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and it calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.

UNIT III THERMODYNAMIC PROPERTIES 9

Thermodynamic properties – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams.

UNIT IV HEATING AND EXPANSION OF GASES 9

Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT V AIR STANDARD CYCLES 9

Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On Completion of the course, the students would

CO1: Understand the basic concepts and Laws of thermodynamics and its applications.

CO2: Apply second law and analyse the feasibility of system/devices.

CO3: Analyse the thermodynamic property relations and their application to fluid flow.

CO4: Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries.

CO5: Understand the various thermodynamic cycles with its derivation.

CO6 : Understand the engine operating systems and fuel selection process.

TEXT BOOKS:

1. Nag, P.K., "Engineering Thermodynamics ", IInd Edition, Tata McGraw Hill Publishing Co., Ltd., 1995.
2. Smith J.M., VanNess,H.C., &Abbot M.C," Introduction to Chemical Engineering Thermodynamics",McGraw Hill VII Edition 2009.
3. Rao Y.V.C.,"Chemical Engineering Thermodynamics"Universities Press, 2005.

REFERENCES:

1. Bhaskaran, K.A., and Venkatesh, A., "Engineering Thermodynamics ",Tata McGraw Hill, 1973.
2. Khurmi R.S., and Gupta J.K, "Thermal Engineering", S.Chand & Company (P) Ltd.,2001.
3. Kothandaraman and Dhomkundwar,": A course in Thermal Engineering (SI Units)", Dhanpat.

U23CHT32	INDUSTRIAL AND ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop an understanding of the basic concepts of Adsorption and surface activity.
- Preparation, properties and applications of engineering materials.
- Principles and basics of dye and drug manufacturing.

UNIT I BIO CHEMISTRY 9

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

UNIT II ADSORPTION AND SURFACE CHEMISTRY 9

Adsorption, Adsorption Isotherms –Langmuir, Freundlich and BET, Gibbs adsorption isotherm – derivation. Colloids –,Protective colloids, Gold number, Zeta potential, Emulsion, Micelles-Critical micelle concentration, Micellar catalysis. Surfactants.

UNIT III NUCLEAR AND PHOTOCHEMISTRY 9

Radioactivity, Nuclear chain reaction, Nuclear power plant contract Breeder Reactor, Nuclear reaction cross-section. Liquid drop model, nuclear fission. Medical isotopes, Consequences of light absorption- Jabalonski diagram. Fundamentals Laws of photochemistry. Chemiluminescence and bioluminescence.

UNIT IV DYE CHEMISTRY 9

Witt's theory and modern theory of colors – Synthesis of Methyl red, Methyl orange, Congo red, Malachite green, para-rosaniline, phenolphthalein, fluorescence, Classification of dyes,Eosin dyes.

UNIT V PHARMACEUTICAL CHEMISTRY 9

Terminology and synthesis of Antimalarial drugs – chlorophenol and chloroquine Synthesis of Antibacterial drugs – Sulphaniliamide and Sulphapyridine.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able:

CO1 :To infer the quality of water from quality parameter data and properties of Amino acids

CO2 :To identify and apply basic concepts of Adsorption Isotherms in designing the synthesis of Critical micelle concentration and technology applications.

CO3 :To apply the knowledge of Fundamentals Laws of photochemistry selection requirements.

CO4 :To recommend Synthesis of Methyl red, Methyl orange processes and applications.

CO5 :To synthesis of Antimalarial drugs and Sulphaniliamide.

CO6 : To analyze the various chemical properties of fuels.

TEXT BOOKS:

1. B. R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2013.
2. R. L. Madan and G. D. Tuli Physical Chemistry, published by S. Chand Publishing, Edition 2016.

REFERENCES:

1. A. Bahl, B. S Bhal and G D Tuli, Essentials of Physical Chemistry, S. Chand Publishing, Edition 2010.
2. P.C. Jain and Monika Jain, " Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi,2015.
3. Shenai V.A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai,1995.

U23CHT33	CHEMICAL PROCESS CALCULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students 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 INTRODUCTION 9

Base and derived Units - Composition of Mixture and solutions — molality, molarity, normality, mole fraction, mass fraction; Application of Dalton's law and Amagat's law for gas mixture calculation; calculations of pressure, volume and temperature using idealgas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

UNIT II MATERIAL BALANCE 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 HUMIDIFICATION 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 ENERGY BALANCE 9

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, Hess's law of summation, 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 – Theoretical flame Temperature.

UNIT V COMBUSTION 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

COURSE OUTCOMES:

On completion of the course, the students would be able to

CO1: Compute the composition of mixture and solution; apply ideal gas law.

CO2: Calculate the mass/ molar flow rate and composition of streams for diverse unit operation.

CO3: Apply stoichiometric principles to various unit process, bypass, purge and recycle operation.

CO4: Analyze the enthalpy change and adiabatic flame temperature for given system.

CO5: Examine the calorific value of fuel, composition of fuel and flue gas and percentage excess air.

CO6 : Understand the fundamentals ideal gas behavior and material balance.

TEXT BOOKS:

1. Narayanan K.V., Lakshmikutty B, "Stoichiometry and Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2016.
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”,5 th Edn., John Wiley & Sons, New York, 2005.
4. 4. V.Venkataramani, N.Anantharaman and K.M. Meera Sheriffa Begum, 2nd dn., ’Process Calculations’ Prentice Hall of India Ltd, New Delhi. 2013.

REFERENCES:

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

U23CHT34	FLUID MECHANICS FOR CHEMICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries

UNIT I FLUID FLOW PHENOMENA 9

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

UNIT II KINEMATICS OF FLUID FLOW 9

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

UNIT III DIMENSIONAL ANALYSIS 9

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

UNIT IV TRANSPORTATION OF FLUIDS 9

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

UNIT V METERING OF FLUIDS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the students would be able to

CO 1 : To analyze the fluid flow problems.

CO 2 :Understand the fundamental properties of fluids and its characteristics under static conditions.

CO 3 :Develop empirical correlation using dimensionless analysis.

CO 4 :Analyze flow of fluid through pipe and over the of solid,

CO 5 :Understand and select flow meter(s), characteristics of pumps used in Chemical Process Industries .

CO6 :Applying momentum and energy equations incorporating relevant principles.

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Third Edition, McGraw-Hill, (2017).

2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2017.

3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 9th Edition", John Wiley, 2021.

REFERENCES:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.

2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999).

U23CHT35	CHEMICAL PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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 INTRODUCTION - OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 9

Introduction to Chemical Engineering and chemical industries, role of Chemical Engineers, Classification of unit operations and unit processes - Construction of block diagrams and process flow diagram. Oil and Fat — Occurrence and Extraction, Physical and chemical characteristics, Analysis of oil/fat and Uses, hydrogenation of oil. Manufacture of soap and detergent

UNIT II INORGANIC ALKALIS AND ACIDS INDUSTRIES 9

Manufacture of sodium chloride, soda ash, sodium bicarbonate, caustic soda and chlorine, hydrochloric acid, sulfuric acid, phosphoric acid, nitric acid.

UNIT III FERTILIZER INDUSTRIES 9

Manufacture of ammonia, urea, ammonium phosphate, ammonium sulphate, single and triple super phosphate, potassium nitrate, potassium sulphate and potassium chloride- compound fertilizers, Liquid fertilizers – Bio Fertilizers. Introduction to pesticides, herbicides.

UNIT IV POLYMER AND FIBER INDUSTRIES 9

Polymerization technology - Manufacture of polyethylene, polypropylene, polystyrene PVC, nylons 6, nylons 66, polyesters, ABS and SBR, vulcanization of rubber, manufacture of cellulose fiber, Viscous Rayon production

UNIT V MISCELLANEOUS CHEMICAL INDUSTRIES 9

Agro based industries - Sugar industries, Pulp and Paper industries, Manufacture of cement - Manufacture of glass - Paint industries- Constituents, Manufacture of white glass enamels, red oxide primer and exterior emulsion paint.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1: Explain the role of chemical engineers and develop the process flow diagram

CO2: Sketch and explain the production of alkali-based products and mineral acids

CO3: Illustrate the manufacturing process of chemical fertilizers using flow diagram

CO4: Describe the manufacturing process of polymer and allied product with the help of process flow sheet

CO5: Draw a process flow diagram and elaborate production of sugar, paper and pulp, cement, glass and paint

CO6: Identifies and solve engineering problems during production.

TEXT BOOKS:

1. Gopala Rao M. and Marshall Sittig, "Dryden's Outlines of Chemical Technology", 3rd Edition, East West Press, New Delhi, 2008.
2. George T. Austin, "Shreve's Chemical Process Industries", 8th Edition, McGraw Hill International Editions, Singapore, 2002.

REFERENCES:

1. Srikumar Koyikkal,"Chemical Process Technology and Simulation", 3rd Edition, PHI Learning Ltd., 2013.
2. Shukla and G.N. Pandey "Text book on Chemical Technology", 2nd Edition, Vikas Publishing Company, 2001.

U23CHP31	BASIC MECHANICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

The course is aimed to

- Impart practical knowledge in operating IC engines and conduct experiments.
- To make the students understand the test procedures in testing material for engineering applications

LIST OF EXPERIMENTS :

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

***Minimum 10 experiments shall be offered**

LIST OF EQUIPMENTS :

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	2 stroke I C Engines	**1**
2	4 stroke I C Engines	**1**
3	4-stroke petrol engine	**1**
4	4-stroke single cylinder diesel engine	**1**
5	4-stroke twin cylinder diesel engine	**1**
6	Universal Testing Machine	**1**
7	Impact test machine	**1**
8	Torsion test machine	**1**
9	Rockwell hardness test machine	**1**
10	Brinell hardness test machine	**1**
11	Spring test machine	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.

CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.

CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.

CO4: Evaluate the heat distribution from engine and preparing heat balance chart.

CO5: Estimate the engine performance with mechanical loading.

CO6: Estimate the PTD and VTD of two and four stroke engines

U23CHP32	TECHNICAL ANALYSIS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of nitrite in water, cement, oil.
- To gain knowledge of organic synthesis.

LIST OF EXPERIMENTS :

1. Determination of Redwood/ Saybolt numbers, kinematics viscosity and viscosity index of lubricating oils.
2. Determination of flash point of oils.
3. Determination of cloud and pour point of oils.
4. Determination of iodine value of oils.
5. Estimation of silica content in cement.
6. Soap Analysis a. Estimation of total fatty acids b. Estimation of percentage alkali content.
7. Determination of nitrite in water.
8. Analysis of carbohydrates.
9. Analysis of proteins.
10. Quantitative analysis of organic compounds-
    a. Identification of aliphatic/aromatic compounds
    b. Identification of saturated and unsaturated compounds
11. Identidification and characterization of various functional groups
    a. alcohol
    b. ketone
    c. primary,secondary and tertiary amines.
    d. nitro compounds
12. Determination of acid value in the given oils.
13. Introduction to organic synthetic procedures
    a.Acetylation – Preparation of acetanilide from aniline.
    b. Hydrolysis – preparation of salycilic acid from methyl salycilate

***Minimum 10 experiments shall be offered**

LIST OF EQUIPMENTS :

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	Redwood viscometer	**1**
2	Say bolt viscometer	**1**
3	Pensky Martens closed cup apparatus	**1**
4	Cloud and pour point apparatus	**1**
5	Desiccators Apparatus	**5**
6	Silica Crucible	**20**
7	Heating Mantle	**3**
8	Hot air oven	**1**
9	Vacuum Pump	**1**
10	condenser	**10**
11	Reflux condenser	**10**
12	Bomb calorimeter	**1**
13	Cleveland open cup apparatus	**1**
14	COD Reflux	**1**
15	Orsat apparatus	**1**
16	UV – V is Spectrophotometer	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of the course, the students would be able to

CO1. Understand the various techniques involved in organic sysnthesis.

CO2. Determine the properties and characteristics of solvents and mixture.

U23CHT41	INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To understand the theory of elasticity including strain/displacement and Hooke‘s lawrelationships
- To solve for stresses and deflections of beams under unsymmetrical loading.

UNIT I UV SPECTROSCOPY AND NMR SPECTROSCOPY 9

Characteristics of electromagnetic radiations - Definition-wave length, wave number, frequency, energy. The absorption laws - Theory of electronic spectroscopy - Double beam spectrophotometer. Chromospheres - Auxochrome - Types of absorption bands - Absorption and intensity shifts -Applications.Theory - number of signals - Instrumentation - Chemical shift

UNIT II IR SPECTROSCOPY AND MASS SPECTROSCOPY 9

Theory - Vibrational frequency - Number of fundamental vibrations - Hook's law Scanning of IR spectrum - Applications .Basic principles - Theory - Instrumentation - Nitrogen rule - Molecular ion - McLafferty rearrangement - Applications.

UNIT III SEPARATION METHODS 9

Principles of solvent extraction - Extraction techniques - Analytical applications. Principles of chromatography - Different types - Thin layer, column and gas chromatography. Radio chemical methods - Activation analysis - Isotopic dilution methods

UNIT IV THERMAL METHODS AND ELECTROCHEMICAL METHOD 9

Principles of Thermogravimetry - Factors influencing the thermogram - TGA instrument - Applications of TGA - DTA - Definition — Instrumentation - Thermal analysis of calcium oxalate monohydrate and calcium acetate monohydrate - Applications of DTA. Principles of polarography - Half wave potential – Factors affecting the limiting current - Applications of polarography.

UNIT V PRINCIPLES OF GRAVIMETRIC ANALYSIS 9

Methods of obtaining the precipitate - Conditions for precipitation - Choice of precipitants - Advantages of using organic precipitants - Disadvantages - Types of organic precipitants - Specific and selective precipitants - Sequestering agents. Theories of precipitation - Co-

precipitation - Post- precipitation. Effects of digestion - General rules for precipitation - Precipitation from homogeneous medium - Washing of precipitates - Drying of precipitates.

TOTAL : 45 PERIODS

COURSE OUTCOME:

On the completion of the course students are expected to

CO1: Identify the structure of the organic compound from the spectroscopic studies

CO2: Discuss about types of precipitants, their advantages and disadvantages

CO3: Interpret the thermal stability from TGA

CO4: Illustrate flow and viscosity measurement techniques related to production industries.

CO5: Predict the nature of the organic compounds from the various spectroscopic tests CO6: Select suitable measurement instruments required in chemical & petrochemical industries based on learning.

TEXT BOOKS:

Sharma B.K., Instrumental methods of chemical analysis, Eighteenth Edition, GOEL publishingHouse. 2002.

Ewing G.W., Instrumental methods of Chemical Analysis, Fifth Edition, McGraw Hill, New York,1992.

REFERENCE BOOK :

1. Skoog D.A., - Pinciples of Instrumental Analysis, Sixth Edition, Saunders College Publication,2007.

Williard H.H., Meritt L.C and Dean J.H., - Instrumental Methods of Analysis, Sixth Edition, 1990.

U23CHT42	MASS TRANSFER I	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is aimed to enable the students

- Learn and determine mass transfer rates under laminar and turbulent conditions

and apply these concepts in the design of humidification columns, dryers and crystallisers.

UNIT I MOLECULAR DIFFUSION 9

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

UNIT II CONVECTION TRANSFER & INTERPHASE MASS TRANSFER 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. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III HUMIDIFICATION OPERATIONS 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 DRYING 9

Drying – Equilibrium. Classification of dryers-batch drying – Mechanism and time of cross through circulation drying- theoretical estimation of drying rate and time. Continuous dryers – material and energy balance. Advance drying techniques such as freeze drying-microwave drying.

UNIT V CRYSTALLIZATION 9

Crystal geometry. Equilibrium- yield and purity of products, theory of super saturation, nucleation and crystal growth- classification of crystallizers-design of batch crystallizers and continuous crystallizers.

TOTAL : 45 PERIODS

COURSE OUTCOME:

On the completion of the course students are expected to

CO1: Understand the fundamentals, types and mechanism of mass transfer operations.

CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer.

CO3: Understand the basics of humidification process and its application.

CO4: Understand the concept and mechanism of drying operations.

CO5: Understand the concept of crystallization process and identification of suitable Crystallizer.

CO6: Formulate and solve material balances for unit operations such as humidification, drying and crystallization operations.

TEXT BOOKS:

1. Treybal, R. E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill,2017. 72
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., NewJersey, 2003
3. Narayanan K.V. and Lakshmikutty, B "Mass Transfer – Theory and Applications", 1st Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2014.

REFERENCE:

1. McCabe, W.L., Smith, J.C., and Harriot, P.,"Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 5th Edition, Asian Books Pvt. Ltd., India, 2002.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 4th Ed., John Wiley, 2016.

U23CHT43	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impact knowledge in the field of particle size reduction and also construction and working of equipment's used for mechanical operations.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT **9**

General characteristics of solids-different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor-surface area determination-estimation of particle size. Advanced particle size analysis techniques-Screening methods and equipment-screen efficiency-ideal and actual screens.

UNIT II PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT **9**

Laws of size reduction- energy relationships in size reduction-methods of size reduction, classification of equipments-crushers, grinders, disintegrators for coarse, intermediate and fine grinding-power requirement, work index; Advanced size reduction techniques – Nano particle fabrication - Top-down approach - Bottom-up approach. Size enlargement – Importance of size enlargement, principle of granulation, briquetting, palletization, and flocculation. Fundamentals of particle generation.

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

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

UNIT IV FILTRATION AND FILTRATION EQUIPMENTS **9**

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

UNIT V MIXING AND PARTICLE HANDLING 9

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

TOTAL : 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand and determine various properties of particulates

CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement

CO3: Understand various separation and purification techniques employed in solid particles

CO4: Enhance their knowledge on Filtration Process

CO5: Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications.

CO6 :Describe size reduction energy requirements and analyze filtration data.

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles ofUnit Operations", 2nd Edn., John Wiley & Sons, 1994.
4. Hiroaki Masuda , KoHigashitani and Hideto Yoshida, Powder Technology Handbook,3rd Edition.

REFERENCE:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. II, 4th Edn., Asian Books Pvt. Ltd., India, 1998.
2. Christie J. Geankoplis, Transport processes and unit operations.
3. Sunggyu Lee, Kimberly H. Henthorn, Particle Technology and Applications.
4. Martin Rhodes, Introduction to Particle Technology, Second Edition.

U23CHT44 CHEMICAL ENGINEERING THERMODYNAMICS L T P C

3 1 0 3

OBJECTIVES:

- This course helps the students to be proficient in applying thermodynamic principles to various chemical engineering processes involving energy flow, phase and reaction equilibrium.

UNIT I PROPERTIES OF SOLUTIONS 9

Introduction to ideal and non-ideal solutions, Partial molar properties, chemical potential, effect of temperature and pressure on chemical potential, fugacity and fugacity coefficient in solution, Lewis Randell rule, Raoult's law, Henry's law, activity and activity coefficients in solutions, effect of temperature and pressure on activity coefficients, Gibbs Duhem equations, applications, property changes on mixing, heat effects of mixing processes, excess properties, relation between excess Gibbs free energy and activity coefficient.

UNIT II PHASE EQUILIBRIA 9

Criteria for equilibrium between phases in single and multi-component non-reacting systems in terms of chemical potential and fugacity, phase rule & its application, Duhem's theorem, vapour-liquid equilibrium, phase diagrams for homogeneous systems. VLE in ideal solutions, non-ideal solutions, positive and negative deviation, azeotropes, effect of temperature and pressure on azeotrope composition, Pxy and Txy diagrams.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9

Simple models for VLE, VLE at low pressures,Wohl ‟sequation, Van Laarequation, Wilson equation, application of activity coefficient equations in equilibrium calculations, basic idea on NRTL, UNIQUAC and UNIFAC, Dewpoint and bubblepoint calculations with Raoult's law for binary mixtures, VLE by modified Raoult's law, VLE from K-value Correlations.

