ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Alagappa College of Technology

Department: Applied Science and Technology

Programme: B.Tech. Petroleum Engineering and Technology

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I	-	-	4	11	-	-	7	1	-	23
II	-	-	6	15	-	-	-	1	-	22
III	17	-	3	4	-	-	-	-	-	24
IV	15	3	-	-	-	-	2	3	-	23
V	13	3	-	-	-	-	4	3	-	23
VI	-	9	-	-	3	3	3	3	1	22
VII	14	3	-	-	3	3	2	-	-	25
VIII	-	-	-	-	-	-	8	-	-	8
Total	59	18	13	30	6	6	26	11	1	170
% of Category	34.7%	10.6%	7.6%	17.6%	3.5%	3.5%	15.3%	6.5%	0.6%	100%

CATEGORY OF COURSES

PCC – Professional Core Course

PEC – Professional Elective Course

ETC – Emerging Technology Course

OEC – Open Elective Course

SLC – Self Learning Course

ESC – Engineering Science Course

HSMC – Humanities Science and Management Course

SDC – Skill Development Course

UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER – I							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4.	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
5.	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
6.	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
7.	UC23H01	தமிழர்மரபு /Heritage of Tamils	T	1-0-0	1	1	UC
8.	-	NCC/NSS/NSO/YRC		0-0-2	2	-	UC
9.	-	Audit Course–I	-	-	-	-	UC
TOTAL CREDITS						**23**	

*** TCP –** Total Contact Period(s)

#**TYPE OF COURSE**

LIT – Laboratory Integrated Theory
T – Theory
L – Laboratory Course
IPW – Internship cum Project Work
PW – Project Work
CDP – Capstone Design Project

SEMESTER – II							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	PE23201	Solid Mechanics and Offshore Structures	T	3-0-0	3	3	ESC
5.	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
6.	CY23C07	Organic Chemistry for Technologists	LIT	3-0-2	5	4	HSMC
7.	UC23H02	தமிழரும் தொழில்நுட்பமும்/Tamils and Technology	T	1-0-0	1	1	UC
TOTAL CREDITS						**22**	

SEMESTER – III							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	MA23C07	Numerical and Statistical methods	T	3-1-0	4	4	HSMC
2.	PE23301	Fluids and Solid operations	LIT	3-0-2	5	4	PCC
3.	PE23302	Stoichiometry	T	3-0-0	3	3	PCC
4.	GY23C02	Petroleum Geology	LIT	3-0-2	5	4	PCC
5.	PE23303	Thermodynamics for Petroleum Engineers	T	3-0-0	3	3	PCC
6.	PE23304	Reservoir Engineering	T	3-0-0	3	3	PCC
7.	PE23305	Instrumental Methods of Analysis	T	3-0-0	3	3	ESC
8.	-	Audit Course–II	-	-	-	-	UC
TOTAL CREDITS						**24**	

SEMESTER – IV							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23401	Process Heat Transfer	LIT	3-0-2	5	4	PCC
2.	PE23402	Drilling Operations	LIT	3-0-2	5	4	PCC
3.	PE23403	Petroleum Refining and Petrochemicals	LIT	3-0-2	5	4	PCC
4.	-	Skill Development Course I	-	-	-	2	SDC
5.	PE23404	Chemical Reaction Engineering	T	3-0-0	3	3	PCC
6.	-	Professional Elective –I	T	3-0-0	3	3	PEC
7.	PE23U01	Standards - Petroleum Engineering and Technology	T	1-0-0	1	1	UC
8.	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
TOTAL CREDITS						**23**	