UNIT IV APPLICATION OF PHASE EQUILIBRIA 9

Excess Gibbs free energy model, thermodynamic consistency of phase equilibria,application of the correlation and prediction of phase equilibria in distillation process. Liquid-liquid equilibrium, binary and ternary equilibrium diagrams, use of triangular diagrams for ternary equilibrium, Different types of ternary systems and their representation on triangular coordinates. Introduction to VLLE, solid vapor equilibrium, solid liquid equilibrium.

UNIT V CHEMICAL REACTION EQUILIBRIA 9

Chemical reaction equilibria, reactions toichiometry, criteria of chemical equilibrium, equilibrium constant,standard free energy change, standard state, feasibility of reaction, effect of temperature on equilibrium constant, Giauque Functions, evaluation of K, equilibrium conversion in gas phase reactions, effect of pressure on equilibrium constant, effect of pressure, Inert materials, excess of reactants & products on equilibrium composition. phase-rule for reacting systems

TOTAL : 45 PERIODS

COURSE OUTCOME:

On completion of the course, student will be able to

CO1 : Apply fundamental concepts of thermodynamics in solutions.

CO2 : Application of thermodynamics to phase equilibria.

CO3 : Apply thermodynamics concept to predict phase equilibria.

CO4: VLE calculations.

CO5: Understand other equilibrium process in chemical engineering.

CO6: Application of thermodynamics to reaction equilibria.

TEXT BOOKS:

1. Smith, J.M. and Van Ness, H.C., Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill, 2005.
2. Narayanan K.V., A Text Book of Chemical Engineering Thermodynamics, 3rd Edition,
3. Prentice Hall of India Pvt. Ltd. 2013.

REFERENCE:

1. Gopinath Halder, Introduction to Chemical Engineering Thermodynamics, 2nd Edition, PHI Learning Pvt. Ltd., 2009.
2. Rao Y.V.C., Chemical Engineering Thermodynamics, 3rd Edition, University Press (I) Ltd., Hyderabad, 2004.

U23CHT45	HEAT TRANSFER	L	T	P	C
		3	1	0	3

OBJECTIVES:

The course is aimed to

- Teach the fundamental concepts of heat transfer via conduction, convection, radiation, boiling and condensation and its application to the students

UNIT I CONDUCTION 9

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer ; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement - effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction.

UNIT II CONVECTION 9

Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate.

UNIT III CONDENSATION ,BOILING AND RADIATION 9

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces.

UNIT IV EVAPORATION 9

Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring's rule.

UNIT V HEAT EXCHANGER 9

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers.

TOTAL : 45 PERIODS

COURSE OUTCOME:

On the completion of the course students are expected to

CO1: Familiarize with the fundamental concepts of Heat Transfer. Provide the student with knowledge about heat transfer by conduction in solids for steady state.

CO2: Understand convect ive heat transfer and use of heat transfer coefficients for laminar and turbulent flows.

CO3: Have knowledge about boundary layer flow, laminar and turbulent flows.

CO4: Calculate and use overall heat transfer coefficients in designing heat exchangers.

CO5: Have knowledge about heat transfer with phase change (Boiling and condensation) and evaporation.

CO6: Understand radiative heat transfer including blackbody radiation and Kirchoff'slaw, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems.

TEXT BOOKS:

1. Holman, J. P., 'Heat Transfer ', 10th Edn., McGraw Hill,2010.
2. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984.
3. Kern, D.Q., "Process Heat Transfer ", McGraw-Hill, 1999.
4. B.K. Dutta, Heat transfer principles and applications, PHI Learning PVT Ltd, 2016.

REFERENCE:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering",6th Edn., McGraw-Hill, 2001.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

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U23GET41	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	2

OBJECTIVES:

- To the study of nature and the 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 envisions the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.

UNIT I ECOSYSTEM AND BIODIVERSITY 9

Definition, Scope and importance of environment – Need for public awareness. Eco-system- Types 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 9

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 9

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 ENVIRONMENTAL ISSUES 9

Social Issues and possible solutions – climate change, global warming, acid rain,ozone layer depletion, nuclear accidents and holocaust - Population growth, variation among nations population explosion – family welfare programme – human rights – value education – HIV / AIDS – women and child welfare

UNIT V SUSTAINABILITY PRACTICES 9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Development, GDP, Sustainability- 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- economic and technological change.

TOTAL : 45 PERIODS

COURSE OUTCOME:

On the completion of the course students are expected to

CO1: Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection.

CO2: One will obtain knowledge on the following after completing the course.

CO3: Public awareness of environmental is at infant stage.

CO4: Ignorance and incomplete knowledge has lead to misconceptions

CO5: Development and improvement in std. of living has lead to serious environmental Disasters.

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition,Pearson Education, 2004.
2. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and CaseStudies, Prentice Hall.
3. Dr.J. Manivel and Dr.A. Arunkumar, "Environmental Science & Engineering" R.K.Publishers, 1st Edition 2023.

REFERENCE:

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. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
4. Erach Bharuch "Textbook of Environmental Studies for Undergraduate Courses" OrientBlackswan Pvt. Ltd. 2013.

U23CHP41	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To enable the students 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**

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	VISCOMETER	1
2	VENTURIMETER	1
3	ORIFICE METER	1
4	ROTAMETER	1
5	WEIR AND NOTCHES	1

6	OPEN DRUM WITH ORIFICE	1
7	PIPES AND FITTINGS	1
8	HELICAL AND SPIRAL COILS	1
9	CENTRIFUGAL PUMP/GEAR PUMP/RECIPROCATING	1
10	PACKED COLUMN	1
11	FLUIDIZED BED	1

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines.

CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines.

CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines.

CO4: Evaluate the heat distribution from engine and preparing heat balance chart.

CO5: Estimate the engine performance with mechanical loading.

CO6: Estimate the PTD and VTD of two and four stroke engines

U23CHP42 MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES:

The course is aimed to

- Develop sound practical knowledge on different types of mechanical operations equipments.

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
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

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	SIEVE SHAKER	1
2	LEAF FILTER	1
3	PLATE AND FRAME FILTER PRESS	1
4	SEDIMENTATION JAR	1
5	JAW CRUSHER	1
6	BALL MILL/PULVERIZER/HAMMER MILL	1
7	CYCLONE SEPARATOR	1
8	ROLL CRUSHER	1
9	ELUTRIATOR	1
10	DROP WEIGHT CRUSHER	1
11	TEST SIEVES	1

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the size analysis in solid- solid separation systems.

CO2: Capability to select different solid - fluid separation equipments.

CO3: Evaluate the size reduction and various crushing parameters.

CO4: Estimate the separation characteristics.

CO5: Understand the technical methods related to unit operations in process plant.

CO6 : Estimate the Drop Weight Crusher

U23CHT51	PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control. First order systems and their transientresponse 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 pneumaticand 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-N tuning rules, C-C tuningrules.

UNIT V ADVANCED CONTROL SCHEMES 9

Intro Feedback control of systems with dead time and inverse response. Control systems with multipleloops. Advanced Control Schemes a) Feed forward b) ratio control. control of distillation towers and heat exchangers,

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and discuss the importance of process control in process operation and the role ofprocess control engineer

CO2: Understand and design the modern hardware and instrumentation needed to implement process control.

CO3: Explain the fundamentals of loop systems

CO4: Describe the frequency of response.

CO5: Illustrate the concepts of advanced control systems.

CO6: Basics of dynamics and control

TEXT BOOKS :

1. Coughnowr, D., ― Process Systems Analysis and Control ―, 3rd Edn., McGraw Hill, New York,2008.

REFERENCE:

1. J. Marlin, T. E., ― Process Control ―, 2nd Edn, McGraw Hill, New York, 2000.

U23CHT52	MASS TRANSFER II	L	T	P	C
		3	1	0	3

OBJECTIVES:

The course is aimed to

- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

UNIT I ABSORPTION 9

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

UNIT II DISTILLATION 9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by 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 9

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

UNIT IV LEACHING 9

Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), 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 **9**

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: apply the concept of vapour-liquid equilibrium and its application in the distillation.

CO2: analyze distillation operations through stage concept, use graphical methods to estimate the number of ideal stages in distillation operation.

CO3: Understand concept and determine the theoretical stages, number of transfer units and height requirements for a gas absorption process.

CO4: analyze extraction and leaching operations through ternary diagrams

CO5: Describe core principles of leaching, setting up mass balances,

CO6: Understand the concept of adsorption techniques, various isotherms and ion exchange Process.

TEXT BOOKS :

1. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill,2017.
2. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCE:

1. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall I nc., New Jersey, 2003.
2. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006..
3. King, C. J., "Separation Processes ", 2nd Edn., Tata McGraw-Hill 1980.

U23CHT53	CHEMICAL REACTION ENGINEERING I	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is aimed to

- Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, non-isothermal operation of reactors and gain knowledge about non ideal reactors.

UNIT I INTREPRETATION OF REACTOR DATA 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. Half-life calculation. Temperature dependent rate expression.

UNIT II DESIGN OF SINGLE IDEAL REACTORS 9

Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, and size comparison of reactors.

UNIT III DESIGN OF MULTIPLE REACTOR SYSTEMS 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 NON-ISOTHERMAL REACTIONS 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 NON IDEAL FLOW 9

The residence time distribution for chemical reactors, residence time functions and relationship between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the kinetics of homogenous reaction.

CO2: Develop performance equation and determine the conversion for different reactors.

CO3: Understand the reactor arrangement in series and parallel configuration.

CO4: Understand the design of reactor for multiple reactions.

CO5: Understand the non-isotherm operation of the reactor and gain knowledge on the residence time distribution function and analyze the non-ideality in the reactor

CO6: Understand the Half-life calculation and non-ideal reactors.

TEXT BOOKS :

1. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 2006.
2. H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008.
3. Lanny D. Schmidth The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004.

REFERENCES:

1. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013
2. G.Fronment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3 rd edition,2010
3. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981

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U23CHT54	FERTILIZER TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is aimed to

- To describe about resources of fertilizer production and classification of fertilizers.

.

UNIT I GLOBAL OUTLOOK OF FERTILIZER RESOURCES 9

Role of organic manures and Chemical Fertilizers - Types of Chemical fertilizers, growth of fertilizer industry in India, their location, energy consumption in various fertilizer processes - materials of various fertilizer processes, materials consumption in fertilizer industry.

UNIT II NITROGENOUS FERTILIZERS 9

Feed stock for production of Ammonia, Natural gas, associated gas, Coke oven gas Ammonium Sulphate, Ammonium Nitrate, Urea, Calcium Ammonia Nitrate, Ammonium chlorides Methods of Production, characteristics and specification - Storage and handling.

UNIT III PHOSPHATE FERTILIZER 9

Raw materials for the manufacture of Phosphate fertilizer - Phosphate Rock, Sulphur, Pyrites etc Processes for the production of Sulfuric and Phosphoric acid - Phosphate fertilizers, ground rock phosphate, bone meal, methods of production, characteristics and specifications for single super phosphate, triple super phosphate

UNIT IV NPK FERTILIZERS 9

NPK Fertilizers - Methods of production, Characteristics and specifications for complex fertilizers, methods of production of Ammonia phosphate, Sulphate, Di-ammonium phosphate and Nitro phosphates - NPK Fertilizers - Urea, Ammonium Phosphate, Mono ammonium Phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MIXED FERTILIZERS 9

Mixed fertilizers - Granulated mixtures – Bio fertilizers - Secondary and Micro Nutrients, Fluid Fertilizers - Controlled release fertilizers Pollution from fertilizer industry - Solid, liquid and gaseous pollution standards

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the Global fertilizers resources.

CO2: Understand the nitrogen fertilizer manufacturing..

CO3: Understand the reactor arrangement of phosphate fertilizers.

CO4: Understand the NPK fertilizers

CO5: Understand the mixed fertilizers

CO6: Understand the fertilizers technology used in agricultural field.

TEXT BOOKS :

1 1Slack, A, V., Chemistry and Technology of Fertilizers, Inter science, New York, 1998

2. Pozin, M, E., Fertilizer Manufacture, MIR Publishers, Moscow, 1986.

REFERENCES:

1. Carpentire, L. J., New Developments in Phosphate Fertilizer Technology, Elsevier, New Delhi, 1971

U23CHP51 **MASS TRANSFER LABORATORY** **L T P C**
0 0 3 1.5

OBJECTIVES:

The course is aimed to

- Develop s ound practical knowledge for students on different types of masstransfer equipment's design procedures for adiabatic reaction rates, optimum temperature progression, size of reactor.

LIST OF EXPERIMENTS*

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of forced draft dryer
7. Adsorption studies
8. Cross current leaching studies
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Demonstration of Gas – Liquid absorption

LIST OF EQUIPMENTS:

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1.	Simple distillation setup	**1**
2.	Steam distillation setup	**1**
3.	Packed column	**1**
4.	Vacuum Dryer	**1**
5.	Tray Dryer	**1**
6.	Rotary Dryer	**1**
7.	Ion exchange column	**1**
8.	Rotating disc contractor	**1**
9.	Adsorption column	**1**
10.	Absorption column setup	**1**
11.	Leaching column setup	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the diffusivity practically and compare the results with the empirical correlations.

CO2: Estimate the mass transfer rate and mass transfer co-efficient.

CO3: Evaluate the performance/calculate the parameters in different distillation processes.

CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations

CO5: Estimate the drying characteristics.

U23CHP52	HEAT TRANSFER LABORATORY FOR CHEMICAL ENGINEERS	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

The course is aimed to

- Develop sound practical knowledge for students on different types of heat transfer equipments.

LIST OF EXPERIMENTS*

1. Measurement of Thermal Conductivity of metal rod
2. Performance studies on Cooling Tower
3. Batch drying kinetics using Tray Dryer
4. Heat transfer in Open Pan Evaporator
5. Boiling Heat Transfer
6. Heat Transfer through Packed Bed
7. Heat Transfer in a Double Pipe Heat Exchanger
8. Heat Transfer in a Bare and Finned Tube Heat Exchanger
9. Heat Transfer in a Vertical and Horizontal Condenser
10. Heat Transfer in Helical Coils
11. Heat Transfer in Agitated Vessels
12. Heat transfer studies in Stefan - Boltzmann apparatus

LIST OF EQUIPMENTS:

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1.	Double Pipe Heat Exchanger	**1**
2.	Bare and Finned Tube Heat Exchanger	**1**
3.	Cooling Tower	**1**
4.	Tray Dryer	**1**

5.	Open Pan Evaporator	**1**
6.	Boiler	**1**
7.	Packed Bed	**1**
8.	Vertical and Horizontal Condenser	**1**
9.	Helical Coil	**1**
10.	Agitated Vessels	**1**
11.	Stefan - Boltzmann apparatus	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Apply the concepts of heat transfer and fluid dynamics to the operation of heat transfer equipments.

CO2: Estimate the heat transfer rate and heat transfer co-efficient.

CO3: To perform heat transfer operation and to compare observed with predicted performance.

CO4: Evaluate the performance/calculate the parameters in heat transfer equipments.

CO5: Collect and analyse the heat transfer data practically and Conduct experiments to solve complex engineering problems effectively as an individual as well as team work.

U23CHT61	CHEMICAL PROCESS ECONOMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The course deals with the thought processes, concepts, methods, and knowledge bases used by engineers to cost engineering projects and to evaluate the merit of making a particular investment, and to choose the best of a series of alternative investments to achieve a desired objective.

UNIT I PROCESS DESIGN DEVELOPMENT 9

Types of Designs, Material and Energy Balance, Equipment Sizing and Selection, Process Flow Sheet and P&I Diagrams, Selection of Plant Location and Layout, Factors affecting Plant Design.

UNIT II ENGINEERING ECONOMICS FOR PROCESS ENGINEERS, INTEREST &INVESTMENT COSTS 9

Time Value of Money, Equations for Economic Studies, Equivalence, Amortization, Capital Recovery, Depreciation- Nature of Depreciation, Methods of determining depreciation, Depletion.

UNIT III COST ESTIMATION AND ANNUAL REPORTS 9

Capital Requirements for Process Plants, Cost Indices. Equipment Costs, The William six-tenth's Factor, Service Facilities, Capital requirements for Complete Plant, The Balance Sheet, Sources of Capital, Variable Costs, Fixed Costs, Income Statement, Income Statement Ratios.

UNIT IV ECONOMICS OF INVESTMENT ALTERNATIVE 9

Economics of Selecting alternates, Annual Cost methods, Present worth method, Equivalent Alternate, Rate of Return and payout-time, Economic Production Charts, Capacity Factors, Break Even Analysis – basic assumptions – break even chart – managerial use of breakeven analysis.

UNIT V ECONOMIC BALANCE 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1 - Explain and apply the basic principles of materials and energy balances; draw and interpret pictures and diagrams depicting processes.

CO2 - Familiarize the concepts of time value of money

CO2 - Improve their ability to prepare balance sheet and profit-loss statements.

CO3 - Expose the essential features of selection of alternatives in process plants.

CO4 - Familiarize concepts of the economic balance and economic analysis of process plant.

CO5 - Familiarize concepts of the economic balance and economic analysis of process plant.

CO6- The concepts of Economic Production Charts.

TEXT BOOKS :

1. Max. S,Peters and Klaus. D Timmerhaus, Plant Design and Economics for Chemical Engineers, 5th Edition, McGraw Hill International Editions, New York, 2004.
2. Herbert E Schweyer, Process Engineering Economics, McGraw Hill, 2017.

REFERENCE:

1. Jelen F.C. and Black J.H.,Cost and Optimization Engineering, 4th Edition, McGraw Hill, 2000.
2. James.R.Couper, Process Engineering Economics, 1st Edition, Marcel Dekker Inc, New York, 2003.

U23CHT62	CHEMICAL REACTION ENGINEERING II	L	T	P	C
		3	1	0	3

OBJECTIVES: The course is aimed to

- Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.

UNIT I ADSORPTION AND CATALYTIC REACTOR 9

Catalysis and adsorption: physical properties of catalyst, surface area, void volume, solid density, volume determination, catalyst classification and preparation, catalyst promoters, catalyst inhibitors, catalyst poisons. Adsorption Isotherms Freundlich and Langumir isotherms.

UNIT II GAS SOLID NON CATALYTIC REACTOR 9

Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single and Mixed Sizes, design of fluid –particle reactors.

UNIT III GAS SOLID CATALYTIC REACTOR 9

Gas solid catalytic reaction: steps in catalytic reaction, Single site, dual site mechanisms, Langmuir Hinshelwood, Eley Rideal, Rate controlling steps. Experimental methods for determining rate, differential, integral reactor and reactor deign.

UNIT IV CATALYTIC REACTORS 9

Diffusion within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non isothermal condition.

UNIT V FLUID- FLUID NON-CATALYTIC REACTOR 9

Fluid Fluid reaction. Kinetics and design of Fluid- Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction ,Factors to select the contactor, Tower Reactor Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the gas solid non catalytic reaction and different models for non catalytic reaction.

CO2: Understand catalyst, catalyst preparation, property estimation and isotherm study.

CO3: Understand the gas solid catalytic reaction and their mechanism

CO4: Design of catalytic reactor for gas solid reaction.

CO5: Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design.

CO6: Understand the concepts of catalyst inhibitors and catalyst poisons.

TEXT BOOKS :

1. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981.

2. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 2006

H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008.

REFERENCE:

1. Lanny D. Schmidt The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004.

2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013.

3. G.F. Froment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3rd edition,2010.

U23GET61 **HUMAN VALUES AND ETHICS** **L T P C**

3 0 0 3

OBJECTIVES:

The course is aimed to

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

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 9

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

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the Human values .

CO2: Gain knowledge about engineering ethics.

CO3: Understand the fundamentals of experimens.

CO4: Understand the safety in industries.

CO5: Understand the knowledge about global issues.

CO6: Understand the concepts of ethics in a human life .

TEXT BOOKS :

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, ―Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004.

2. Mike W. Martin and Roland Schinzinger, ―Ethics in Engineering‖, Tata McGraw Hill, New Delhi, 2003.(1998).

REFERENCE:

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

U23CHP61 **CHEMICAL REACTION ENGINEERING LABORATORY**

L	T	P	C
0	0	3	1.5

OBJECTIVES:

The course is aimed to

- Develop sound practical knowledge for students on different types of reactors.

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 Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Study of temperature dependence of rate constant using CSTR.
10. Kinetic studies in Sono chemical reactor
11. Studies on Cascade CSTR
12. Kinetics of photochemical reaction
13. Demonstration of heterogeneous catalytic reaction
14. Demonstration of gas-liquid reaction
15. Determination of Activation Energy of a reaction
16. Kinetic study in semi batch reactor

LIST OF EQUIPMENTS:

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	Batch reactor	**1**
2	Plug flow reactor	**2**
3	CSTR	**1**
4	Packed bed reactor	**1**
5	PFR followed by a CSTR	**1**
6	Sono chemical reactor	**1**
7	Cascade CSTR	**2**
8	Photochemical reactor	**1**
9	Semi batch reactor	**1**
10	Temperature dependent kinetics set up	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Determine the rate constant experimentally in a batch reactor.

CO2: Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)

CO3: Study of temperature dependence of rate constant.

CO4: Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.

CO5: Determine the conversion of reactor arranged in series and the rate constant using sono and photo chemical reactors.

CO6:Understand the concepts of gas-liquid reaction.

U23CHP62	PROCESS CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- 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
17. Optimum Controller Tuning using Ziegler Nichols method

*Minimum 10 experiments shall be offered.

LIST OF EQUIPMENTS:

S.NO	NAME OF THE EQUIPMENTS	QUANTITY
1	U tube manometer with controller	**1**
2	Interacting Tank	**1**
3	Non-Interacting Tank	**1**
4	Closed loop control system	**1**
5	ON/OFF controller	**1**
6	Control valve characteristics	**1**
7	Pressure Tunner	**1**
8	Temperature tuner	**1**
9	Proportional Controller	**1**
10	Flow transmitter	**1**
11	Level transmitter	**1**
12	cascade control system	**1**

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Able to determine the response of a first order and second order system for various input.

CO2: Able to determine the response of a interacting and non- interacting system for various input.

CO3: Understand the difference between an open loop and closed loop system.

CO4: Understand the concept of three classical controller P, PI, PID controller.

CO5: Understand the concept of stability and tuning of a system.

CO6: Understand the concept of Tuning of pressure system

U23CHT71	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is aimed to

- Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.

UNIT I MOMENTUM TRANSPORT 9

Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton's law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit.

UNIT II ENERGY TRANSPORT 9

Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier's law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT III MASS TRANSPORT 9

Diffusivity, temperature and pressure effect on diffusivity, Fick's law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst.

UNIT IV EQUATIONS OF CHANGE AND THEIR APPLICATIONS 9

Momentum: Equations of continuity, motion and mechanical energy (Isothermal), Energy: Equation of energy (non-isothermal). Mass: Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component). Solutions of momentum, heat and mass transfer problems discussed under shell balance by applications of equation of change, dimensional analysis of equations of change.

UNIT V TRANSPORT IN TURBULENT FLOWS AND ANALOGIES **9**

Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.

CO2: Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions.

CO3: Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.

CO4: Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems.

CO5: Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport.

CO6: Understand the mechanisms of shell momentum balance method.

TEXT BOOKS :

1. Bird, R. B., Stewart, W. E. and Lighfoot, E. W., “Transport Phenomena”, 2nd Edn., John Wiley, 2006

2. Brodkey, R. S., and Hershey, H. C., “Transport Phenomena”, McGraw-Hill, 1987.

REFERENCE:

1. Welty, J. R., Wilson, R. W., and Wicks, C. W., “Fundamentals of Momentum Heat and Mass Transfer”, 5th Edition. John Wiley, New York,2008.

2. Slattery, J. S., “Advanced Transport Phenomena”, Cambridge University Press, London, 1999.

3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1993.

U23CHT72	PROCESS EQUIPMENT DESIGN FOR CHEMICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is aimed to

- Determine the design tool and softwares.

UNIT I INTRODUCTION

Introduction to Introduction to principles involved in the design and construction of plant, Design codes, pressure,emperature, factor of safety, corrosion allowance, weld joint efficiency factor, design loadings,Poisson‘s ratio, dilation of pressure vessels, criteria of failure, material of construction

UNIT II HEAT EXCHANGER DESIGN 9

Classification of shell and tube heat exchanger, material of construction, cleaning of heat exchangers,heat transfer fluid, agitated vessels, description of shell, tubes, bonnet and channel, pass partition plate, nozzle, baffles, tie rods, baffle spacers, flanges, gaskets and expansion joints. Energy balance,heat duty consideration and process design of double pipe and shell and tube heat exchangers

UNIT III EVAPORATOR DESIGN 9

Steam – Uses of steam – Outstanding qualities of steam – BPE – Duhring‘s rule – Principle of multiple effect evaporation – Temperature driving force – Evaporators types and its selection – Design of singleand multiple effect evaporators. Design of batch and continuous Dryers.

UNIT IV MASS TRANSFER EQUIPMENT 9

Mass Transfer Equipment‘s: Types of mass transfer equipment‘s, packed and tray type towers

UNIT V MECHANICAL DESIGN 9

Mechanical design of tall vessels for distillation and absorption columns

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the fundamentals of design

CO2: Gain knowledge about heat exchangers

CO3: Understand the fundamentals of evaporator

CO4: Convert a process and instrumentation diagram to a control block diagram

CO5: Understand the knowledge about mechanical design

CO6: Understand the concepts of design equipments.

TEXT BOOKS :

1. Ernest E. Ludwig., ―Applied Process Design for Chemical and Petrochemical Plants‖, Vol.I, II andIII, Gulf Professional Publishing, 2002..

2. Dawande, S. D., ―Process Design of Equipment‘s‖, 4th Edition, Central Techno Publications,Nagpur, 2005.

3. Coulson J M and Richardson R E, ―Chemical Engineering‖ Vol 2 and 6, Pergamon Press (1998).

REFERENCE:

1. Marlin, T.E.,- Process Control -, 2nd Edn, McGraw Hill, New York, 2000.

2. Jason L.Speyer,Walter H.Chung, Stochastic Process Estimation and Control, Pvt Ltd

U23CHP71	PROCESS EQUIPMENT DESIGN AND DRAWING LABORATORY	L	T	P	C
		3	1	0	1.5

OBJECTIVES:

The course is aimed to

- Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the Knowledge for the reactor design.

UNIT I **9**

Heat Exchangers, Condensers, Evaporators.

UNIT II **9**

Cooling Tower, Dryers.

UNIT III **9**

Absorption column, Distillation Column, Extraction Column, Adsorption column.

UNIT IV **9**

Packed bed Reactors, Pressure Vessel, Storage Vessel.

UNIT V **9**

Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of Construction and Selection of process equipments.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA

CO2: Design Cooling towers and evaporators and design evaporators and crystallizer

CO3: Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors

CO4: Calculate the design specifications of packed bed reactor and storage vessels, bins and silos

CO5: Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)

U23CHP72	COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

The course is aimed to

- Solve chemical engineering problems form core courses using Excel, MATLAB, Polymath / problem solving software tool and chemical process simulation software tool.

SUGGESTED EXERCISES

1. Friction factor, pressure drop, minimum fluidization velocity calculations
2. Settling velocity, drag coefficient, Reynolds number estimations
3. Equation of state, activity coefficient, VLE data, equilibrium conversion calculations
4. Empirical equation in fluid flow, heat and mass transfer operations
5. Solving a simple flow sheet by simultaneous approach
6. One, two and three dimensional heat conduction equations
7. Differential equation for reactors in series, non isothermal reactors, dispersion models, gravity tank
8. Partial differential equation involved in heat transfer, mass transfer, reaction engineering
9. First order and second order system in control system
10. Simulation of heat exchangers, Distillation, Absorber, Extraction column, reactors.
11. Simulation of process plant/simple flow sheet

SPECIFIC EXAMPLES :

1. Solving chemical Engineering Numerical problems (fluid flow, mechanical operations, heat transfer, mass transfer, thermodynamics and reaction Engineering problems) using Goal seek, solver, Regression function of Microsoft office Excel.
2. Solve simultaneous equation in chemical engineering by Matrix method using Microsoft office Excel.
3. Solve differential equation in chemical engineering by Runge Kutta method using Microsoft office Excel
4. Solving simultaneous equations, linear and non linear equations and differential equations in Chemical Engineering using problem solving software tool/Polymath
5. Solving Simultaneous equations, Differential equations and Partial differential Equations in Chemical Engineering using MATLAB.
6. Apply MATLAB Simulink tool to simulate Chemical process control systems with suitable examples.
7. Predictions thermodynamics properties using PROCESS SIMULATION SOFTWARE TOOL

8. Steady state simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL
9. Steady state simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL
10. Steady state simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL
11. Steady state simulation of an Absorption column using PROCESS SIMULATION SOFTWARE TOOL
12. Dynamic simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL
13. Dynamic simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL
14. Dynamic simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL

TOTAL: 60 PERIODS

TEXT BOOKS :

1. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.
2. Michael B. Cutlip, Mordechai ShachamProblem Solving in Chemical and Biochemical Engineering with, Excel, and MATLAB, 2nd Edition, Prentice Hall, 2008

REFERENCES:

1. Pradeep Ahuja Introduction to Numerical Methods in Chemical Engineering PHI New delhi, 2010
2. Amiya K.Jana, Process Simulation and Control using Aspen , PHI New delhi, 2012
3. H.S. Fogler, Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, 1999.

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Solving chemical engineering problems using different tools available in the excel software.

CO2: Solving simultaneous equation and differential equation using polymath

CO3: Solving simultaneous equation and differential equation using Matlab

CO4: Simulation of simple chemical process with controller using simulink tool

CO5: Estimation of fluid property and understand the unit operation simulation using process simulation tool.

U23CHP73	INTERNSHIP	L	T	P	C
		0	0	0	1

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 for internal evaluation.

U23CHP81	PROJECT WORK	L	T	P	C
		0	0	12	10

COURSE OBJECTIVES:

The objective of the project work is to enable the students to work in convenient groups of not more than four members in a group on a project involving theoretical and experimental studies related to Chemical Engineering. Every Project Work shall have a Guide who is a member of the faculty of Chemical Engineering of the college where the student is registered. The hours allotted for this course shall be utilized by the students to receive directions from the Guide, on library reading, laboratory work, computer analysis or field work and also to present in periodical seminars the progress made in the project.

Each student shall finally produce a comprehensive report covering background information, literature Survey, problem statement, Project work details and conclusions.

This experience of project work shall help the student in expanding his / her knowledge base and also provide opportunity to utilize the creative ability and inference capability.

TOTAL : 180 PERIODS

EVALUATION PROCEDURE

The method of evaluation will be as follows:

1	Internal Marks (decided by conducting 3 reviews by the guide appointed by the Institution)	20 marks
2	Evaluation of Project Report: (Evaluated by the external examiner appointed the University). Every student belonging to the same group gets the same mark	30 marks
3	Viva voce examination: (evaluated by the internal examiner appointed by the HOD with the approval of HOI, external examiner appointed by the University and Guide of the course – with equal Weightage)	50 marks

TOTAL:100 MARKS

U23CHV11	PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the fundamental and methodologies in the petroleum refining processes.
- To enable students to examine how each refinery process works.
- To enable students to express the objectives of petroleum refining and classify the processes used in petroleum refining.
- To enable students learn how physical and chemical principles are applied to achieve the objectives of each refinery process

UNIT I CRUDE CHEMISTRY AND PRODUCTS 9

Origin, Formation and Evaluation of Crude Oil -Indian petroleum industries- types of Hydrocarbon -composition of crude oil (PONA,S,N_2 etc) -Thermo-physical and physical properties of crude oil-petroleum standards- chemical analysis data- Testing methods of petroleum products-Chemical quality of products-Types of crude-Crude assay- selection of crude based on product yield.

UNIT II BASICS FOR REFINING 9

Properties of gas-Ideal gas laws-partial pressure-specific gravity-density-Properties of liquidviscosity and index-boiling point-pressure of fluid at rest-flow resistance-static/induced pressurespecific/latent heat/condensation-modes of heat transfer-diffusion mass transfer-properties of solid.

UNIT III PETROLEUM THERMODYNAMICS AND CALCULATION 9

First/second law-behavior of gas and liquid – PVT relationship- equation of state-VLE-equilibrium constant-Multi component liquid vapor composition calculation-specific gravity calculation-TBP distillation-ASTM-conversion to pseudo-components-Molecular weight calculation-pseudo-critical properties-calculation of enthalpy of petroleum fractions-Generalized equation for thermo physical properties of petroleum.

UNIT IV REFINERY UNIT OPERATIONS AND CALCULATION **9**

Distillation-types-column internals-multi component distillation-relative volatility-azeotropic mixture- absorption- desorption- adsorption- refrigeration - extraction- drying curve-humfidication principle- crystallization-stripping operation-.boiling curve- application of all operation in refinery and its basic design calculations

UNIT V REFINERY PROCESSES AND CATALYST FUNDAMENTAL **9**

Treating processes of petroleum products- Thermal/catalytic/hydo cracking-reforming/ isomerization /alkylation -principles and reactions- Catalyst phenomenon and theory-surface area/void volume/porosity- catalyst classification and preparation/selectivity/yield/reactivity heterogeneous reactions- catalytic reactor types (packed bed/moving bed/fluidized bed)- residence time-space velocity- Catalyst loading techniques

TOTAL :45 PERIODS

COURSE OUTCOMES:

The students shall be exposed to

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

CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

CO2: Understand the insights of primary treatment processes to produce the precursors.

CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes and Learn the importance of optimization of process parameters for the high yield of 118 petroleum products.

CO6: Understand the concepts of Catalyst loading techniques

TEXT BOOKS:

1. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
2. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
3. The Chemistry and technology of Petroleum, James G. Speight, CRC Press, taylor& Francis Group
4. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000
5. Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaisbupetrolepublications,France 2003.
6. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7thEdition, McGraw-Hill,2005.
7. Treybal,R.E.,"MassTransferOperations",3rdEdn.,McGraw-Hill,1981.

REFERENCES:

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
2. J. H. Gary, H. Hanwerk and M. J. Kaiser,,, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007
3. Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2nd edition, 1988
4. R.N. Watkin, "Petroleum Refinery Distillation", Gulf Publishing Co, Houstan, Texas, USA, 2nd edition, 1981

5. Handbook of Petroleum Analysis, James G. Speight, Wiley-Interscience, John Wiley & Sons, Inc., Publications 6. Holland, C. D. (1963). Multicomponent distillation. Prentice-Hall.

U23CHV12	PRIMARY REFINING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.
- To enable students to examine how each refinery process works.
- To enable students learn each operating variables are applied to achieve the objectives of each refinery process

UNIT I FEED PREPARATION 9

Pipelines from port to tank farm -safety and regulations -storage techniques in crude oil-impurities removal- measuring by dipping -spiking techniques -types of salts in crude -desalting process – electric desalter- preheating train and design- furnace and its operation.

UNIT II ATMOSPHERIC DISTILLATION 9

Operation and process description of ADU-design characteristics of ADU tower-cutpoints-degree of fractionation-over flash-column pressure and overhead temperature- Preflash systemoverhead system-side streams-intermediate pump around and reflux systems-Refinery off gas – LPG treatment-Naphtha stabilizer and splitter-side stripping sections-operating variables.

UNIT III VACUUM DISTILLATION 9

Operation of VDU- Need of vacuum- ejectors and its types/principle- Overhead ejector systemflash zone- draw off temperature- internal flow in VDU- light/middle/heavy cuts-routing to secondary units- lube based treatments-packing section tower loading of VDU.

UNIT IV LUBE OIL BASE STOCKS 9

Viscosity index calculation and pour point - LOBS processing by solvent treatment and hydro treatment- solvent selection-solvent extraction by NMP, furfural,- MEK solvent dewaxing/- refrigerating and filtration -hydro finishing- types of LOBS based on VI- types or groups of lube processing-spindle/LN/IN/HN/BN processing and blending.

UNIT V ASPHALT AND WAX TECHNOLOGY 9

Vacuum residue properties- propane deasphalting-asphalt processing and types-chemical structure-air blowing of bitumen- slack wax processing- wax and types/properties- wax deoiling-unit operations in wax plants- refrigerating and filtration/ hydro treating of wax-molding and storage.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1:Understand the methodologies in the primary petroleum refining processes like crude preparation, atmospheric and vacuum distillation, Lube, asphalt and wax processing.

CO2:understand how each refinery process works

CO3:learn the operating variables which are applied to achieve the objectives of each refinery process

CO4: Understand the methodologies of processing and blending

CO5: Apply the concepts in asphalt processing and wax treatment technology

CO6: Understand the concepts in LPG treatment-Naphtha stabilizer.

TEXT BOOKS:

1. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
2. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000
3. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
4. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007

5.Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES:

1. J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002
2. G.D. Hobson, "Modern Petroleum Technology", Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3. David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing,Springer,2006.

4.Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987

U23CHV13	SECONDARY REFINING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the methodologies in the secondary petroleum refining or upgrading processes like thermal cracking, coking, catalytic cracking, hydrocracking ,hydro treating, reforming, isomerization, alkylation and sulfur finishing processes
- To enable students to learn refinery operation on FCC, Vis breaker, DCU, Reformer, etc. and operation on utilities like steam, cooling water, instrument air, H2, N2 etc.
- To enable students learn each operating variables of all units

UNIT I THERMAL CRACKING AND COKING 9

Resid upgradation technologies- cracking-thermal cracking-mechanism/principle/reactionsprocess variables- Visbreaking- soaker process- coil visbreaker-Disadvantages-Cokingthermodynamics and mechanism of coking-delayed coking-operation-fluid coking-flexicokingtypes of coke and properties- yield pattern of cracking and coking

UNIT II CATALYTIC CRACKING 9

Principles of catalytic cracking-mechanisms- FCC- main reaction of FCC- role of FCC in refinery Fluidization- feedstocks/products/yield pattern- Kinetics and thermodynamics of FCC reactions FCC catalyst and licensor technologies- reaction/regeneration/fractionation sections-slide valves and its importance- riser/cyclone separator/reactor internals-RFCC/MSCC/Petro FCC.

UNIT III HYDROGEN AND HYDROCONVERSION 9

H_2 requirements-steam reforming and shift conversion-operation and thermodynamics of reformer and NI catalyst-Hydro treatment processes- catalyst and reaction chemistry-Naphtha/Diesel/lube/wax/gasoline hydro treatment- Hydrocracking process- Typical hydrocracker in refinery- catalyst/severity/conversion/Temperature profile for yield pattern-reaction kinetics of hydrocracker- Operation and variables.

UNIT IV REFORMING/ISOMERISATION/ALKYLATION 9

Reforming feed index-RON-various reforming technologies-platforming reactions-kinetics and thermodynamics of Pt catalyst reactions-Operation in Straight Run and Continuous Run mode yield calculation- Isomerization techniques- reactions and kinetics- various technologies in isomimportance of catalyst-hexane production-Alkylation process-reactions – various alkylation processes- process variables in reforming/isom/alky.