SEMESTER – V							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23501	Petroleum Formation Evaluation	T	3-0-0	3	3	PCC
2.	PE23502	Well Completion Techniques	T	3-0-0	3	3	PCC
3.	PE23503	Mass Transfer	LIT	3-0-2	5	4	PCC
4.	PE23504	Petroleum Production Engineering	T	3-0-0	3	3	PCC
5.	-	Professional Elective II	T	3-0-0	3	3	PEC
6.	-	Skill Development Course II	-	-	-	2	SDC
7.	-	Industry Oriented Course – I	-	-	-	1	SDC
8.	PE23U02	Perspectives of Sustainable Development	LIT	2-0-2	4	3	UC
9.	PE23505	Summer Internship I	IPW	0-0-2	2	1	SDC
TOTAL CREDITS						**23**	
COURSES FOR HONOURS DEGREE (OPTIONAL)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – I	T	3-0-0	3	3	PEC
2.	-	Honours Elective – II	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE (OPTIONAL)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	-	Minor Elective – I	T	3-0-0	3	3	PEC
2.	-	Minor Elective – II	T	3-0-0	3	3	PEC

SEMESTER – VI (PREFERENCE FOR FOREIGN EXCHANGE)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	-	Professional Elective – III	T	3-0-0	3	3	PEC
2.	-	Professional Elective – IV	T	3-0-0	3	3	PEC
3.	-	Professional Elective – V	T	3-0-0	3	3	PEC
4.	-	Open Elective I	T	3-0-0	3	3	OEC
5.	-	Emerging Technology Course I	-	-	-	3	ETC-I
6.	PE23L01	Self-Learning Course	L	0-0-2	2	1	SLC
7.	-	Skill Development Course III	-	-	-	2	SDC
8.	-	Industry Oriented Course –II	-	-	-	1	SDC
9.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
					TOTAL CREDITS	**22**	
COURSES FOR HONOURS DEGREE (OPTIONAL)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23D02	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – III	T	3-0-0	3	3	PEC
2.	-	Honours Elective – IV	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE (OPTIONAL)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	-	Minor Elective – III	T	3-0-0	3	3	PEC
2.	-	Minor Elective – IV	T	3-0-0	3	3	PEC

SEMESTER – VII							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23701	Water flooding and Enhanced Oil Recovery	T	3-0-0	3	3	PCC
2.	PE23702	Process Dynamics and Control	LIT	3-0-2	5	4	PCC
3.	PE23703	Compliances In Oil And Gas Industry	T	3-0-0	3	3	PCC
4.	PE23704	Petroleum Equipment Design	T	3-1-0	4	4	PCC
5.	-	Open Elective II	T	3-0-0	3	3	OEC
6.	-	Professional Elective – VI	T	3-0-0	3	3	PEC
7.	-	Emerging Technology Course II	-	-	-	3	ETC-II
8.	-	Industry Oriented Course - III	-	-	-	1	SDC
9.	PE23705	Summer Internship	IPW	0-0-2	2	1	SDC
TOTAL CREDITS						**25**	
COURSES FOR HONOURS DEGREE (OPTIONAL)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – V	T	3-0-0	3	3	PEC
2.	-	Honours Elective – VI	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE (OPTIONAL)							
1.	-	Minor Elective – V	T	3-0-0	3	3	PEC
2.	-	Minor Elective – VI	T	3-0-0	3	3	PEC

SEMESTER – VIII							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE#**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.	PE23801	Project Work / Internship cum Project Work	IPW	0-0-16	16	8	SDC
				Total Credits		**8**	

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Professional Elective	Vertical I Upstream Processing	Vertical II Petrochemical Process Technology	Vertical III Hydrocarbon Transportation and Storage	Vertical IV Health, Safety and Environment	Vertical V Process Intensification	Vertical VI Energy Engineering
1.	Oil and Gas Well Testing	Petrochemical Unit processes	Piping Engineering	Principles of safety management	Multi Component Distillation	Renewable and Non-renewable Energy
2.	Offshore Drilling and Production Practices	Corrosion in the oil and Gas Industry	Storage Transportation of Crude oil and Natural gas	Industrial safety, health and environment acts	Emergency Response and Disaster Management	Energy Conservation and Management
3.	Mud Engineering	Process Equipment Auxiliaries and Utilities	Design of Pressure Vessels and storage Vessels	Fire engineering	Optimization of Chemical Processes	Energy Auditing & Demand Side Management
4.	Integrated Oil and Gas reservoir Management	Polymer Technology	Pipeline Engineering	Safety in oil & gas industry	Modern Separation Techniques	Energy Storage Systems
5.	Flow Assurance	Carbon capture storage and Sequestration	Petroleum Economics and merger acquisition	Industrial hygiene	Fluidization Engineering	Biofuels
6.	Reservoir Modelling and Simulation	Fertilizer Technology	Transportation and Marketing of Petroleum and Petroleum Products	Transportation system and safety	Waste Management	Unconventional Hydrocarbon Sources
7.	Natural Gas Engineering and Processing	Petrochemical Derivatives	City Gas Distribution	Drilling Safety	LNG & Storage of Natural Gas	Circular Economy
8.	Advanced Drilling Technology	Refinery Process Design	Product Design and Development for Petrochemical Engineers	Process hazard analysis	Process Modelling and simulation	Optimum Utilization of Heat and Power