UNIT V FINISHING PROCESSES AND UTILITIES 9

Sources of sulfur in refinery-types of sulfur compounds in crude-sweetening processes- various sulfur treatment process in products-H_2S properties and removal by physical and chemical process- Amine selection –amine absorption and regeneration-sour water stripping- Merox process- Sulfur recovery from H_2S by Claus /super Claus/ modified Claus technology/SCOT Process/CS_2 process; Electricity and steam generation by Gas turbine/boiler-Cooling tower operation-Fuel oil-Cryogenic distillation of air to N_2 and O_2 production- Instrument air operation

TOTAL :45 PERIODS

COURSE OUTCOMES:

After successful completion of this course students are expected to be able to:

CO1: acquires knowledge on different methodologies in the secondary petroleum refining processes like thermal cracking, coking, catalytic cracking, hydrocracking.

CO2: understand the operation on FCC, Vis breaker, DCU, Reformer.

CO3: helps to understand the operation on utilities like steam, cooling water, instrument air, H_2, N_2.

CO4: understand the basic knowledge on isomerisation, alkylation and reforming process.

CO5: gather some knowledge in the finishing processes and their operations in refining industries

CO6: understand the basic knowledge on Electricity and steam generation by Gas turbine.

TEXT BOOKS:

1. Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Modern Petroleum Refining Processes, BK BhaskaraRao, Oxford & IBH Publishinng Co. Pvt. Ltd.
2. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000
3. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
4. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007
5. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

REFERENCES:

1. J.G. Speight and B. Ozum, "Petroleum Refining Processes", Marcel Dekker Inc, New York, 2002
2. G.D. Hobson, "Modern Petroleum Technology", Vol I & II, John Wiley & Sons, New York, 5th edition, 1984
3. David.S.J."STAN"Jones and Peter R.Pujado "Handbook of Petroleum Processing, Springer,2006.
4. Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987

U23CHV14	REFINERY ADVANCEMENTS AND ENVIRONMENTAL REGULATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the advanced techniques, automation, units integration and instrumentation techniques in refinery.
- To enable students to understand the environmental regulations, safety and government policies on refinery
- To enable students learn the energy saving techniques and refinery economics.

UNIT I ENVIRONMENTAL REGULATION AND GOVERNMENT POLICIES **9**

Classes of petroleum based on flash point- storage tank design- GAS/LIQUID/SOLID wastes form refinery units-environmental standards on air and water pollution and control-Solid waste management- Sludge conditioning and treatment and disposal- Effluent treatment plant-TTP greenhouse gases-Bharat stages and its regulations- Recent modification for BS-6- Policies on biofuel-EBP-Bio-diesel.

UNIT II CORROSION AND SAFETY 9

Corrosion- reaction and types- refinery corrosion tests- controlling parameters- corrosion control in equipment and pipelines-Types of fire- Safety triangle- Firefighting equipment-PPE- HAZOP studies- Petroleum disasters case study- process safety protocol- pressure relief systems- flare systems- CBD/OWS- MSDS for units- oil spilling and skimming

UNIT III ADVANCEMENTS IN REFINERY **9**

Instrumentation- Flow/pressure/temperature/level transmitter-Control systems and logics – controller types- mode of controllers- cascade, split range, ratio etc. - P/PI/PID controllers and control tuning-process optimization by APC/DMC- DCS/PLC systems.

UNIT IV REFINERY UNIT INTEGRATION AND RECENT TRENDS **9**

Overall modern refinery flow sheet- products routing- naphtha utilization route up and integration- Diesel/gasoline/ATF/kerosene route up to blending header- Blending processesline blending- Blending of diesel and MS calculation- LP model for blending operation- Recent trends in ADU with pre flash- RFCC-OHCU-Prime G+-catalytic dewaxing- PSA technology-DWC technology- Blue H2 process-Pre reforming- moving bed in CRU and isom-Advanced lube processing

UNIT V ENERGY SAVING AND REFINERY ECONOMICS **9**

Furnace efficiency calculation-steam utilization- plume length- insulation of pipelines- heat tracing-steam traps-Standard Refinery Fuel Tonnage- Fuel and loss- operational cost- margin cost- refining capacity-complexity factor- crude oil evaluation and procurement-monthly production planning- cracks-Gross Refinery Margin-operation optimization by Linear Programming model-shutdown planning- Refinery Transfer Price-taxation-pricing

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will gain knowledge on the need for sustainable agriculture

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

CO1:understanding the regulations and government policies in refining industries.

CO2: acquire some knowledge on advanced techniques, automation and instrumentation techniques.

CO3: understand the different controllers and automated control systems in refineries.

CO4: gathers knowledge on unit integrations in refineries.

CO5: understand the basis on energy saving techniques and refinery economics

CO6: understand the basic concept of PSA technology

TEXT BOOKS:

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969
2. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press , 5th Edition, 2007 127

3. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology
4. Coughanowr, D. R., & Leblanc, S. E. (2008). Introductory concepts. Process SystemsAnalysisandControl, 3rd Ed, 1-6.
5. Industrial Instrumentation, Donald P. Eckman, CBS, 2004.
6. Smith,R. Chemical process: design and integration. JohnWiley&Sons 2005.
7. Corrosion Control in the Oil and Gas Industry 1st Edition, Sankara Papavinasam, 2013
8. Gilbert, M. Masters., "Introduction to Environmental Engineering and Science", 3rd edition 2008

REFERENCES:

1. Luyben, W. L., Tyréus, B. D., & Luyben, M. L. (1998). Plant wide process control (Vol. 43). New York: McGraw-Hill.
2. Stephanopoulos, G. (1984). Chemical process control (Vol. 2). New Jersey: Prentice hall.
3. Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice -Hall India , 2000
5. Petroleum Economics, Jean Masseron, Technip; 4threvised Edition, 2000. (ISBN-10: 2710805979; ISBN-13: 978-2710805977)
6. Cheremisinoff N.P. and Graffia M.L., "Environmental Health and Safety Management. A Guide to Compliance", Pressure safety de-sign practices for refinery and chemical operations", Jaico Publication. 2003
7. Fontana, M.G., "Corrosion Engineering", Edn 3, McGraw Hill, 1989

U23CHV15	PETROLEUM EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study and analyze suitable equipment for particular reservoir conditions.

UNIT I INTRODUCTION 9

Casing program, casing and tubing design, principles of cementing, completion added skin, well perforating, hydraulic fracturing. DRILL BIT DESIGN.ROLLER CONE BITS.PDC DRILL BITS.NOMENCLATURE AND IADC CODES for drill bits. BHA (Bottom hole assembly). ESP(Electrical submersible pumps). SRP(Sucker rod pumping) unit design.

UNIT II DESIGN OF PRODUCTION AND PROCESSING EQUIPMENTS 9

Design of Surface Facilities -Design of production and processing equipment, including separation problems, treating, and transmission systems.

UNIT III RESERVOIR ENGINEERING 9

Capstone design in the areas of geology, reservoir engineering, production, drilling and well completions to practical design problems based on real field data with all of the associated shortcomings and uncertainties. Use of commercial software.

UNIT IV OIL AND GAS TREATMENT 9

Oil desalting-horizontal and spherical electrical dehydrators- Natural Gas Dehydration-Horton sphere- Natural Gas Sweetening. Crude & Condensate Stabilization-design of stabilizer- Oil and Gas Treatment. Treating Equipment.

UNIT V DESIGN OF PIPELINE 9

Refinery Equipment Design-atmospheric distillation column Design and construction of on/ offshore pipelines, Fields Problems in pipeline, Hydrates, scaling & wax etc and their mitigation.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the drill bit fundamentals, codes and standards

CO2: Understand design of production and processing equipment.

CO3: Understand the Capstone design in reservoir engineering.

CO4: Understand the design of Oil and Gas Treatment Equipment

CO5: Understand the design of pipe systems.

CO6: understand the basic concept of transmission systems.

TEXT BOOKS:

1. Petroleum Exploration Hand Book by Moody, G.B.
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al

REFERENCES:

1. Standard Hand Book of Petroleum & Natural Gas Engineering" – 2 nd Edition 2005-William C.Lyons& Gary J.Plisga-Gulf professional publishing comp (Elsevier).

U23CHV16	POLYMER SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand the basic concept and classification of polymers
- To know the manufacturing and applications of engineering thermoplastics
- To understand the preparation methods of thermosetting polymers

UNIT I INTRODUCTION TO POLYMERS 9

Basics, classification of polymers, functionality, polymerization techniques- Bulk, solution, suspension and emulsion.

UNIT II ENGINEERING THERMOPLSTICS AND APPLICATIONS 9

Engineering Thermoplstics- Aliphatic polyamides: Structure, properties manufacture and applications of Nylon 6, Nylon 66. Polyesters: Structure, properties manufacture and applications of PET. Structure, properties manufacture and uses of PMMA.

UNIT III THERMOSETTING PLASTICS 9

Preparation, Properties and uses of Epoxy resins, Phenol formaldehyde, Urea Formaldehyde andSilicone resins.

UNIT IV POLYMER PROCESSING AND MOULDING 9

Hand layup, Compression molding, Calendering, Die casting and Thermoforming.

UNIT V POLYMER TESTING 9

Tensile Test, Flexural Test, Impact Test, Thermogravimetric analysis, Dynamic mechanical analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: To study the importance and classification of polymers

CO2: Summaries the raw materials, sources, production, properties and applications of various thermoplastics

CO3: To understand the uses the various thermosetting plastics

CO4: Know the various methods used to processing polymers

CO5: To understand the testing property of polymers

CO6: To understand the various polymers used in engineering field.

TEXT BOOKS:

1. V.R. Gowariker, Polymer Science, New Age International (P) Limited, New Delhi, 2005.

REFERENCES:

1. J.A. Brydson, Plastics Materials, 7 th edition, Butterworth Heinemann (1999)
2. Manas Chanda, SalilK.Roy, Plastics Technology Handbook, 4 thEdn., CRC press (2006)
3. Vishu Shah, Handbook of Plastic Testing Technology, 3 rdEdn., John Wiley & Sons 2007.

U23CHV21	BIOENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in bioenergy industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I BIOMASS 9

Biomass sources and classification; Biomass characteristics & preparation; Chemical composition and properties of biomass; Size reduction, Briquetting of loose biomass, Drying, Storage and handling of biomass.

UNIT II BIOGAS TECHNOLOGY 9

Biogas technology: Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Dry and wet fermentation, Digestors for rural application-High rate digesters for industrial waste water treatment.

UNIT III BIOMASS CONVERSION TECHNIQUES 9

Pyrolysis and thermo-chemical conversion: Thermo-chemical conversion of lignocellulosic biomass. Incineration for safe disposal of hazardous waste, Biomass processing for liquid fuel production, Pyrolysis of biomass-pyrolysis regime, effect of particle size, temperature, and products obtained.

UNIT IV GASIFIERS 9

Gasification of biomass: Thermochemical principles: Effect of pressure, temperature and introducing steam and oxygen. Design and operation of Fixed and Fluidised Bed Gasifiers, Safety aspects.

UNIT V BIOMASS COGENERATION SYSTEM 9

Combustion of biomass and cogeneration systems: Combustion of woody biomass-theory, calculations and design of equipment, Cogeneration in biomass processing industries. Case studies: Combustion of rice husk, Use of bagasse for cogeneration.

TOTAL :45 PERIOD

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the fundamental knowledge on classification, characterization and sources of biomass

CO2: learn the production of biogas

CO3: gather knowledge on the operations of incineration, pyrolysis.

CO4: understand the process in gasification of biomass

CO5: knowledge on the types of combustion of biomass.

CO6: understand the basic concept of Cogeneration in biomass processing industries.

TEXT BOOKS:

1. Anju Dahiya, Bioenergy: Biomass to biofuels First Edition, Academic Press, 2014.
2. Li, Yebo, and Samir Kumar Khanal. Bioenergy: principles and applications

REFERENCES:

1. Vaughn C Nelson, Kenneth L. Starcher. Introduction to bioenergy. CRC Press, 2017.
2. Wall, Judy D., Caroline S. Harwood, and Arnold Demain. "Bioenergy." Bioenergy.. ASM Press, 2008

U23MEV36	RENEWABLE ENERGY RESOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I INTRODUCTION 9

Introduction: Energy: Past, Today, and Future. A brief history of energy consumption. Energy & Environment. Renewable Energy – Quality, quantity, availability, advantageous and limitations.

UNIT II SOLAR ENERGY 9

Solar energy: Sun and its Energy: Basics of Solar Energy. Solar Energy in the Past. Solar Thermal Energy Solar Photovoltaic.

UNIT III BIO AND GEOTHERMAL ENERGY 9

Bio energy & Geothermal energy: Conversion. Bio degradation. Biogas generation. Fuel properties. Biomass gasifier. Geothermal Resources, Geothermal Technologies.

UNIT IV WIND ENERGY 9

Wind energy: Wind Resources. Wind Turbines. Environmental Impact. Data and energy estimation. Conversion. Wind mill Performance and applications.

UNIT V OCEAN AND TIDAL ENERGY 9

Tidal energy; Ocean Energy Potential against Wind and Solar. Wave Characteristics and Statistics. Wave Energy Devices. Tide Energy Technologies. Ocean Thermal Energy. Osmotic Power.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the fundamental knowledge on history, consumption of energy

CO2: learn the production of solar energy

CO3: gather knowledge on the geothermal and bio energy

CO4: understand the process in gasification of biomass

CO5: understand the production of wind energy and their utilization

CO6: knowledge on the production and utilization of tidal energy

TEXT BOOKS:

1. Mukherjee, D., and S. Chakrabarti. Fundamentals of renewable energy systems. New Age International, 2004.

2. Jenkins, Nicholas, and Janaka Ekanayake. Renewable energy engineering. Cambridge University Press, 2017A. Chawvel and G. Lefebvre, “Petrochemical Process”, Vol. I & II, Gulf Publishing Co., Houston, London.

REFERENCES:

1. Kishore, V. V. N., ed. Renewable energy engineering and technology: principles and practice. The Energy and Resources Institute (TERI), 2010.

2. Tiwari, Gopal Nath, and Rajeev Kumar Mishra. Advanced renewable energy sources. Royal Society of Chemistry, 2012.

U23CHV23	PINCH TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I INTRODUCTION 9

Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.

UNIT II TARGETING 9

Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting and continuous targeting.

UNIT III PINCH METHODOLOGY 9

Pinch Methodology: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram.

UNIT IV DESIGN AND OPTIMIZATION 9

Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, CP table, heuristics and optimization of heat exchanger network: optimality for a minimum area network.

UNIT V ANALYSIS OF VARIOUS PROCESSES 9

Energy and Resource Analysis of various processes, Batch process, distillation process, evaporation process, reaction process, process using mass separating agent.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the pinch concept and process thermodynamics

CO2: Identify minimum energy targets

CO3: Classify different choices and constraint during heat exchange networking

CO4: Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes

CO5: Analyze the concepts in various chemical processes.

CO6: knowledge on the evaporation process.

TEXT BOOKS:

1.V. Uday Shenoy" Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995.

REFERENCES:

1. D.W. Linnhoff et al., "User Guide on Process Integration for the efficient use of Energy", Institution of Chemical Engineers, U.K., 1994.
2. James M. Douglas “Conceptual Design of Chemical Process”, McGraw Hill, New York, 1988.

Anil Kumar, “Chemical Process Synthesis and Engineering Design”, Tata McGraw Hill New Delhi, 1977.

U23CHV24 HYDROGEN AND FUEL CELL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To create awareness about alternate clean fuel available. To familiarize the students with the concepts and chemistry of fuel cell

UNIT I INTRODUCTION **9**

Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.

UNIT II FUEL CELL KINETICS 9

Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

UNIT III CHARACTERIZATION TECHNIQUES **9**

Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.

UNIT IV RENEWABLE SOURCES **9**

Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V APPLICATIONS OF FUEL CELL **9**

Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1: aware of alternate energy sources and its importance of it.

CO2 : understand the fuel cell kinetics

CO3: able to understand the characterization techniques

CO4: Analyze the renewable sources and storage

CO5: Understand the applications of fuel cells in various fields.

CO6: Understand the concepts of Fuel cell modeling and system

TEXT BOOKS:

1. Gregor Hoogers, “Fuel Cell Technology Handbook”, CRC Press, 2003.
2. R.P. O'Hayre,S. Cha, W. Colella, F.B. Prinz, “Fuel Cell Fundamentals”, Wiley, 2006.
3. A. J.Bard, L. R. Faulkner, “Electrochemical Methods”, Wiley, 2004

REFERENCES:

1. S. Basu, “Fuel Cell Science and Technology”, Springer, 2007
2. H. Liu, “Principles of Fuel Cells”, Taylor & Francis, 2006

U23MET73	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I INTRODUCTION 9

Power Plants - Features, Components and Layouts - Working of Power Plants, Power Plant Economics.

UNIT II BOILERS 9

Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers - Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers

UNIT III STEAM TURBINE 9

Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines - Trouble Shooting

UNIT IV GAS TURBINE PLANT 9

Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power Plants Components - Economics & Future of Combined Cycles

UNIT V ADVANCED POWER CYCLES 9

Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) – Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1: understand the fundamental knowledge on components, layouts and working of power plants

CO2 : learn the types, classification and usage of boilers

CO3: gather knowledge on classification and usage of steam turbines

CO4: understand the types of gas turbines

CO5: knowledge on the application of integration of various process in power plants

CO6: Understand the concepts of Indirect Fired Combined Cycle

TEXT BOOKS:

1.Thomas C. Elliott ,"Standard Hand Book of Power Plant Engineering"

REFERENCES:

1. E L Wakil, "Power Plant Engineering", McGraw-hill Book Co, N.Y. 2001
2. Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003
3. Nag, P.K., "Power Plant Engineering", 2 nd Edition, TMH, 2001

U23CHV26	NON-RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I INTRODUCTION 9

Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources.

UNIT II COAL GENERATION 9

Types of coal; Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal.

UNIT III NATURAL GAS 9

Resources of for Natural Gas, Properties and classification of natural gas, transporation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal

UNIT IV NUCLEAR ENGINEERING FUNDAMENTALS 9

Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Nuclear Fuels; Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium.

UNIT V NUCLEAR ENERGY 9

Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant -Waste Management and Safety

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1: understand the fundamental knowledge on petroleum and its products

CO2 : learn the usage of coal, types and its composition

CO3: gather knowledge on the properties, classification and products of natural gas

CO4: understand the fundamentals of nuclear engineering

CO5: knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.

CO6: Understand the concepts of boiling water reactors.

TEXT BOOKS:

- Breeze, Paul. Nuclear power. Academic Press, 2016
- Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversion processes and applications. Newnes, 2016
- Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable and Conventional. " Khanna Publication, 3rd (2012)

U23CHV31	AIR POLLUTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn about Air Pollution, effects of air pollution, Global effects,
- Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and
- dispersion and Prediction of air quality.

UNIT I INTRODUCTION 9

Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties ofAir Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index.

UNIT II GASEOUS POLLUTANTS 9

Absorption- Principles, Description of equipment-Packed and Plate columns -Design and Performance equations; .Adsorption- Principle Adsorbents, Equipment descriptions - PSA - Adsorption cycle - Solvent recovery system-Continuous Rotary bed, Fluidized bed, Design and Performance equations ; Incinerators, Hydrocarbon incineration kinetics- Equipment description- Design and Performance equations.

UNIT III PARTICULATE AIR POLLUTION 9

Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficiency – Gravity Settling chambers Cyclones- Electrostatic precipitators and Bag houses.

UNIT IV AIR POLLUTION CONTROL 9

Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristics and control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters – Techniques of air pollution control - equipments

UNIT V AIR POLLUTION MODELLING 9

Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the nature and characteristics of air pollutants, and basic concepts of air quality management.