VERTICAL I: UPSTREAM PROCESSING

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23001	Oil and Gas Well Testing	T	3-0-0	3	3
2.	PE23002	Offshore Drilling and Production Practices	T	3-0-0	3	3
3.	PE23003	Mud Engineering	T	3-0-0	3	3
4.	PE23004	Integrated Oil and Gas Reservoir Management	T	3-0-0	3	3
5.	PE23005	Flow Assurance	T	3-0-0	3	3
6.	PE23006	Reservoir Modeling and Simulation	T	3-0-0	3	3
7.	PE23007	Natural Gas Engineering and Processing	T	3-0-0	3	3
8.	PE23008	Advanced Drilling Technology	T	3-0-0	3	3

VERTICAL II: PETROCHEMICAL PROCESS TECHNOLOGY

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23009	Petrochemical Unit processes	T	3-0-0	3	3
2.	PE23010	Corrosion in the oil and Gas Industry	T	3-0-0	3	3
3.	PE23011	Process Equipment Auxiliaries and Utilities	T	3-0-0	3	3
4.	PE23012	Polymer Technology	T	3-0-0	3	3
5.	PE23013	Carbon capture storage and Sequestration	T	3-0-0	3	3
6.	PE23014	Fertilizer Technology	T	3-0-0	3	3
7.	PE23015	Petrochemical Derivatives	T	3-0-0	3	3
8.	PE23016	Refinery Process Design	T	3-0-0	3	3

VERTICAL III: HYDROCARBON TRANSPORTATION AND STORAGE

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23017	Piping Engineering	T	3-0-0	3	3
2.	PE23018	Storage Transportation of Crude oil and Natural gas	T	3-0-0	3	3
3.	PE23019	Design of Pressure Vessels and storage Vessels	T	3-0-0	3	3
4.	PE23020	Pipeline Engineering	T	3-0-0	3	3
5.	PE23021	Petroleum Economics and merger acquisition	T	3-0-0	3	3
6.	PE23022	Transportation and Marketing of Petroleum and Petroleum Products	T	3-0-0	3	3
7.	PE23023	City Gas Distribution	T	3-0-0	3	3
8.	PE23024	Product Design and Development for Petrochemical Engineers	T	3-0-0	3	3

VERTICAL IV: HEALTH, SAFETY AND ENVIRONMENT

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23025	Principles of safety management	T	3-0-0	3	3
2.	PE23026	Industrial safety, health and environment acts	T	3-0-0	3	3
3.	PE23027	Fire engineering	T	3-0-0	3	3
4.	PE23028	Safety in oil & gas industry	T	3-0-0	3	3
5.	PE23029	Industrial hygiene	T	3-0-0	3	3
6.	PE23030	Transportation system and safety	T	3-0-0	3	3
7.	PE23031	Drilling Safety	T	3-0-0	3	3
8.	PE23032	Process hazard analysis	T	3-0-0	3	3

VERTICAL V: PROCESS INTENSIFICATION

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23033	Multi Component Distillation	T	3-0-0	3	3
2.	PE23034	Emergency Response and Disaster Management	T	3-0-0	3	3
3.	CH23C02	Optimization of Chemical Processes	T	3-0-0	3	3
4.	PE23035	Modern Separation Techniques	T	3-0-0	3	3
5.	PE23036	Fluidization Engineering	T	3-0-0	3	3
6.	PE23037	Waste Management	T	3-0-0	3	3
7.	PE23038	LNG & Storage of Natural Gas	T	3-0-0	3	3
8.	PE23039	Process Modelling and simulation	T	3-0-0	3	3

VERTICAL VI: ENERGY ENGINEERING

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23040	Renewable and Non-renewable Energy	T	3-0-0	3	3
2.	PE23041	Energy Conservation and Management	T	3-0-0	3	3
3.	PE23042	Energy Auditing & Demand Side Management	T	3-0-0	3	3
4.	PE23043	Energy Storage Systems	T	3-0-0	3	3
5.	PE23044	Biofuels	T	3-0-0	3	3
6.	PE23045	Unconventional Hydrocarbon Sources	T	3-0-0	3	3
7.	PE23046	Circular economy	T	3-0-0	3	3
8	PE23047	Optimum Utilization of Heat and Power	T	3-0-0	3	3

EMERGING TECHNOLOGY COURSES (ETC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23E01	Reservoir and Refining Simulation	L	0-0-6	6	3
2.	PE23E02	Digitalization for Oil & Gas Industry	T	3-0-0	3	3
3.	PE23E03	Data analytics and AI for oil and gas industry	T	3-0-0	3	3
4.	PE23E04	Hydrogen Energy: Production, Storage, Transportation and Safety	T	3-0-0	3	3

SKILL DEVELOPMENT COURSES (SDC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23S01	Industrial Instrumentation	T	2-0-0	2	2
2.	PE23S02	Simulation Tools For Petroleum Engineers	L	0-0-4	4	2
3.	PE23S03	Computer Aided Design And Computer Aided Engineering	L	0-0-4	4	2
4.	EN23C03	Employability Skills Lab	L	0-0-4	4	2

OPEN ELECTIVE COURSE (OEC)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS / WEEK		CREDITS
				L-T-P	TCP*	
1.	PE23901	Introduction to Petroleum Engineering	T	3-0-0	3	3
2.	PE23902	Industrial Safety Management	T	3-0-0	3	3
3.	PE23903	Lifestyle Modifications and Health in Unison	T	3-0-0	3	3
4.	PE23904	Biomass Conversion And Technologies	T	3-0-0	3	3

COURSES TO BE STUDIES BY DIPLOMA LATERAL ENTRY STUDENTS

SL. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE#	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	CATE GORY
				L	T	P			
1	CS23C02	Computer Programming in Python	LIT	3	0	2	5	4	ESC
2	PE23201	Solid Mechanics and Offshore Structures	T	3	0	0	3	3	ESC

COURSES TO BE STUDIES BY B.SC LATERAL ENTRY STUDENTS

SL. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE#	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	CATE GORY
				L	T	P			
1	ME23C01	Engineering Drawing and 3D Modelling	LIT	2	0	4	6	4	SDC
2	PE23201	Solid Mechanics and Offshore Structures	T	3	0	0	3	3	ESC

UNIVERSITY COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	UC23H01	தமிழர்மரபு /Heritage of Tamils	T	1	0	0	1	1
2.	-	NCC/NSS/NSO/YRC	L	0	0	2	2	0
3.	-	Audit Course - I*	T	2	0	0	2	0
4.	UC23H02	தமிழரும் தொழில்நுட்பமும்/Tamils and Technology	T	1	0	0	1	1
5.	-	Audit Course -II*	T	2	0	0	2	0
6.	PE23U01	Standards - Petroleum Engineering and Technology	T	1	0	0	1	1
7.	UC23U01	Universal Human Values	LIT	1	0	2	3	2
8.	PE23U02	Perspectives of Sustainable Development	LIT	2	0	2	4	3
9.	UC23E01	Entrepreneurship Development Course	LIT	2	0	2	4	3

EN23C01 **FOUNDATION ENGLISH** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS **6**

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS 9+3

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- Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.