CO2: Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards

CO3: Understand the knowledge about particulate air pollutants and control devices.

CO4: Relate the air quality behaviour and its measurement

CO5: Control the air pollution in industries using various models.

CO6: Understand the concept of Pollution Prevention

TEXT BOOKS :

2. Richardw.Boubeletal.,"FundamentalsofAirPollution",AcademicPress, NewYork,1994.
3. NoelDeNevers,"AirPollutionControlEngg.",McGrawHill,NewYork,1995.
4. M.N.Raoetal.,"AirPollution"TataMcGrawHill,1989

REFERENCE:

2. David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.
3. Stern, A.C., Air Pollution (Vol.I – Vol.VIII), Academic Press, 2006.
4. Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons,Inc.,2000.
5. Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd
6. Edition John Wiley Sons, 2012
7. Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4th edn, 1997.

U23CHV32	INDUSTRIAL WASTE WATER TREATMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.
-

UNIT I WASTE WATER TREATMENT AN OVERVIEW 9

Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents.

UNIT II CHEMICAL UNIT PROCESSES 9

Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization – disinfection

UNIT III BIOLOGICAL TREATMENT 9

Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type.

UNIT IV TREATMENT METHODS 9

Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal

UNIT V ADVANCED WASTE WATER TREATMENT 9

Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge. - Software Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement.

CO2: Understand the various pollutant treatment techniques.

CO3: Understand the concepts using biological treatment methods

CO4: Analyze the reactors used for various treatment techniques

CO5: Understand the membrane based electrochemical process for pollutant treatment.

CO6: Understand the concepts aerobic and anaerobic treatment .

TEXT BOOKS :

1. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
3. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007.

REFERENCE:

1. Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006.
2. Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition,Tata McGraw-Hill, 1995. 14
3. Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2002.
4. Sincero, P.A., and Sincero, A.G., Physical Chemical treatment of water and wastewater, IWA Publications, 2002.
5. Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009.Biston, 2002.
6. 2. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
7. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
8. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007.

U23CHV33	SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT I INTRODUCTION 9

Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) –- Role of public and NGO‟s- Public Private participation – Elements of Municipal Solid Waste Management Plan.

UNIT II SOURCE REDUCTION, WASTE STORAGE AND RECYCLING 9

Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes.

UNIT III COLLECTION AND TRANSFER OF WASTES 9

Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.

UNIT IV PROCESSING OF WASTES 9

Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options – case studies under Indian conditions.

UNIT V WASTE DISPOSAL 9

Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – Dumpsite Rehabilitation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: State solid waste characteristics and its sources.

CO2: Identify and analyze different methods of treatment of solid waste.

CO3: Illustrate Industrial practices in solid waste management.

CO4: Discuss the significance of recycling reuse and reclamation of solid wastes.

CO5: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

CO6: Understand the concepts Elements of integrated solid waste management

TEXT BOOKS :

1. William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
2. John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.
3. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". McGraw Hill, New York, 1993.
4. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource RecoveryEngineering", Prentice Hall, Inc., 1981

REFERENCE:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of UrbanDevelopment, New Delhi, 2000.
2. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996.

U23CHV34	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

UNIT I INTRODUCTION 9

Impacts of Development on Environment – Rio Principles of Sustainable Development Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

UNIT II ENVIRONMENTAL ASSESSMENT 9

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing- Environmental Clearance

UNIT IV SOCIO ECONOMIC ASSESSMENT 9

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis.

UNIT V MONITORING STUDIES AND APPLICATIONS 9

Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit ; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1:Understand the concept of environmental Impact assessment

CO2: Know various components and assessment techniques of EIA.

CO3:Understand Environmental management plan

CO4: Understand socio economic assessment plans

CO5: gain knowledge about EIA monitoring studies through various industrial exposure

CO6: Understand the concept of Economic valuation of Environmental impacts

TEXT BOOKS :

1. Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 1996.
2. Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science, London, 2009.
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrentproblems, Wiley-Interscience, New Jersey, 2003.
4. Anjaneyulu, Y., and Manickam, V., Environmental Impact Assessment, Methodologies, 2nd Edition, BS Publications, 2007

REFERENCE:

1. Becker H. A., Frank Vanclay, "The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing,2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme,2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

U23CHV35	PROCESS SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I PROCESS SAFETY INFORMATION 9

Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) – Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges

UNIT II SAFETY PROGRAMMES AND PROCEDURES 9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning

UNIT III ACCIDENT ANALYSIS 9

Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations ; Past accident analysis Fixborough- Mexico- Chernobyl nuclear disaster-Bhopal gas analysis-process safety indicators

UNIT IV PROCESS HAZARD ANALYSIS 9

Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA,Overview of PHA Techniques, Selection of PHA techniques Implementation ofrecommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V SAFETY MANAGEMENT 9

Employee Participation – Overview, Benefits of Employee participation, Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes-Institutionalizing and integrating safety into the PSM fabric, 5 tier approach, selection, training, Performance monitoring; Case studies – Process safety management in industry – present and futuristic approach.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1- understand the fundamental knowledge on petroleum and its products

CO2- learn the usage of coal, types and its composition

CO3- gather knowledge on the properties, classification and products of natural gas

CO4- understand the fundamentals of nuclear engineering

CO5- knowledge on the usage of nuclear reactors, nuclear waste management and safety usage. CO6: understand the fundamentals of Asset Integrity Process Hazard Analysis

TEXT BOOKS :

1. Breeze, Paul. Nuclear power. Academic Press, 2016
2. Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversion processes and applications. Newnes, 2016
3. Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable and Conventional. " Khanna Publication, 3rd (2012)

REFERENCE:

1. Dr.M.D.Rageeb Md,Usman Sanjay A, Nagdev,Dr.Ravindra S.Sonawane ,Hazards and Safety Management, Khanna Publication,2020

U23CHV36	RISK AND HAZOP ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge and skills to identify, assess and mitigate the environmental and hazop impacts of developmental projects

UNIT I RISK ANALYSIS 9

Risk analysis introduction, quantitative risk assessment, rapid risk analysis –comprehensive risk analysis – identification, evaluation and control of risk.

UNIT II RISK ASSESSMENT 9

Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis.

UNIT III EMERGENCY PLANNING 9

Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies- marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

UNIT IV HAZARD 9

Hazard - Hazard identification – methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V HAZOP 9

Introduction to HAZOP-Significance of HAZOP -HAZOP procedure –HAZOP Analysis - Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the knowledge of types of risks arising in working environment

CO2: Perform Risk Assurance and Assessment

CO3: Design Risk management systems and planning

CO4: Analyze the effect of process hazard

CO5: hazop and its consequences and to create hazard free working premises

CO6: Understand the concepts of Significance of HAZOP

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

REFERENCE:

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

U23CHV41	COMPUTATIONAL TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable students learn the fundamentals of Biochemical Processes and Biomolecules

UNIT I NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAICEQUATIONS **9**

Gauss elimination, LU decomposition, matrix inversion, Tri-diagonal matrix algorithm, Gauss-Seidelmethod, Chemical Engineering problems involving solution of linear algebraic equations.

UNIT II NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS **9**

Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations

UNIT III INTERPOLATION AND NUMERICAL INTEGRATION **9**

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

UNIT IV NUMERICAL METHODS FOR ODES **9**

Euler method – explicit and implicit, Runge-Kutta method – 2 nd and 4 th order, Boundary value problems – shooting method, Chemical engineering problems involving single and system of ODEs.

UNIT V NUMERICAL METHODS FOR PDES **9**

Introduction to Partial Differential Equations: Characterization of PDEs, parabolic, elliptic and first order hyperbolic equations, explicit and implicit methods, Chemical engineering problems involving the three types of PDEs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the numerical methods for linear algebraic equations.

CO2: Identify numerical methods for non linear algebraic equations

CO3: Identify different methods for interpolation and numerical integration

CO4: knowledge on the numerical methods for ordinary differential equations

CO5: understand the basic methods for partial differential equations

CO6: understand the basic concepts of Boundary value problems

TEXT BOOKS :

1. Chapra. S. C. & Canale, R. P., "Numerical Methods for Engineers", Eighth Edition, McGraw Hill, 2021.
2. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.
3. Ahuja, P., "Introduction to Numerical methods in Chemical Engineering" 2nd Edition, PHI learning Private Ltd, 2019.

REFERENCE:

1. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000

U23CHV42	OPTIMIZATION OF CHEMICAL PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields.

UNIT I PROBLEM FORMULATION & CLASSIFCATION **9**

Introduction; formulation of objective functions; fitting models to data; classification of functions;necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods.

UNIT II LINEAR PROGRAMMING **9**

Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming.

UNIT III NON-LINEAR PROGRAMMING 9

The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming.

UNIT IV NUMERICAL METHODS 9

Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant method.

UNIT V APPLICATIONS 9

Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course students are expected to be able to:

CO1:Be familiar on the basic problem formulation and optimization.

CO2:Understand mathematical characteristics of Linear programming

CO3:Learn computational solution techniques for nonlinear unconstrained optimization.

CO4:Understand various techniques used in constrained optimization

CO5:Apply the optimal and dynamic optimization.

CO6: Understand various techniques of geometric and dynamic programming

TEXT BOOKS :

1. Edgar T.F., Himmelblau D.M., Lasdon,L.S.,
2. Optimization of Chemical Processes, Second Edition, McGraw-Hill, New York, 2001.
3. Rao, S. S., Engineering Optimization: Theory and Practice, Fifth Edition, Wiley, New York, 2019.

REFERENCE:

1. Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.

U23CHV43	PROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand fermentation and its kinetics
- To understand structural, functional properties of microbes
- To design fermenter with auxiliaries

UNIT I INTRODUCTION AND FIRST PRINCIPLES 9

Definition, Uses of Mathematical Models - Principles of formulation, Classification of Process, Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation – Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples.

UNIT II LUMPED SYSTEMS 9

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system.

UNIT III STAGED OPERATIONS AND DISTRIBUTED SYSTEMS 9

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators.

UNIT IV FITTING MODEL TO DATA 9

Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R2).

UNIT V SIMULATION OF BASIC MODELS 9

MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler’s explicit and implicit techniques, Introduction to ODE 45 solver, Dynamic simulation of simple tank, variable flow tank, enclosed tank with isothermal compression, mixing vessel, mixing vessel with reaction using ODE 45 solver.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics

CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods

CO3: Create the mathematical models for different unit operations equipments

CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems

CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions

CO6: Understand the fundamentals of Cubic Model and Polynomial model using Regression

TEXT BOOKS :

1. Bequette, B. W., Process Dynamics: Modeling, Analysis, and Simulation. Prentice-Hall, 2002.

2. Babu, B V., Process Plant Simulation, Oxford University Press, 2004

3. Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, Prentice Hall India Pvt. Ltd, 2011.

REFERENCE:

1. Luyben, W.L.: Process Modeling, Simulatio5n and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.

2. Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

U23CHV44	PINCH ANALYSIS AND HEAT EXCHANGER NETWORK DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the fundamentals of bio separations
- To design unit operations steps for various downstream purification steps
- To gain knowledge on theory, design, and application of Bioprocessing

UNIT I INTRODUCTION 9

Pinch analysis, process synthesis, pinch point, composite curves, energy targeting: problem table algorithm, shifted composite curve, capital cost, total cost targeting, process modification.

UNIT II TARGETING 9

Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting.

UNIT III PINCH ANALYSIS 9

Identification of streams, temperature, enthalpy diagram, minimum temperature difference, construction of composite curves, energy cost target, optimum target, design of heat exchanger network.

UNIT IV PINCH DESIGN AND OPTIMIZATION 9

Networks for maximum energy recovery, Pinch design method, flexibility criteria of the pinch, optimization of heat exchanger network, optimality for a minimum area network, Sensitivity analysis.

UNIT V ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES 9

Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent, heat pipes and heat pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the basic concept of bioseparation processes

CO2: acquire knowledge on theory, design, and application of bioprocessing

CO3: to understand the basic concepts absorption and their problems in bioprocessing

CO4: gather knowledge on extraction of bioproducts using different methods

CO5: acquire knowledge on chromatography techniques and their analysis, membrane separation

process

CO6: to understand the basic concepts Batch process,

TEXT BOOKS :

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press
3. B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
4. Bioseparation & bioprocessing (2nd Ed) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)

REFERENCE:

1. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
2. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982. Scopes Ak, Protein Purification, IRL Press, 1993
3. Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993
4. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989
5. T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances in Biochemical Engineering /Biotechnology, Vol 56) by Springer Verlag

U23CHV45	CHEMICAL PROCESS FLOW SHEETING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Enzymes, homogeneity, and heterogenicity
- To understand structural, functional properties, and metabolic pathways
- To learn immobilization procedures, and types.
- To design enzyme reactors
-

UNIT I FLOWSHEETING 9

Introduction, symbols, flowsheet presentation with examples, manual flowsheet calculation, flowsheeting approaches.

UNIT II DECOMPOSITION OF NETWORKS 9

Partitioning and tearing a flowsheet, tearing algorithms based on signal flow graph, algorithms based on reduced graph, comparing various tearing algorithms

UNIT III SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING 9

Principle of method, convergence of flowsheet using different methods - Newton's method, direct substitution, Wegstein's method, dominant Eigenvalue method, quasi Newton method, criteria for acceleration .

UNIT IV FLOWSHEETING BY EQUATION SOLVING METHODS 9

Precedence ordering, disjoining, tearing a system of equations, SWS algorithm, maintaining sparsity, solution of system of equations using Newton's method

UNIT V CASE STUDIES 9

Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems,Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products as biosensors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the basic concept in preparation of flowsheet

CO2: knowledge on preparing networks

CO3: understand different approach in flows heeting

CO4: to learn the flowsheet preparation by equation solving methods

CO5: Evaluate the case studies using flowsheeting software.

CO6: understand the basic concept of various tearing algorithms

TEXT BOOKS :

1. Babu, B V., Process Plant Simulation, Oxford University Press, 2004

REFERENCE:

1. W.Westerberg,H.P.Hutchison, R.L.Motard, P.Winter , Process Flow Sheeting, Cambridge University ,2011.

U23AET72	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn computational fluid dynamics

UNIT I INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS **9**

Introduction to numerical fluid dynamics - Introduction to governing equations of fluid dynamics and modelling of fluid flow – The substantial derivative and the physical meaning of divergence of a vector. Boundary conditions for various types of fluid flow conditions - Introduction to mathematical properties of fluid dynamic equations and classification of partial differential equations - General behaviour of different classes of partial differential equations and their relation to fluid dynamics - A general discussion on hyperbolic, parabolic and elliptic equations.

UNIT II GRID GENERATION **9**

Introduction to grid generation in computational fluid dynamics - Structured grid generation techniques – algebraic methods, conformal mapping and methods using partial differential equations - Boundary value problem of numerical grid generation-grid control functions- branch cut - The boundary conditions of first kind - orthogonality of grid lines- boundary point grid control. Unstructured grids, Cartesian grids, hybrid grids, grids around typical 2D and 3D geometries.

UNIT III TIME DEPENDENT METHODS **9**

Introduction to time dependent methods - Explicit time dependent methods –Description of Lax Wendroff Scheme and Mac Cormack's two step predictor – corrector method - Description of time split methods. Introduction to implicit methods and respective stability properties of explicit and implicit methods -Construction of implicit methods for time dependent problems - Linearization, choice of explicit operator and numerical dissipation aspects.problems.

UNIT IV FINITE VOLUME METHOD **9**

Introduction to Finite volume Method - Different Flux evaluation schemes, central, upwind and hybrid schemes - Staggered grid approach - Pressure-Velocity coupling - SIMPLE, SIMPLER algorithms, pressure correction equation (both incompressible and compressible forms) - Application of Finite Volume Method -artificial diffusion.

UNIT V INTRODUCTION TO CFD COMMERCIAL CODES **9**

Basic programming rules, Data type arrays – pointers – operators-code flow chart- Write codes to- impose initial condition, parabolic velocity profile, forward, backward Euler time integration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to
CO1: Understand the basics of CFD and governing equations for conservation of mass momentum and energy
CO2: Understand mathematical characteristics of partial differential equations
CO3: learn computational solution techniques for time integration of ordinary differential equations
CO4 gain knowledge in various discreitization techniques used in CFD
CO5: Understand flow field computation techniques for steady and unsteady flows
CO6: Understand the basics of central differencing scheme for convection

TEXT BOOKS :

1. Versteeg H. K. and Malalasekera, W., An introduction to computational fluid dynamics: the finite volume method, Second edition, Pearson, 2008.
2. Anderson, J. D. Computational fluid dynamics: The Basics with Applications, McGraw-Hill, 1995.

REFERENCE:

1. Ranade, V. V., Computational flow modeling for Chemical Reactor Engineering, AcademicPress, 2002

U23CHV51	CHEMICAL PLANT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the intricacies in equipment sizing and selection amongst options therein
- To leverage lessons learnt in designing chemical process unit with safety as paramount

UNIT I ROTARY EQUIPMENT 9

Pumps: Various types: Centrifugal, Reciprocating& Other Positive displacement types – Plunger, Piston, Diaphragm, Gear, Screw, Lobe, Vane, etc.; Compressors: Various types: Axial, Centrifugal, Reciprocating, and other positive displacement type such as Rotary Screw, Scroll, etc. Further, compressors are classified into two namely Oil free and Oil flooded lubricated; Fans: Various types: Axial fans (including Propeller, Tube-axial, and Vane-axial) and Centrifugal fans. Further fans are classified as Induced draft and Forced draft types; Steam Turbines: : Various types: Back Pressure and Condensing Types with and without extraction, Impulse & Reaction types; Gas Turbines : Various types: Turbojet, Turboprop, Turbofan and Turboshaft Engines;Motor :Various types: AC motors (Synchronous & Asynchronous motors), DC motors (brushed and brushless), Variable Frequency and Variable Speed motors and Special purpose motors, Generator: Various types: AC and DC generator; Other Special Equipment: Various types: Power Recovery Turbines, Heat Pumps, Ejector pump, NASH vacuum pump Case Studies – From Industries on operations and maintenance aspects viz. Trouble shooting, Energy improvement, Capacity augmentation, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT II STATIC EQUIPMENT - HEAT TRANSFER EQUIPMENT 9

Heat Exchangers– Shell and Tube, Double Pipe, Plate &Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; Fired Heaters& Boilers–With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation, Refrigeration& Air Conditioning– HVAC (Heating, Ventilation, and Air Conditioning); Miscellaneous – Chilled water system with vapour compression refrigeration, Ejector refrigeration system, direct contact heat exchanger (such as cooling towers, Jet condensers, direct contact feed), Incinerator. Case Studies – From Industries on operations and maintenance aspects viz. Fouling control, Pinch study for energy recovery, Capacity creep, Design tips, Equipment safety, Catastrophic incidents, etc. Heat Exchangers– Shell and Tube, Double Pipe, Plate &Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; Fired Heaters& Boilers–With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation, Refrigeration& Air Conditioning– HVAC (Heating, Ventilation, and Air Conditioning); Miscellaneous – Chilled water system with vapour compression refrigeration, Ejector refrigeration system, direct contact heat exchanger (such as cooling towers, Jet condensers, direct contact feed), Incinerator. Case Studies – From Industries on operations and maintenance aspects viz. Fouling control, Pinch study for energy recovery, Capacity creep, Design tips, Equipment safety, Catastrophic incidents, etc.

UNIT III STATIC EQUIPMENT - MASS TRANSFER 9

Mass Transfer Operations: Multi Component Distillation columns, Extractive distillation, Reactive Distillation, Azeotropic distillation, Divided wall columns, Dryers, Adsorption Isotherm, Pressure Swing Adsorption, Importance of recycles and Optimization needs, Absorption processes & operating variables, Liquid – Liquid Solvent Extraction ; Humidification & dehumidification, Evaporation, Precipitation, Crystallizers, Membrane filtration; Reactors– CSTR, Slurry phase reactor, Tubular, Trickle Bed Reactor, etc., thermodynamically controlled reaction and kinetically controlled reaction, Reaction Kinetics, Importance of Reactor internals. Case Studies – From industries across life cycle such as Trouble shooting, enhance conversion & selectivity, IoT use, Debottlenecking, Design tips, Safety Incidents "Fit - For Purpose" Assessment, etc.

UNIT IV EQUIPMENT ANCILLARIES 9

Special equipment– Static Mixer, Agitators, Jet Mixing, Ejectors, Eductors, Structured Packing, Grid Packing and Random Packing, Demisters, Vortex Breaker, Calming Baffles, Schoepentoeter, Vapour horn device, Cyclone separators; Package units – Inert gas generators, Feed stream filters (Mechanical, Chemical), Scrubbers, Spray Nozzles, Guard beds, Flare stack, Ground Flare, Flame arrestors, Strainers, Spring supports, Expansion joints, Electrostatic Precipitators; Steam Traps – Thermodynamic, Inverted Bucket type, Thermostatic – Float, Bimetallic type, etc., Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V STATIC EQUIPMENT - PRESSURE VESSELS, INTERNALS &SAFETY VALVES 9

Pressure Vessels – Vertical / Horizontal, Knock Out Drums, Steam and Blow down drum, Cold & Hot Separators, Surge drum, Deaerators, Water Seal Pot, Molecular seals, Shock Absorbers, Pressure snubber, Silencer, Slug Catcher, Desalter, Coke drum; Vessel & Columns - associated structural accessories such as Platforms, Ladders, Staircase etc. Internals –Column internals such as Trays (Sieve, Valve, Bubble Cap, Baffle, Dual flow, Multi down comer, Chimney tray etc.), Packings (structured, grid, random, etc.), Packed tower internals – Bed support plates, Liquid distributors, Bed limiters etc.; Mist eliminators, Demisters, Coalescing pads, Vortex breakers etc. Safety Valves: Normal, balanced bellows, pilot operated, etc., Rupture Discs, and Design codes governing Safety valve design, Case Studies– From industrial operations & maintenance activities–ASME codes, Trouble shooting, Efficiency tracking, Use of IoT, Debottlenecking, and Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the knowledge Power Recovery Turbines, Heat Pumps,

CO2: learn the operations of boilers, heat exchangers, refrigeration and air conditioners.

CO3: knowledge on operations of reactors, humidifiers and mass transfer operations

CO4: learn the different types of equipments in process industries

CO5: understand the knowledge on usage of different valves such as pressure, safety and internal.

CO6: understand the knowledge Design codes governing Safety valve design

TEXT BOOKS :

1. Chemical Engineering Handbook - Robert H. Perry; Don W. Green and James O. Maloney
2. Heat Transfer – D.Q. Kern
3. Mass Transfer Operations – Robert E. Treybal
4. Principles of Mass Transfer and separation Processes – BK Dutta
   Fluid Mechanics, Heat Transfer, and Mass Transfer (Chemical Engineering Practice) – KSN

REFERENCE:

1. Applied Process Design for Chemical and Petrochemical Plants – **Ernest E. Ludwig.**

U23CHV52	PLANT LAYOUT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the importance of plant layout in mitigating risk on people, plant, planet
- To apply knowledge in placing equipment for ease of operability & maintainability

UNIT I STANDARDS FOR AREA CLASSIFICATION 9

Standards for area classification–Electrical Area classifications, OSHA (Occupational Safety and Health Administration) regulations, National Fire Protection Association (NFPA), Petroleum Hazards Classification, IP15 Petroleum classification based on flash point, OISD standards (Oil Industry Safety Directorate), API Codes (American Petroleum Institute), PESO (Petroleum and Explosives Safety Organization) guidelines, Investigations Reports & Best practices data Chemical Safety Board, USA Case Studies – From Industries on Lessons from Incidents from Environmental Protection Agency (EPA), Safety & Environmental Incidents, etc.

UNIT II INTER UNIT DISTANCES 9

Distance between plants, substation, centralized control room, utilities sections / captive power plants; Inter-distance between adjacent Columns, Storage tanks, Tank dykes; Flare stack location (based on Prevailing up-wind direction), Design to keep it smokeless, Sterile zone/area – Governing API /OISD Standards, Field cabins. Access to firefighting facilities, Fire tank capacity, Foam need assessment, Design to tackle simultaneous fire incidents, Protection of fire network and ensuring availability on demand, Risk evaluation(arising from inventory of inflammable liquid, potential formation of explosive mixture, operation above auto-ignition temperature, toxic release, etc.) based on credible scenario;3D models used in equipment & piping isometric, Maintenance accessibility, Safe work place specially at elevated platform, Ease of emergency evacuation; Bow Tie Analysis to mitigate risk right at design stage, Blast proof design of control room, Minimize employee occupancy at a given time in risk zone. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT III STORAGE TANKS 9

Storage Tanks – Fixed or Floating roof, Mounded Bullet tanks, Cryogenic storage tanks & their special design requirements, Special designs along with breather systems, Lightening arrestors, Earth pits, other appurtenances –Manways for roofs or tank sidewalls, Catwalks, Roof vents, Roof hatches, Nozzles, Roofs (flat-style, knuckle-style, or pitched), Aluminium geodesic domes, Ladders, etc. Comfort factors Vs Inventory carrying cost, Safe operation of floating roof travel, breather sizing, steam coils design, rainwater drains, dyke capacity, inter tank distance based on product hazard classification, tank inspection schedule, ease of

cleaning, confined place entry, water spray and other firefighting feature, fugitive emission control, etc. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Water traps and roof collapse, safe filling height, Design tips, Safety & Environmental Incidents, etc.

UNIT IV AT RISK SYSTEMS AND EQUIPMENT 9

At-risk systems and equipment: Fuel gas systems, Fuel oil network, Hydrogen gas for generator cooling in power plants; Plant battery systems, Ammonia systems, Solid handling of coal and coke dust, Sulphur yard, Toxic gas loss of containment, etc, MSDS of every stream being handled / processed, Spent catalyst safe disposal ;Safe at Risk Assessment: Overall risk assessment using credible scenario along with preventive measures &systems to be in place to eliminate / minimize loss of containment. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Process Control, Early event detection, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT V BASIC ENGINEERING DESIGN PACKAGE 9

Basic Engineering Design Package (BEDP): First document to be prepared and approved between Process Engineering Team and Owner's representative. It shall cover not limited to – Site Conditions (weather, wind rose, seismic activity, water table, etc.); System of measurement (in FPS or MKS for flow of gas / liquid / steam, temperature, pressure, heat duty, inferential properties,etc.), Design considerations and margins, Design philosophies such as Operating & Control philosophy, Vent & Drain philosophy, Isolation philosophy, sparing philosophy etc. Raw material details (Capacity, conditions, logistics including receipt modes & storage criteria) Product offtake plans and modes of distribution, environmental norms, Levels of power & utilities that would be available for safe and hassle free operations ; Green belt cover, use of renewables, zero liquid discharge, maximum air cooling / condensing, storm water channel considerations, rain water harvesting ; Flare gas recovery, flight path and tall structures in industry premises, MIQA (mechanical integrity and quality assurance) considerations, equipment designed life ; Feed definition / variability / flexibility, product mix& swings, product quality, custody transfer design basis, turnaround plans ; Energy & loss targets and best in class design considerations, criteria for smooth and faster start-up, onstream factor, spinning margin, applicable codes, built in features for continual improvement, advanced process control and other s/w deployment for SCM (Supply Chain Mgt) and O&M (Operation and Maintenance) excellence. Case Studies – Lessons learnt from Industries viz. examples of regret investment, deviations from original design & impact thereof, market forces & design adaptability, challenges in product quality, etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement.

CO2: Understand the various pollutant treatment techniques.

CO3: Understand the concepts using biological treatment methods

CO4: Analyze the reactors used for various treatment techniques

CO5: Understand the membrane based electrochemical process for pollutant treatment

CO6: Understand the concepts modes of distribution

TEXT BOOKS :

1. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
3. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007

REFERENCE:

1. Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006.
2. Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition,Tata McGraw-Hill, 1995. 14
3. Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2002.
4. Sincero, P.A., and Sincero, A.G., Physical Chemical treatment of water and wastewater, IWA Publications, 2002.
5. Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009.Biston, 2002.
6. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.

U23CHV53	DESIGN SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the process safety systems both to prevent incident & to minimize loss
- To apply the principles 'safe at risk' to assess likely unsafe conditions in unit operation

UNIT I SAFETY SYSTEMS 9

Safety systems: Deployment of sensors (Toxic, HC and Thermal) at critical locations, Fire network including elevated fire monitors, Egress system, Escape route and Assembly point, Water curtain, eye wash requirement, Clean and cooler water supply ;Dovetail Early Event Detections system to forecast and forewarn on 'unsafe' conditions emerging in process units, Cause & Effect diagram, Alarm rationalization, Partial or Total Plant Trips review; Setting up IOW (Integrity Operating Window), Utility stations at strategic locations in process units (for supply of LP steam, Nitrogen, Industrial Air, Service water), Fire Proofing of structures, ROVs (Remote Operated Valves), EIVs (Emergency Isolation Valves), Redundancy in trips (1 oo 1; 2 oo 3) and avoidance of spurious trips ;SIL (Safety Integrity Level) in process safety, HIPS (High Integrity Protection System),Shutdown system reset – Field or Controlled room, Centralized Vs Decentralized Control centre, Need of Chemical filter in Control Room Air conditioning, Cyber-attack prevention, Mutual aid plan. Case Studies – From Peer Industries on Performance Benchmark, Process safety Management, Safety Culture, Asset Integrity, Litigations, Safety & Environmental Incidents, etc. .

UNIT II ELECTRICAL SYSTEMS 9

Power systems – KV level, 3 phase and single phase, LT, HT generation and distribution network systems, MCC / PCC (motor control centre and power control centre) substations, Electrical Energy Audits, Exergy analysis, Cogen design aspects ; Emergency Power needs based on process criticalities (including power back up for fire water and plant safe shut down), Load shedding, Essential and Non- essential power load ;Uninterrupted Power System (UPS), Load assessment for UPS, Battery bank ;Earth pit design and maintenance aspects, Earth – Neutral Differential & impacts of stray voltage, Fault Level and its relevance in industry, Start-up load, Power from two independent Sources, Relay / Fuse Coordination. Electrical load distribution and its influence on safety relief / flare load in an industrial complex, Interphase with DCS (Distributed Control System), PLCs (programmable logic controls), I/P (Current to Pneumatic transmission) convertor failures ;An overview on electrical failures viz. cable fault, over load, over voltage due to surges, lightning strokes, aging of conductor, internal & external stresses on the conductors, spike in power banks, etc., Case Studies – Industries experiences on Steam – Power balance for efficiency enhancement, smart debottlenecking to minimize cable routing & MCC / PCC use, Safety & Environmental Incidents, etc.

UNIT III FLARE SYSTEM 9

LP, HP, LLP and H2S flares, Types – Single Point Flares (Sonic & Subsonic), Multi Point Flares, Coanda Flares, Vent Tips, Enclosed Flares and Air Assisted Gas Flares ;Pilot gas system, Electronic ignition, Flare tip design, Flare noise reduction, Fire Ball prevention, Smokeless flare at worst weather conditions, Radiation impact zone, Flare release scenarios (fire, blocked mode, partial and total power failure), Nitrogen purge, flare header network design; Safety margins in design, Assessing flare loss in a multi units complex where metering individual headers is near impossible ;Flare gas recovery and Zero Flare release, Flare gas quality tracking and hydrogen management in refineries & petrochemicals. Case Studies – Industries experiences viz. Flare tips & header maintenance, Trouble shooting, Smart debottlenecking of units to limit flare load within capacity, Safety & Environmental Incidents, etc.

UNIT IV MITIGATION MEASURES 9

HAZOP (Hazard and Operability Study), HAZID (Hazard identification), HAZAN (Hazard Analysis), EERA (Emergency escape route analysis), SIL (Safety Integrity levels) study, QRA (Quantitative Risk Assessment)and Dispersion studies ;Trip reset (Field and Control Room) and MSDS (Material Safety Data Sheet) for all streams being handled, Bow Tie Analysis, Risk Evaluation using 8 x 8 Matrix, FMEA (Failure Modes And Effects Analysis),Insurance premium assessment and measures to minimize ;Best practices – Updated documentation, SOPs (Standard Operating Procedures), 193 SMPs (Standard Maintenance Procedures), PSM audits, Competency mapping and enhancement, employee loyalty programme, etc. Business risk – Risk in transportation of feed and products especially in sea routes (marine pollution); HSE norms non-compliance; Act of force majeure; etc. Case Studies – Industries experiences such as Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents,etc

UNIT V PROCESS CONTROL & INSTRUMENTATION 9

Pneumatic (analogue controls) to DCS journey, Single loop Vs Multi loop controls, I/O cards, Graphic design & grouping to minimize user latency in process control ;Designed for safety through redundancy right from dedicated impulse lines to card level, PLC (Programmable Logic Controls), Cascaded Control, Process Historian, Online reporting by exception, Inferential predictions ;Use of AI / ML in controlling plant within best operating zone, QMIs (Quality Measuring Instruments), Alarm rationalization, Operator Fatigue ;Functional designs in delayed (by a few seconds) trip, Machine monitoring viz. signature analysis (vibration and axial displacement), surge control with differing mol wt of process gas, tribology analysis ;Emphasis on lab instrumentation to get “tell-tale” indications on existence of unsafe conditions, hand held instrumentations to work in confined space, communication system (field & control room, etc.) etc. CCTV at select places to monitor and alert well in advance. Centralized fire control panel for the whole premises by way of wired network of safety sensors. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: learn the safety systems both to prevent incident & to minimize loss

CO2: understand the safety in electrical systems

CO3: knowledge on flare systems and their safety

CO4: get thorough knowledge on risk analysis and mitigation

CO5: knowledge on the control systems and their safety usage in different process industries

CO6:: understand the safety CCTV at select places

TEXT BOOKS :

1. Chemical Process Safety: Fundamentals With Applications - DANIEL A CROWL
2. Fundamentals of Process Safety Engineering - Samarendra Kumar Biswas

REFERENCE:

1. Chemical Process Safety - Aarti Kashyap
2. Process Safety - Klein James A and Bruce K Vaughan

U23CHV54	MATERIAL SELECTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand various degradation mechanism that engineers' face in chemical plants
- To mitigate with right choice metallurgy or chemical solution or operational changes

UNIT I CORROSION 9

Different Degradation Mechanism as seen in various Chemical process industries, Corrosion (wet H2S, Naphthenic acid bearing Crude Processing, CO2 stress corrosion cracking, polythionic acid formation potential, amine stress corrosion cracking, microbiologically induced corrosion, corrosion under insulation, galvanic corrosion, caustic embrittlement, introduction & diffusion of hydrogen, Chloride stress corrosion cracking, etc.) ;Monitoring and prevention, NACE (National Association of Corrosion Engineers) guidelines, Life Cycle Cost Optimization and right MOC (Material of construction), Trade-off between MOC Vs Chemical inhibitors / Additives Solutions ;'NO HARM' requirements in chemical solutions, Operation within 'best operating zone', Corrosion coupons and test methods in lab, Need & challenges in asset Integrity management, Coatings, Leak Detection & Repair. Case Studies – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.

UNIT II ASSETS RELIABILITY ENHANCEMENT & INCIDENT ELIMINATION **9**

Risk envelope, Inputs on FERT (Fire, Explosivity, Reactivity and Toxicity), Quantification of unplanned interruption viz. impact on Safety, Environment and Loss of properties / business erosion, Early Event Detection using AI / ML, Surface Chemistry, Advanced Lab Techniques (SEM - Scanning Electron Microscopy, Corrosion probes, Field Signature Method, Non-intrusive techniques, Ultimate Analysis, Atomic ratios on debris, Tell-Tale Indications, etc.), Case Studies – From Industries on process / equipment reliability viz. Asset integrity, Asset sweating within safe operating window, Design errors, Safety & Environmental Incidents, Human factors, etc.

UNIT III FLOW AND ACOUSTIC INDUCED VIBRATION IN PIPES **9**

Flow Induced Vibration in pipes: Flow regimes – Slug flow, plug flow, annular, dispersed, etc. Flows in Vertical and Horizontal pipes, Design criticalities in two phase (gas & liquid) and slurry flow (solid and liquid), Handling of steam condensate& prevention of water hammering, Piping Configurations for symmetrical flow distribution, Use CFD (Computational Fluid Dynamics) to assess - selective erosion in some section of pipes, cycling pattern of vibration, heat flux or fluid film temperature variation in heater tubes, etc., Suitability of Material of Constructions for different operating severity and feed stocks including changes in process conditions during start up, shut down, catalyst pre-sulphating, etc. Acoustic induced vibrations in pipes due to high velocity gas streams in pipes (Near sonic velocity conditions). Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting and controlling flow regimes to avoid vibration, Design tips, Safety & Environmental Incidents, etc.

UNIT IV FOULING AND COKING **9**

Asphaltenes precipitation, Wax deposits, Gum formation, Ageing of hydrocarbon on prolonged storage and filter plugging ;Dewatering and prevention of ingress of corrosion products leading to fouling, dead zone (stagnant) prevention, Inserting storage tanks to avoid oxidation induced feed / product degradation, Incompatibility of mixing, Shear stress assessment, Assessment of Cokeprecursors and elimination / removal during processing ;Chemical (anti-foulant) additives to mitigate fouling / coking, process variables impacting fouling specially in exchangers, heater pipes and column internals, Methods of decoking – steam-air decoking, mechanical, pigging and spalling ;Use of quench oil in gas / naphtha cracker heaters to keep asphaltenes in suspension, polymerisation prevention, hypothesis on coking viz. pyrolytic coke, filamentous coke, amorphous coke formation, etc. Case Studies – From Industries on operational excellence viz. Trouble shooting, Efficacy of chemicals, Processing different feedstocks with confidence, Design tips, Safety & Environmental Incidents, etc.

UNIT V ADVANCEMENT IN MATERIAL SCIENCE 9

Academy to list the course content including use of graphene, metal organic framework, super conductors, replacement of Lithium for battery making, etc. In addition, Nano materials, there are lot more efforts needed to minimize dependence on import for some of the metals used in catalyst, defence needs, etc. which can only be substituted with effective end application needs and metallurgy and or alloy use. Case Studies – From market and strategic needs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the basic concept on corrosion and their types in chemical industry

CO2: know the degradation mechanism that engineers' face in chemical plants

CO3: recognize the different flows in pipes and their acoustic induced vibrations

CO4: gain knowledge in the concept of fouling in pipes and methods of decoking

CO5: gather some knowledge on advancement in material science usage

CO6: understand the basic concept on market and strategic needs.