CO 2 :Use differential calculus ideas on several variable functions.

CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.

CO 4 :Apply multiple integral ideas in solving areas and volumes problems.

CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint,

New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

CY23C01 **ENGINEERING CHEMISTRY** **L T P C**

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion-measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing

Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

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

1’ = Low; ‘2’ = Medium; ‘3’ = High

CS23C02 COMPUTER PROGRAMMING IN PYTHON L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
- To solve problems using data structures and abstraction techniques.
- To create programming solutions using libraries and packages.
- To design solutions to domain problems using programming problem-solving techniques.

UNIT I – Structured Programming 9+6

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching**.**

PRACTICALS:

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

UNIT II – Modularity and Decomposition 9+6

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

PRACTICALS:

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

UNIT Ill – Data Structures and Abstractions 9+6

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries: Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

PRACTICALS:

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions
- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations
- Create Python programs using Dictionary, Nested Dictionary and comprehensions

- Create Python programs by applying functional programming concepts

UNIT IV – Libraries and Modules **9+6**

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

PRACTICALS:

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

UNIT V – Simple Problem Solving Techniques in Programming **9+6**

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

TOTAL = 45 + 30 = 75 PERIODS

Course Outcomes

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

TEXT BOOKS

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First Edition, 2023

REFERENCE BOOKS

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.
4. Python official documentation and tutorial, https://docs.python.org/3/
5. Numerical Python official documentation and tutorial, https://numpy.org/

CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		1								1	1	
2	2		2		1								1	1	
3	2	1	2		1								1	1	
4	2	1	2	1	1								1	1	
5	2	1	2	1	1								1	1	
Avg	2	1	2	1	1								1	1	

1 - low, 2 - medium, 3 - high, '-' - no correlation

ME23C01	ENGINEERING DRAWING AND 3D MODELLING	L	T	P	C
		2	0	4	4

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

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UNIT 1: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

(6+12 = 18 Hours)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT 2: PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

(6+12 = 18 Hours)

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches

UNIT 3: 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

(6+12 = 18 Hours)

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT 4: SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

(6+12 = 18 Hours)

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT 5: LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

(6+12 = 18 Hours)

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

COURSE OBJECTIVES

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

COURSE OUTCOMES

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

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD software

CO4: Determine the true shape of a sectioned solid and draft the assembled parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

Text book

1. "Engineering Drawing" by N S Parthasarathy and Vela Murali, Oxford University Press; UK ed. Edition, 2015.

2. “Engineering Drawing + Auto CAD” by Venugopal K, V. Prabhu Raja, New Age International Publishers, Sixth edition (1 January 2022).

References

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta, Charotar Publishing House, 2nd edition, 2018.
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal, Vikas Publishing House, 3rd edition, 2020.
3. "Engineering Drawing With Auto CAD" by B V R Gupta, McGraw Hill Education, 4th edition, 2019.
4. "Engineering Drawing" by P S Gill, Tata McGraw Hill Education, 5th edition, 2018.
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe, Cengage Learning, 2nd edition, 2020.
6. "Engineering Drawing" by M B Shah, Charotar Publishing House, 3rd edition, 2019
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi, Pearson Education, 2nd edition, 2018.
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy, Scitech Publications, 3rd edition, 2020.
9. "CAED: Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B, CBS Publishers & Distributors, 2nd, 2019.
10. "Computer-Aided Engineering Drawing" by Subrata Pal, Oxford University Press, 2nd, 2020.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.
ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.
iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.
iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.
ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.
iii. Hands-on session of preparing base material & Joint groove for welding.
iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.
ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,
iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.
iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.
ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.
iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.
v. Hands-on session of integration of sensors and actuators with a Microcontroller.
vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.
ii. Demonstration of Assembly Modelling of components.
iii. Fabrication of simple components / parts using 3D Printers.
iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.

CO2: Make simple parts using suitable welding processes.

CO3: Setup wiring of distribution boards, machines, etc.

CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.

CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
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 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 C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **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 aClassical Language - C lassical 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.

UNIT V 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 C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L T P C 2 0 0 2

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 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
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 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
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 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02 **PROFESSIONAL COMMUNICATION** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT **6**

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: **6**

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION **6**

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: **6**

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION **6**

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: **6**

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT **6**

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: **6**

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab Assessment
- Group discussion (Peer assessment)
- Listening

External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to
- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.

2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.
3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.
Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01	ENGINEERING PHYSICS	L	T	P	C
	(Common to all branches of B.E/B.Tech Programmes)	3	0	2	4

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS 9+6

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS 9+6

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

1. Non-uniform bending -Determination of Young's modulus of the material of the beam.
2. Uniform bending -Determination of Young's modulus of the material of the beam
3. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS 9+6

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

1. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
2. Melde's string experiment - Standing waves.
3. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS 9+6

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer –– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers –– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

1. Laser - Determination of the width of the groove of the compact disc using laser. Laser Parameters
   Determination of the wavelength of the laser using grating
2. Air wedge -Determination of the thickness of a thin sheet/wire
3. Optical fibre - Determination of Numerical Aperture and acceptance angle
   -Determination of bending loss of fibre.
4. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

1. Photoelectric effect – Determination of Planck's constant.
2. Black Body Radiation (Demonstration)
3. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.

4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

PE23201	SOLID MECHANICS AND OFFSHORE STRUCTURES	L	T	P	C
		3	0	0	3

OBJECTIVE:

This course will help students expand their knowledge on the basic principles established in solid mechanics and offshore structures.

UNIT – I: **9**

Stresses and strains: kinds of – stress-strains, elasticity and plasticity, Hooks law, stress – strain diagrams, modules of elasticity, Poisson's ratio, linear and volumetric strain, relation between E, N, and K, bars of uniform strength, compound bars and temperature stresses.

UNIT – II: **9**

Types of supports – loads – Shear force and bending moment for cantilever and simply supported beams without overhanging for all types of loads.

Theory of simple bending, simple bending formula, Distribution of Flexural and Shear stress in Beam section – Shear stress formula – Shear stress distribution for some standard sections

UNIT – III: **9**

Thin cylindrical shells: stress in cylindrical shells due to internal pressures, circumferential stress, longitudinal stress, design of thin cylindrical shells, spherical shells, change in dimension of the shell due to internal pressure, change in volume of the shell due to internal pressure.

Thick Cylinders: Lame's equation- cylinders subjected to inside and outside pressures columns and Struts.

UNIT – IV **9**

Floating structures, basic hydrostatics, centre of gravity, center of buoyancy, displacement, law of floatation, draft, keel, Simpson's rule for areas and centroids, second moments of area, moments of inertia, mass moment of inertia, calculation of metacentric height, Stability of floating structures, Definition of neutrally and positively buoyant structures.

UNIT – V **9**

Functions of offshore structures, Fixed offshore structures, Types of fixed structures, fabrication, transportation, installation and operation of offshore structures, construction of offshore concrete structures, Definition of compliant structures, Types of complaint structures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamental principles of stresses and strains.
CO2: Assess different types of supports and loads.

CO3: Critically evaluate the cylindrical shells
CO4: Develop stability of floating structures.
CO5: Evaluate the functions of offshore structures and fixed offshore structures.

TEXT BOOKS:

1. Junarkar, S.B., Mechanics of Structure Vol. 1, 21st Edition, Character Publishing House, Anand, Indian, (1995).
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series, McGraw Hill International Editions, Third Edition, 1994.
3. Bansal, R.K, Strength of Materials, Laxmi Publications(P) Ltd., Fourth Edition 2010.
4. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", McGraw-Hill Education (India) Pvt. Ltd. 10th Edition, 2013.
5. A Textbook of Fluid Mechanics and Hydraulic Machines. By R. K. Bansal,· Laxmi Publication.

REFERENCE BOOKS:

1. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)
4. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.