TEXT BOOKS :

1. Corrosion Mechanisms (Chemical Industries) - Florian Mansfeld
2. Organic Chemicals in the Environment Mechanisms of Degradation and Transformation - Alasdair H. Neilson, Ann-Sofie Allard

REFERENCE:

1. NACE documents - American Petroleum Institute (API) 571 standards

U23CHV55	STATUTORY REQUIREMENTS AND CUSTOMER CARE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the purpose of competitive edge within the regulatory systems set
- To leverage learning to become SMART manufacturer within norms of responsive care

UNIT I PEOPLE AND PROCESS SAFETY 9

Factory Act, IBR (Indian Boiler Regulations), Weights & Measures, Power Connection from State Electricity Board, Labour Legislation, Compensation, Fines, Litigations, Image, etc. and other commercial approvals like company registration, GST Registration, IT act, Excise Regulations etc. For operations under EOU (Export oriented units) or SEZ (Special Economic Zones), take additional approval from Export Processing Zone (EPZ) and SEBI. Case Studies – Assess the number of days taken for all such approval and apply LEAN to crunch time

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UNIT II SAFETY PROGRAMMES AND PROCEDURES 9

Water act, Air act, for highly polluting industry category EIA (Environment Impact Assessment) is mandatory, Environmental Protection Act, Licence needed for 'Drugs & Pharmaceuticals' from State Drug Controller, Hazardous substance management, Waste Management rules, Pollution Control Boards / Consent to operate (State and Union Government) specially for Industries Requiring Water and Affecting Effluent Disposal… Case Studies – Assess the number of days taken for all such approval and apply LEAN to crunch time. Additionally, benchmark on HSE norms to compare with peer industries for improvement options.

UNIT III CUSTOMER CARE 9

Customer definition, Kano Model, CRM, PFABFS model (Property, Feature, Advantage, Benefit and Savings both monetary and emotional value); Product Supply Specification based on end use applications with competitive edge over peer industries; Quality Cost, Custody transfer precision, Wing to Wing co-operation with customers / suppliers to enhance value chain returns; Development of new products and services – Ideation, proof of concept, pilot run & commercialization. Case Studies – Products & Services that made difference, Companies that disappeared when changes were not picked up in time, Point of Sale tips for lasting impression, Cycle time to launch new product.

UNIT IV INTERNSHIP PREPARATION AND DO'S & DON'TS 9

Safety Contact, Mandatory use of PPE, Assembly points, Alarm station, Mock drills, Firefighting apparatus use on demand, know the escape routes; Shadow the trainer, learning objective – pick any one viz. Catalysis – past say three to five catalyst change, the conversion variation, generation of low value side reactions, sintering & loss of margin, H2

loss, any tell-tale indications from apple core tests of spent catalyst, Deep dive into design of say, heat exchangers network with a view to achieve O&M excellence, Asset reliability – O&M efforts to continuously track PSM critical equipment, Energy benchmarking, Overall processing margins against best in class peer industries, Inventory management and assessment of revenue by blocked investment, Water management, etc. Case studies – In nearby cluster of industries at Tamil Nadu, assess O&M gaps and work to bridge the gap, learn about competencies gaps, past LFIs with RCA initiated, etc.

UNIT V SUSTAINABILITY REPORTING 9

Understanding aspects like 'Net Zero Concept', Green House Gases release reduction, ZLD (zero Liquid discharge), Benefits to the society, Concepts of linear economy and circular economy, Life Cycle Analysis, Think Global and Act Local, learn on 17 Sustainable Development Goals as per UN charter, Use Global Reporting Initiative (GRI) formats for Sustainability reporting, Project assignment – Work on Sustainability reporting for nearby cluster of industries in Tamil Nadu

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: understand the basic on different acts and their regulations
CO2: basic knowledge in different ACT on water, air and environmental protection
CO3: knowledge on the preparation of Kano model, CRM, PFABFSCO4 – gain the knowledge on Do's and Don'ts in an internship program
CO4: : understand the concepts of Water management
CO5: understand the concepts of ZLD, GHG release and circular economy
CO6: knowledge on the Project assignment.

TEXT BOOKS :

1. Beyond Competitive Advantage - Todd Zenger, 2016 Competitive Advantage: Creating and Sustaining Superior performance – Michael E. Porter

REFERENCE:

1. Sustainability What Everyone Needs to Know - Paul B. Thompson, Patricia E. Norris

U23CHV56	PROCESS PLANT UTILITIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the design and management of utilities system in any chemical industry
- To apply energy conservation techniques right at design and strive net zero emission

UNIT I BASIC UTILITIES 9

Air (Industrial Service and Instrument), Cold Box air Liquification Plant, Nitrogen, Inert gas generation; Water (Potable, Service, Utility, Cooling Boiler Feed water, DM water, Desal water, RO permeate, etc.); Steam (High Pressure, Medium, Low and Very Low-pressure system), Condensate Polishing, Hot oil system, Thermic fluids for energy supply to Process equipment.

UNIT II POWER GENERATION 9

Power Generation : Gas turbines (types of fuel Vs operational reliability), Open and closed cycle, Steam Turbine generators, Power Recovery Turbo generators, IC Engines Power Generators, Renewables Power – Solar, Wind, Waves, Geo thermal, Biomass.

UNIT III WASTEWATER TREATMENT 9

Wastewater Treatment: Bioremediation, WWTP (Wastewater Treatment Plants along with separation system and biochemical processes to reduce BOD / COD (Biochemical Oxygen Demand and Chemical Oxygen Demand), Recalcitrant material adding to COD, Considerations in deployment of RO Membrane and reuse of treated water. Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

UNIT IV GAS PROCESSING 9

LNG/ CNG, Refinery Gas Treating, Sour Gas Processing, Amine Absorption and Regeneration Processes, Sulphur Recovery & Removal, Gas dehydration & Dew pointing..

UNIT V COOLING WATER SYSTEM 9

Cooling water System: Cooling towers (CT), Wet and Dry Bulb and its relation to CT performance, Induced Vs Natural Draft CT, COC (Cycle of Concentration), Minimize / eliminate drift loss, CW network, assessment of cooling effectiveness in multiple parallel exchangers with availability of combined flow.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: gain knowledge in the importance of process plant utilities

CO2: Understand the Requisites of Industrial Water and treatment methodologies

CO3: be familiar on various types of steam generators and boiler corrosion

CO4: Understand the concept of refrigeration used in industries

CO5: Learn the classification of compressors and humidification equipments

CO6: Understand the concept of Environmental Incidents

TEXT BOOKS :

1. Introduction to Process Engineering and Design – Shuchen B Thakore & Bharat I Bhatt (2017) McGraw Hill 2nd Edition.

2. Plant Utilities - D. B. DHONE Publisher Nirali Prakashan, 2018

REFERENCE:

1. A Working Guide to Process Equipment - Norman Lieberman, Elizabeth Lieberman

ELECTIVE– MANAGEMENT COURSES

U23GET71	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The Main Learning objective of This Course is To Prepare the students For:

1. Sketch The evolution Of management.
2. Extract the function sand Principles of management.
3. Learn the application of the principles in an Organization.
4. Study the various hr Related activities.
5. Analyse the position of self And company goals towards Business.

UNITI INTRODUCTIONTOMANAGEMENTAND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management

UNITII PLANNING 9

Nature and purpose of planning–Planning process–Types of planning–Objectives–Settingobjectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNITIII ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNITIV DIRECTING 9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques–Jobsatisfaction–Jobenrichment–Leadership–typesandtheoriesofleadership– Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNITV CONTROLLING 9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

At the end of the course the students would be able to

CO1 : Understanding of managerial functions like planning, organizing, staffing, leading & controlling.

CO2 : Basic knowledge on international aspect of management.

CO3: Ability to understand management concept of organizing.

CO4: Ability to understand management concept of directing.
CO5: Ability to understand management concept of controlling
CO6: Understand the application of the principles in an organization.

TEXT BOOKS:

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGrawHill, 1998.
2. StephenP. Robbins and MaryCoulter,“Management”,PrenticeHall(India)Pvt.Ltd.,10th

REFERENCEBOOKS:

1. Robert Kreitner and MamataMohapatra,“Management”,Biztantra,2008.
2. StephenA. Robbins and DavidA.Decenzo and MaryCoulter,“Fundamentals of
3. Management”PearsonEducation, 7thEdition,2011.
4. Tripathy PC and ReddyPN, “Principles of Management”, TataMcgrawHill, 1999.

U23GET72	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
2. Learn the TQM Principles for application.
3. Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
4. Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
5. Illustrate and apply QMS and EMS in any organization.

UNITI INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNITII TQM PRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNITIII TQMTOOLS&TECHNIQUESI 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfall sand Criticisms of Benchmarking -FMEA- Intent, Documentation, Stages: Design FMEA and Process FMEA.

UNITIV TQMTOOLS&TECHNIQUESII 9

Quality circles–Quality Function Deployment (QFD)-Taguchiquality loss function –TPM– Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

UNITV QUALITYMANAGEMENT SYSTEM 9

Introduction-BenefitsofISORegistration-ISO9000SeriesofStandards-Sector-SpecificStandards- AS 9100, TS16949 and TL9000- ISO 9001 Requirements-Implementation-Documentation Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

At the end of the course the students would be able to

CO1 : Ability to apply TQM concepts in a selected enterprise.

CO2 : Ability to apply TQM principles in a selected enterprise.

CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.

CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.

CO5: Ability to apply QMS and EMS in any organization.

CO6: Understand the basics of Six Sigma and apply Traditional tools, Newtools, Benchmarking and FMEA.

TEXT BOOKS:

1. Dale H. Bester filed, Carol B.Michna, Glen H. Bester field, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

REFERENCEBOOKS:

1. Joel.E.Ross, "Total Quality Management– Textand Cases",Routledge, 2017.
2. Kiran.D.R,"TotalQualityManagement:Keyconceptsandcasestudies,Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM–TextwithCases", Butterworth–HeinemannLtd., Oxford, Third Edition, 2003.
4. Suganthi,Land Anand Samuel, "Total Quality Management", Prentice Hall (India)Pvt. Ltd., 2006

U23GET73	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Understanding the concept of Engineering Economics.
2. Implement various microeconomics concepts in real life.
3. Gaining knowledge in the field of macroeconomics to enable the students to have better
4. Understanding of various components of macroeconomics.
5. Understanding the different procedures of pricing.

UNIT I DEMAND & SUPPLY ANALYSIS 9

Managerial Economics - Relationship with other disciplines -Firms: Types, objectives and goals - Managerialdecisions-Decisionanalysis.Demand-Typesofdemand–Determinantsofdemand- Demand function – Demand elasticity - Demand forecasting - Supply – Determinants of supply - Supply function -Supply elasticity.

UNIT II PRODUCTION AND COST ANALYSIS 9

Productionfunction-Returnstoscale-Productionoptimization-Leastcostinput-Isoquants-Managerial uses of production function. Cost Concepts –Cost function-Determinants of cost-Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

UNIT III PRICING 9

Determinants of Price- Pricing under different objectives and different market structures- Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARYTREATMENT) 9

Balancesheetandrelatedconcepts-Profit&LossStatementandrelatedconcepts –Financial Ratio Analysis - Cash flow analysis - Funds flow analysis – Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9

Investments-Risks and return evaluation of investment decision-Averagerate of return-Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

CO2: Evaluate the economic theories, cost concepts and pricing policies

CO3: Understand the market structures and integration concepts

CO4: Understand the measures of national income, the function sofbanks and concepts of globalization

CO5: Apply the concepts of financial management for project appraisal

CO6: Understand the various cost related concept sinmicro economics.

TEXT BOOKS:

1. Panneer Selvam,R,“Engineering Economics”,Prentice Hall of IndiaLtd, NewDelhi,2001.
2. Managerial Economics: Analysis, ProblemsandCases-P.L.Mehta, Edition, 13.Publisher, Sultan Chand, 2007.

REFERENCEBOOKS:

1. ChanS.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald.G.Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010
3. Degarmo, E.P., Sullivan, W.GandCanada, J.R, “EngineeringEconomy”, Macmillan, New York, 2011.
4. ZahidAkhan: Engineering Economy, "EngineeringEconomy",DorlingKindersley,2012
5. Dr.S.N.Maheswariand Dr.S.K.Maheshwari: Financial Accounting, Vikas,2009

U23GET74	HUMAN RESOURCE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide knowledge about management issues related to staffing,
2. To provide knowledge about management issues related to training
3. To provide knowledge about management issues related to performance
4. To provide knowledge about management issues related to compensation
5. To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNITI INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9

The importance of human resources– Objective of Human Resource Management– Human resource policies - Role of human resource manager.

UNITII HUMAN RESOURCE PLANNING 9

Importance of Human Resource Planning– Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

UNITIII TRAINING AND EXECUTIV EDEVELOPMENT 9

Types of training and Executive development methods– purpose– benefits

UNITIV EMPLOYEE COMPENSATION 9

Compensation plan–Reward–Motivation– Career Development -Mentor–Protégé relationships.

UNITV PERFORMANCE EVALUATION AND CONTROL 9

Performance evaluation– Feedback- The control process– Importance– Methods– grievances– Causes – Redressal methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: To gain knowledge on the various aspects of HRM

CO2: To gain knowledge needed for success as a human resources professional

CO3: To develop the skills needed for a successful HR manager

CO4: To prepare to implement the concepts learned in the workplace

CO5: To aware of the emerging concepts in the field of HRM

CO6: Gainknowledgeonmanagementissuesrelatedtohumanfactorsconsiderationand compliance with human resource requirements.

TEXT BOOKS:

1. Decenzo and Robbins,"HumanResourceManagement",8thEdition,Wiley,2007.
2. John Bernardin.H. ,"Human Resource Management –An Experimental Approach", 5thEdition, Tata McGraw Hill, 2013, New Delhi.

REFERENCE BOOKS:

1. LuisR. Gomez-Mejia, DavidB.Balkin and RobertL. Cardy, “Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited,2007.

U23GET75	KNOWLEDGE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Learn the Evolution of Knowledge management.
2. Be familiar with tools.
3. Be exposed to Applications.
4. Gain knowledge on the concepts of some case studies.
5. Gain knowledge on management Applications.

UNITI INTRODUCTION 9

Introduction: An Introduction to Knowledge Management -The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management – Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNITII CREATINGTHE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNITIII KNOWLEDGE MANAGEMENT-THETOOLS 9

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management – Knowledge Management and Vocabulary Control – Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNITIV KNOWLEDGE MANAGEMENT APPLICATION 9

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Centre, Knowledge, Management in the Health Sciences, Knowledge Management in Developing Countries).

UNITV FUTURETRENDSANDCASESTUDIES 9

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan – A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSEOUTCOMES:

At the end of the course the students would be able to

CO1 : Under stand the process of acquire knowledge from experts.
CO2 : Understand the learning organization.
CO3: Use the knowledge management tools.
CO4: Develop knowledge management Applications.
CO5: Design and develop enterprise applications.
CO6: Understand the Evolution of Knowledge management.

TEXT BOOKS:

1. Srikantaiah, T.K., Koenig,M., “Knowledge Management for the Information Professional” Information Today, Inc., 2000.

REFERENCEBOOKS:

1. 1.Nonaka,I.,Takeuchi,H.,“TheKnowledge-CreatingCompany:HowJapaneseCompanies Create the Dynamics of Innovation”, Oxford University Press, 1995.

U23GET76	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions functioning professional organizations.
2. To study the planning; organizing and staffing functions of management in professional organization.
3. To study the leading; controlling and decision making functions of manage mention professional organization.
4. To learn the organization altheory in professional organization.
5. To learn the principles of productivity and modern concepts in manage mention professional organization.

UNITI INTRODUCTIONTO MANAGEMENT 9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg'sTenManagerialRoles–PrinciplesofTaylor;Fayol;Weber;Parker–Forms of Organization:SoleProprietorship;Partnership;Company(PrivateandPublic);Cooperative– PublicSectorVs.PrivateSectorOrganization –Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNITII FUNCTIONSOFMANAGEMENT-I 9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNITIII FUNCTIONSOFMANAGEMENT-II 9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) –Communication:Purpose;Model;Barriers–Controlling:Process;Types;Levels;Guidelines; Audit(External, Internal, Merits);PreventiveControl–DecisionMaking:Elements;Characteristics; Nature; Process; Classifications.

UNITIV ORGANIZATIONTHEORY 9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNITV PRODUCTIVITYANDMODERN TOPICS 9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSEOUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Explain basic concepts of management; approaches to management; contributors to management studies;
- **CO2 :** Discuss the planning; organizing and staffing functions of management in professional organization.
- **CO3:** Apply the leading; controlling and decision making functions of management in professional organization.
- **CO4:** Discuss the organization altheory in professional organization.
- **CO5:** Apply principles of productivity and modern concepts in management in professional organization.
- **CO6:** Develop various forms of business organization and trade unions function in professional organizations.

TEXT BOOKS:

1. M.GovindarajanandS.Natarajan,"PrinciplesofManagement",PrenticeHallofIndia,New Delhi, 2009.
2. Koontz.H.andWeihrich.H.,"EssentialsofManagement:AnInternationalPerspective",8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCEBOOKS:

1. JosephJ, Massie,"Essentials of Management",4thEdition,PearsonEducation, 1987.
2. Saxena,P.K.,"PrinciplesofManagement:AModernApproach",GlobalIndia Publications, 2009.
3. S.Chandran,"Organizational Behaviours",Vikas Publishing HousePvt. Ltd.,1994.
4. RichardL.Daft,"OrganizationTheoryandDesign",SouthWesternCollegePublishing,11th Edition, 2012.
5. S.TrevisCerto,"ModernManagementConceptsandSkills",PearsonEducation,2018.

U23CHO01	ENERGY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart in depth understanding of the issues related with renewable energy and their development.

UNIT I INTRODUCTION TO CONVENTIONAL AND NON-CONVENTIONAL ENERGY SOURCES **9**

Conventional energy sources; non-conventional energy sources; Energy sources, Coal, Oil, Natural gas, nuclear fuels, Hydro power advantages. Classification of fuels. Introduction to solar energy, Solar radiation and its measurement, , solar radiation at earth's surface, solar radiation geometry, solar radiation measurement. Applications, solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

UNIT II ENERGY FROM BIOMASS (BIO – ENERGY): INTRODUCTION **9**

Biomass conversion Technologies. Wet processes, Dry processes. Biogas generation. Factors affecting bio digestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant.

UNIT III BIO – ENERGY (THERMAL CONVERSION) AND ELECTRICAL CONDUCTION (MHD) **9**

Methods of obtaining energy from biomass, Thermal gasification of biomass, Classification of biomass gasifiers, Chemistry of gasification process, Applications of the gasifiers. Magneto hydrodynamic generator, electrical conductivity and formation of MHD, performance comparison of open and closed cycle.

UNIT IV WIND ENERGY AND OTEC **9**

Basic components of WECS (wind energy conversion system): Classification of WECS, Types of wind machines, horizontal axis machines, vertical axis machines. Applications of wind energy. Energy from the oceans: Introduction, Ocean thermal electric conversion (OTEC), Methods of ocean thermal electric power generation, Open cycle OTEC system, Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans.

UNIT V FUEL CELLS BASICS AND WASTE HEAT RECOVERY **9**

Fuel Cells, Difference between batteries and fuel cells, Components of fuel cells, Principle of working of fuel cells, Fuel cell types: Alkaline fuel cells. Polymer electrolyte fuel cells, Phosphoric acid fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Applications. Co-generation- waste heat recovery and heat pump.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Understand various conventional and non- conventional energy sources.
CO2 - Evaluate the advantages and disadvantages of various types of bio gas generators
CO3 - Demonstrate the working principle of biomass gasifiers
CO4 - Classify wind energy conversion systems
CO5 - Compare the various methods of generating ocean thermal electric power
CO6 - Demonstrate the working principle of various kinds of fuel cells.

TEXT BOOKS :

1.Rai G.D., Non Conventional Energy Sources, 4th Edition, Khanna Publishers, New Delhi, 2004.
2. Rao S.S., Energy Technology, 3rd Edition, Khanna Publishers, New Delhi, 2009

REFERENCE:

1.R.K.Singal, Efficient utilization of energy, 2nd Edition ,New Age International Publishers, New Delhi ,2017
2.Christopher H. and Armsteed H., Geothermal Energy, 3rd Edition, John Wiley, New York, 2000.