COURSE ARTICULATION MATRIX:

Course Outcome	Statements	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the fundamental principles of stresses and strains	3	3	3	2	1	3	3	3	1	2	3	3	2	-	-
CO2	Assess different types of supports and loads	3	3	3	2	-	3	3	3	1	2	3	3	2	-	-
CO3	Critically evaluate the cylindrical shells	3	3	3	2	-	3	3	3	1	2	3	3	2	-	-
CO4	Develop stability of floating structures	3	3	3	2	-	3	3	3	1	2	3	3	2	-	-
CO5	Evaluate the functions of offshore structures and fixed offshore structures	3	3	3	2	-	3	3	3	1	2	3	3	2	-	-
Overall CO		**3**	**3**	**3**	**2**	**1**	**3**	**3**	**3**	**1**	**2**	**3**	**3**	**2**	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

EE23C03	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

UNIT-I BASIC ELECTRICAL CIRCUITS 6

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES 6

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation.

AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS 6

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT Applications: Diode Bridge Rectifier and Shunt Regulator.

Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS 6

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION 6

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments, Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter- DSO - Block Diagram Approach.

TOTAL:30 PERIODS

LAB COMPONENET:

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
8. Characteristics of LVDT.
9. Three phase power measurement using two wattmeter method.
10. Study of DSO.

COURSE OUTCOMES:

Students will be able to

CO1 Compute the electric circuit parameters for simple circuits.

CO2 Understand the working principles and characteristics of electrical machines.

CO3 Understand the basic electronic devices.

CO4 Understand the basic operating principles of sensors and transducer.
CO5 Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, “Basic Electrical and Electronics Enigneering”, McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, “Principles of Electrical Engineering and Electronics”, McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, “Principles of Electrical Machines”, S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, “Electronic principles”, McGraw Hill Education, Seventh Edition, 2017.

Mapping COs and POs:

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

CY23C07	ORGANIC CHEMISTRY FOR TECHNOLOGISTS	L	T	P	C
		3	0	2	4

OBJECTIVE

The course is aimed to teach various reaction mechanisms, preparation of organic compounds and their properties which will be a base for the study on Chemical Reaction Engineering

UNIT I CARBOHYDRATES 9

Introduction – various definitions and classifications of carbohydrates – Configurations of aldoses and ketoses upto six carbon atoms- D and L configurations – Anomerism- Epimerism- Preparation, Chemical properties, different structures (Fisher, Haworth, Pyranose and Furanose) and Uses of Monosaccharides (Glucose & Fructose). Ascending in carbohydrate series – (Aldo pentose to aldo hexose by Kiliani- Fischer, Improved Kiliani Fischer, Wolfrom and Sowden methods) – Descending in carbohydrate series (Aldo hexose to aldo pentose by Ruff, Wohl and Mac Donald methods) - aldose to isomeric Ketose – Ketose to isomeric Aldose – Aldose to epimer

LIST OF EXPERIMENTS 6

1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturated compounds: Identification and characterization of various functional groups by their characteristic reactions of carbohydrates.

UNIT II HETEROCYCLIC COMPOUNDS 9

Preparation and Industrial applications of 5 and 6 membered hetero cyclic compounds and their derivatives – Pyrrole, Furan, Furfural, Tetrahydro Furan, Thiophene and Pyridine and fused heterocyclic compounds - Indole, Quinoline and Isoquinoline. Conversion of THF into Nylon 6-6

LIST OF EXPERIMENTS 6

1. Identification and characterization of various functional groups by their characteristic reactions of alcohol and aldehyde

UNIT III SYNTHESIS OF IMPORTANT ORGANIC COMPOUNDS 9

Synthesis of hydrocarbons, higher alkanes, alkenes, alkynes, alcohols, esters, aldehydes, mono and di carboxylic acids, diketones, cyclic compounds and ring opening reactions from Grignard reagent, Ethyl aceto acetate and Malonic ester

LIST OF EXPERIMENTS 6

1. Identification and characterization of various functional groups by their characteristic reactions of carboxylic acid, ketone, phenol and ester
2. Analysis of an unknown organic compound and preparation of suitable solid derivatives (Benzoic acid from Benzaldhehyde, hydrolysis of ester and meta- dinitrobenzene from nitrobenzene)

UNIT IV DYE CHEMISTRY **9**

Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Witt's theory and modern theory of colors – synthesis of azo dye, methyl red, methyl orange, congo red, malachite green, p-rosaniline, phenolphthalein, fluorescence, eosin dyes.