U23CHO02	CORROSION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide fundamental understanding of aspects of electrochemistry and material science relevant to corrosion phenomena, prevention and remediation of corrosion.

UNIT I INTRODUCTION 9

Definition of Corrosion, corrosion damage, effect of material safety and reliability, classification of corrosion, expression of corrosion rate, electrochemical corrosion reaction, redox reaction, effect of oxygen, oxidizers. Effect of temperatures, concentration of chemicals on corrosion rate, Corrosion: direct & two stage attack, electrochemical attack.

UNIT II TYPES OF CORROSION 9

Effect of galvanic coupling, metallurgical aspects, metallic properties, ringworm corrosion, Principle of modern corrosion theory, Forms of corrosion, Uniform attack, galvanic corrosion, crevice corrosion, pitting inter-granular corrosion and hydrogen damage, higher corrosion resistance through proper selection of material.

UNIT III CORROSION PROTECTTIVE MEASURES 9

Technologies of anodisation, enameling, rubber lining, glass lining, refractory lining, painting and other surface protective measures. Pourbaix Diagram For Iron, Magnesium And Aluminum.

UNIT IV APPLICATION OF CORROSION ENGINEERING 9

Corrosion engineering in special applications such as material transport, pumping, filtration, condensation, boiling, riveting, welding, and high temperature environments. Surfacing Processes – CVD And PVD Processes, Sputter Coating. Laser and Ion Implantation, Arc Spray, Plasma Spray, Flame Spray, HVOF.

UNIT V CORROSION TESTING AND MEASUREMENTS 9

Corrosion testing, monitoring and inspection, laboratory corrosion test, accelerated chemical tests for studying different forms of corrosion, electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, cost factor in competitive corrosion prevention and inhibition techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, student will be able to

CO1 - Equipped with in an introduction to corrosion and its mechanism/types.

CO2 - Enable to explain the different types of corrosion.

CO3 - Inculcate the protective measures to overcome corrosion.

CO4 - Development of advanced technological process for corrosion prevention.

CO5 - Measurement and monitoring of corrosion mechanism.

CO6 - Attribute in depth knowledge to solve industrial corrosion situations.

TEXT BOOKS :

1. Uhlig. H.H. "Corrosion And Corrosion Control". 2nd edition, John Wiley & Sons. New York. USA. 2002.

2. Butler, G. &Ison, H.C.K., Corrosion & its Prevention in Waters, 5th Edition, Leonard Hill, London, 2010.

3. Maslow, P., Chemical Materials for Construction, 3rd Edition, Structures Publishing Co., 2001.

REFERENCE:

1. Fontance, M.G. &Gtretrnee, N.D., Corrosion Engineering, 4th Edition, McGraw Hill, 2006.

2. Rajagopalan, K.S. Corrosion and its Prevention, Chemical Engineering Education Development Centre, IIT Madras,
2005.

U23CHO03	INTRODUCTION TO INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on safety engineering fundamentals and safety management practices.

UNIT I INTRODUCTION 9

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT II CHEMICAL HAZARDS 9

Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation – Industrial Hygiene – Industrial Toxicology.

UNIT III ENVIRONMENTAL CONTROL 9

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring

Instruments, Control of Noise, Vibration, - Personal Protection.

UNIT IV HAZARD ANALYSIS 9

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

UNIT V SAFETY REGULATIONS 9

Explosions – Disaster management – catastrophe control, hazard control , Safety education and training - Factories Act, Safety regulations Product safety – case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students must be able to identify and prevent chemical, environmental mechanical.
CO2: Understand the fire hazard through analysis.
CO3: Apply proper safety techniques on safety engineering and management.
CO4: Understand the Industrial Health Hazards and Environmental Control.
CO5: Gain knowledge about System Safety Analysis and Techniques.
CO6: Gain knowledge on Factories Act and apply it on Product safety.

TEXT BOOKS :

1. John V.Grimaldi, “Safety Management”, AITB S Publishers, 2003.
2. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.

REFERENCE:

1.Safety Manual, “EDEL Engineering Consultancy”, 2000.
2. David L.Goetsch, “Occupational Safety and Health for Technologists”, 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.

		L	T	P	C
U23CHO04	**ADVANCES IN POLLUTION CONTROL**	**3**	**0**	**0**	**3**

OBJECTIVES:

The purpose of learning this course is to

- Provide exposure to the pollution control techniques.
- Generate awareness about the environmental pollution.
- Understand the concept of pollution prevention.
- Understand about the clean technology.
- Provide knowledge on -which will enable the students to have a career and professional accomplishment in the public or private sector.

UNIT I ENVIRONMENT AWARENESS 9

Environment - friendly Chemical Process; Hazard and risk analysis; Environmental Audit.

UNIT II CHEMICAL ENGINEERING PROCESSES 9

Unit Operations - application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes.

UNIT III ADVANCED WASTEWATER TREATMENT 9

Technologies used in advanced treatment - Classification of technologies Removal of Colloids and suspended particles - Depth Filtration - Surface Filtration - Membrane Filtration Absorption – Ion exchange - Advanced oxidation process.

UNIT IV CLEAN TECHNOLOGY 9

Towards Eco-friendly products of chemical industry - Handling emerging pollutants in industrial effluent.

UNIT V POLLUTION PREVENTION 9

Mass exchange network synthesis for pollution control and minimization implications environmental constrains for process design - Policies for regulation of environmental impacts – Concept of common effluent treatment – Environmental legislations – Role of Government and Industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By the end of the course students will be able to

CO1: Aware of past, present and future environment.
CO2: Understand the importance of chemical engineering processes.
CO3: Apply the concept of environmental audit.
CO4: Understand the concepts behind the methodologies to control pollution.
CO5: Apply recycling concepts behind pollution prevention.
CO6: Understand the Concepts of common effluent treatment

TEXT BOOKS :

1. Rao, c s environmental pollution control engineering ,wiley lasern,1991.
2. Peavy H.S. R.owe D.R., and George Technologious, Environmental EngineerinB, McGraw 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 l{all Inc, NY.1982.

REFERENCE:

1. Coulson,,J.M. Richardson, J.F apd R.K Sinnott, Chemical Eng.i\neering Vol. 6, Pergomon.

U23CHV32	INDUSTRIAL WASTE WATER TREATMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The purpose of learning this course is to Focus on the wastewater treatment.
- Analyze the process.
- Understand the theory chemical unit processes.
- Study the biological treatment processes.
- Provide knowledge on advanced treatment processes.

UNIT I WASTE WATER TREATMENT AN OVER-VIEW 9

Terminology - Regulations - Health and Environment Concerns in waste water management - Constituents in waste water inorganic - Organic and metallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION 9

Components of waste water flows - Analysis of Data - Reactors used in waste water treatment - Mass Balance Analysis - Modeling of ideal and non ideal flow in Reactors - Process Selection.

UNIT III CHEMICAL UNIT PROCESSES 9

Role of unit processes in waste water treatment chemical coagulation -Chemical precipitation for improved finance chemical oxidation -Neutralization - Chemical Storage.

UNIT IV BIOLOGICAL TREATMENT 9

Overview of biological treatment- Microbial metabolism- Bactreial growth and energatus- Aerobic Biological oxidation – Anaerobic fermentation and oxidation- Trickling filters – Rotating biological contractors- Combined aerobic Process- Activated sludge flim packing.

UNIT V ADVANCED WASTE WATER TREATMENT 9

Technologies used in advanced treatment- classification of technologies – removal of colloids and suspended particles – depth filtration – surface filtration – membrane filtration absorption – ion exchange – advanced oxidation process.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Have knowledge on physical/chemical/biological characteristics.
CO2: Understand the general treatment process.
CO3: Apply the concepts of chemical unit processes.
CO4 : Study the biological treatment processes.
CO5: Apply the knowledge on advanced treatment processes.

CO6: Understand the filtration processes.

TEXT BOOKS :

1.Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.
2. Waste water Engineering Treatment and reuse Mc Graw Hill , G. Fehobanoglous, H. Biston,2002.

REFERENCE:

1. Unit Operations of Chemical Engineering" Warren. L.McCabe. Julian C.Smith. Peter.
2. Separation Process Principles, J D Seader and E J Henly, John Wiley & sons, NY 1998.

		L	T	P	C
U23CHO05	**WASTE TO ENERGY**	**3**	**0**	**0**	**3**

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated.
- Develop knowledge on biomass pyrolysis process and its applications.
- Develop knowledge on various types of biomass gasifiers and their operations.
- Invent knowledge on biomass combustors and its applications on generating energy.
- Summarize the principles of bio-energy systems and their features.

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE **9**

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT II BIOMASS PYROLYSIS **9**

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION **9**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design,construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bioenergy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production –Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated.
CO2 – Gain knowledge on biomass pyrolysis process and its applications.
CO3 – Develop knowledge on various types of biomass gasifiers and their operations.
CO4 – Gain knowledge on biomass combustors and its applications on generating energy.
CO5 – Understand the principles of bio-energy systems and their features.
CO6 – Develop knowledge on Urban waste to energy conversion.

TEXT BOOKS :

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

REFERENCE:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

U23CHV24	HYDROGEN AND FUEL CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create awareness about alternate clean fuel available. To familiarize the students with the concepts and chemistry of fuel cell

UNIT I INTRODUCTION 9

Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.

UNIT II FUEL CELL KINETICS 9

Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction, exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

UNIT III CHARACTERIZATION TECHNIQUES 9

Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.

UNIT IV RENEWABLE SOURCES 9

Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

UNIT V APPLICATIONS OF FUEL CELL 9

Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable applications

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO 1: aware of alternate energy sources and its importance of it.

CO2 : understand the fuel cell kinetics

CO3: able to understand the characterization techniques

CO4: Analyze the renewable sources and storage

CO5: Understand the applications of fuel cells in various fields.

CO6: Understand the concepts of Fuel cell modeling and system

TEXT BOOKS:

1. Gregor Hoogers, “Fuel Cell Technology Handbook”, CRC Press, 2003.
2. R.P. O'Hayre,S. Cha, W. Colella, F.B. Prinz, “Fuel Cell Fundamentals”, Wiley, 2006.
3. A. J.Bard, L. R. Faulkner, “Electrochemical Methods”, Wiley, 2004

REFERENCES:

1. S. Basu, “Fuel Cell Science and Technology”, Springer, 2007
2. H. Liu, “Principles of Fuel Cells”, Taylor & Francis, 2006

U23CHV16	POLYMER SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Understand the basic concept and classification of polymers
- To know the manufacturing and applications of engineering thermoplastics
- To understand the preparation methods of thermosetting polymers

UNIT I INTRODUCTION TO POLYMERS 9

Basics, classification of polymers, functionality, polymerization techniques- Bulk, solution, suspension and emulsion.

UNIT II ENGINEERING THERMOPLSTICS AND APPLICATIONS 9

Engineering Thermoplstics- Aliphatic polyamides: Structure, properties manufacture and applications of Nylon 6, Nylon 66. Polyesters: Structure, properties manufacture and applications of PET. Structure, properties manufacture and uses of PMMA.

UNIT III THERMOSETTING PLASTICS 9

Preparation, Properties and uses of Epoxy resins, Phenol formaldehyde, Urea Formaldehyde andSilicone resins.

UNIT IV POLYMER PROCESSING AND MOULDING 9

Hand layup, Compression molding, Calendering, Die casting and Thermoforming.

UNIT V POLYMER TESTING 9

Tensile Test, Flexural Test, Impact Test, Thermogravimetric analysis, Dynamic mechanical analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: To study the importance and classification of polymers

CO2: Summaries the raw materials, sources, production, properties and applications of various thermoplastics

CO3: To understand the uses the various thermosetting plastics

CO4: Know the various methods used to processing polymers

CO5: To understand the testing property of polymers

CO6: To understand the various polymers used in engineering field.

TEXT BOOKS:

1. V.R. Gowariker, Polymer Science, New Age International (P) Limited, New Delhi, 2005.

REFERENCES:

1. J.A. Brydson, Plastics Materials, 7 th edition, Butterworth Heinemann (1999)
2. Manas Chanda, SalilK.Roy, Plastics Technology Handbook, 4 thEdn., CRC press

(2006)
3. Vishu Shah, Handbook of Plastic Testing Technology, 3 rdEdn., John Wiley & Sons 2007.

U23CHV31	AIR POLLUTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn about Air Pollution, effects of air pollution, Global effects,
- Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and
- dispersion and Prediction of air quality.

UNIT I INTRODUCTION 9

Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties ofAir Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index.

UNIT II GASEOUS POLLUTANTS 9

Absorption- Principles, Description of equipment-Packed and Plate columns -Design and Performance equations; .Adsorption- Principle Adsorbents, Equipment descriptions - PSA - Adsorption cycle - Solvent recovery system-Continuous Rotary bed, Fluidized bed, Design and Performance equations ; Incinerators, Hydrocarbon incineration kinetics- Equipment description- Design and Performance equations.

UNIT III PARTICULATE AIR POLLUTION 9

Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficiency – Gravity Settling chambers Cyclones- Electrostatic precipitators and Bag houses.

UNIT IV AIR POLLUTION CONTROL 9

Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristics and control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters – Techniques of air pollution control - equipments

UNIT V AIR POLLUTION MODELLING 9

Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the nature and characteristics of air pollutants, and basic concepts of air quality management.

CO2: Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards

CO3: Understand the knowledge about particulate air pollutants and control devices.

CO4: Relate the air quality behaviour and its measurement

CO5: Control the air pollution in industries using various models.

CO6: Understand the concept of Pollution Prevention

TEXT BOOKS :

1. Richardw.Boubeletal.,"FundamentalsofAirPollution",AcademicPress, NewYork,1994.
2. NoelDeNevers,"AirPollutionControlEngg.",McGrawHill,NewYork,1995.
3. M.N.Raoetal.,"AirPollution"TataMcGrawHill,1989

REFERENCE:

1. David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.
2. Stern, A.C., Air Pollution (Vol.I – Vol.VIII), Academic Press, 2006.
3. Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons,Inc.,2000.
4. Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd
5. Edition John Wiley Sons, 2012
6. Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4th edn, 1997.

U23CHO06	PAPER TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- **To enable the students to describe about special paper machines, various processes of paper finishing**

UNIT I MACHINES 9

General description, Stock and machine chest, Regulation boxes, riffles and screens, Origin and development of paper machines.

UNIT II FOUDRINIE 9

Foudrinier part - Foudrinier part operation details, description of press part, press housing, press rolls and doctors, Management and care of press felts.

UNIT III DRYERS 9

Dryer part, Description of typical dryer part, Types of dryers, Steam supply, and control, Handling dryers, felts, Paper machine ventilation..

UNIT IV SPECIAL PAPER MACHINES 9

Calendars - Winders, slitters and reels, cylinder machine, web end and machine details, operating details, special paper machines.

UNIT V PAPER FINISHING 9

Handmade paper and paper finishing, coated papers, paper testing, paper making details.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the basic machineries of paper mill.

CO2: Identify, the press parts.

CO3: Understand the knowledge about various dryers

CO4: understand the various paper machines.

CO5: understand the paper finishing technology.

CO6: Understand the concept of paper technology methods.

TEXT BOOKS :

1. Bearce, George D., Manufacture of Pulp and Paper, Volume V, Mc Graw Hill, New York, 1989

2. MacKinney, R.W.J., Technology of Paper Recycling, Springer publishers, London, 1995.

REFERENCE:

1. Sabit Adanur, Asten ., Paper Machine Clothing: Key to the Paper Making Process, CRC Press New York, Published 1997.

2. Allison Stark Draper, Paper and Pulp Industry, Rosen Publishing Group, 2001.

U23CHO07	SUGAR TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to describe about special sugar mill machines, various processes**.**

UNIT I INTRODUCTION 9

Sugar industry in India. Chemical and Physical properties of Sucrose and reducing sugars. Source for Sucrose. Formation of sucrose plants. Non sugar compounds of sugar cane. Inorganic constituents of sugar cane juices and sugars. Analytical methods used in Sugar Industry.

UNIT II PURIFICATION 9

Chemical technology of the purification processes. Fundamental reactions and physical chemistry aspects of clarification. Liming, sulphitation and carbonation processes. Filtration of sugar juice.

UNIT III EVAPORATION 9

Evaporation of sugar juice. Heat transfer in evaporators. Evaporation equipment and auxiliaries. Methods of obtaining steam and quality of steam. Steam economy. Chemistry of the evaporation process. Scale formation and cleaning of evaporators.

UNIT IV CRYSTALLIZATION 9

Solubility of sucrose. Solubility of sucrose - nucleation in super saturated solutions - kinetics and growth of crystallization. Chemistry of crystallization. Control methods and equipment in sugar crystallization; Technology of sugar crystallization. Evaporation and circulation in vacuum pans

UNIT V CENTRIFUGATION 9

Theory of the centrifugal processes. Centrifugal operation. Engineering principles of sugar centrifugals and the centrifugal process. Centrifugal equipment and auxiliaries. Production of final molasses and its utilizations. Grading of sugar.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1: Understand the basic of sugar mills.

CO2: Identify, the purification process.

CO3: Understand the knowledge about various Evaporation methods

CO4: understand the various crystallization methods

CO5: understand the centrifugation process

CO6: Understand the concept of sugar manufacturing methods.

TEXT BOOKS :

1. Honig P., Principles of Sugar Technology, Vol.1,2 and 3, Elsevier Publishing Company, 1953.

2. Van der Poel P.W., Schwartz T.K., Schiweck H.M., Sugar Technology [Beet and Cane Sugar Manufacture], Beet Sugar Development Foundation (Fort Collins, Colo.), Fourth Edition, Verlag Dr Albert Bartens KG, 1998.

REFERENCE:

1. Payne J.H., Sugarcane factory Analytical control, Fifth Edition, Elsevier Publisher, London, 1968.
2. Jenkins G.H., Introduction to Sugarcane technology, Elsevier Publisher, London, 1966.

U23CHV35	PROCESS SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to learn the operation and methodologies in petrochemical industries
- To enable students to learn the application of petrochemicals in all process fields
- To enable students learn each products of petrochemical industries and its application with production techniques in detail.

UNIT I PROCESS SAFETY INFORMATION 9

Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) – Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization of formats for capturing PSI, Challenges

UNIT II SAFETY PROGRAMMES AND PROCEDURES 9

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning

UNIT III ACCIDENT ANALYSIS 9

Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations ; Past accident analysis Fixborough- Mexico- Chernobyl nuclear disaster-Bhopal gas analysis-process safety indicators

UNIT IV PROCESS HAZARD ANALYSIS 9

Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA,Overview of PHA Techniques, Selection of PHA techniques Implementation ofrecommendation – Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

UNIT V SAFETY MANAGEMENT 9

Employee Participation – Overview, Benefits of Employee participation, Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes-Institutionalizing and integrating safety into the PSM fabric, 5 tier approach, selection, training, Performance monitoring; Case studies – Process safety management in industry – present and futuristic approach.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1- understand the fundamental knowledge on petroleum and its products

CO2- learn the usage of coal, types and its composition

CO3- gather knowledge on the properties, classification and products of natural gas

CO4- understand the fundamentals of nuclear engineering

CO5- knowledge on the usage of nuclear reactors, nuclear waste management and safety usage. CO6: understand the fundamentals of Asset Integrity Process Hazard Analysis

TEXT BOOKS :

1. Breeze, Paul. Nuclear power. Academic Press, 2016
2. Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversion processes and applications. Newnes, 2016
3. Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable and Conventional. " Khanna Publication, 3rd (2012)

REFERENCE:

1. Dr.M.D.Rageeb Md,Usman Sanjay A, Nagdev,Dr.Ravindra S.Sonawane ,Hazards and Safety Management, Khanna Publication,2020