LIST OF EXPERIMENTS **6**

Identification and characterization of various functional groups by their characteristic reactions of primary, secondary and tertiary amines and nitro compounds.

UNIT V PHARMACEUTICAL CHEMISTRY **9**

Synthesis of Malonyl urea, Phenacetin, Isoniazid, Para amino benzoic acid (PABA), Tryptophan Isopentaquine, chloroquine (precursors from m-chloroaniline and Ethyl aceto acetate) - Sulphaniliamide from aniline, chloro benzene, p- toluene sulphonamide - Sulphapyridine from N- ASC and p-nitrochlorobenzene and Chlorampenicol (by Baltz and Long's method). Salol from phenol

LIST OF EXPERIMENTS **6**

1. Methodology of filtration and recrystallization: Introduction to organic synthetic procedures:

i. Acetylation – Preparation of acetanilide from aniline.
ii. Hydrolysis – Preparation of salycilic acid from methyl salyciliate.
iii. Substitution – Conversion of acetone to iodoform.
iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.
v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On successful completion of the course students are expected to

CO1: Classify different types of carbohydrates and to prepare them.
CO2: Discuss the properties and uses of heterocyclic compounds
CO3: Compare and contrast the chemical properties of Grignard reagent, EAA and malonic ester
CO4: Recall the theories and mechanism and to practice reaction of dyes.
CO5: Describe the procedure for synthesizing various Pharmaceutical drugs and their uses.

TEXT BOOKS:

1. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (1996) USA.
2. K.S. Tiwari, N.K. Vishnoi and S.N. Malhotra "A text book of Organic Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998) New Delhi.

REFERENCES:

1. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd., New Delhi,1994.
2. I L Finar "Organic Chemistry" ELBS (1994).
3. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.I Publishing Pvt.Ltd., New Delhi, 1994.
4. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications,Mumbai,1995.

Course Articulation Matrix:

Course Outcome	Statements	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	Classify different types of carbohydrates and to prepare them.	2	2	1	2	1	-	-	-	-	-	-	3	-	-	1
CO2	Discuss the properties and uses of heterocyclic compounds.	2	2	1	2	1	-	-	-	-	-	-	3	3	-	1
CO3	Compare and contrast the chemical properties of Grignard reagent, EAA and malonic ester.	2	2	1	2	1	-	-	-	-	-	-	3	3	-	1
CO4	Recall the theories and mechanism and to practice reaction of dyes.	2	2	1	2	1	-	-	-	-	-	-	3	-	-	1
CO5	Describe the procedure for synthesizing various Pharmaceutical drugs and their uses.	2	2	1	2	1	-	-	-	-	-	-	3	3	-	1
Overall CO		**2**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
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 உற்பத்தித் தொழில் நுட்பம்: **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 வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **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 அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: **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 : 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) (Publishedby: 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.

UC23H02 **TAMILS AND TECHNOLOGY** **L T P C**
1 0 0 1

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 NayakarMahal -ChettiNadu 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 Stonebeads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

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-REFERENCEBOOKS

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 C ivilization 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) (Publishedby: 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.

MA23C07	NUMERICAL AND STATISTICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand and apply numerical methods for solving systems of linear equations.
- To understand and apply numerical integration and differentiation.
- To solving initial value problems of ordinary differential equations numerically.
- To provide an understanding of the statistical methods and concepts by which real-life problems are analyzed.
- To analyze various data by using Statistical Techniques.

UNIT I ROOT FINDING METHOD AND SYSTEM OF LINEAR EQUATIONS 9+3

Root finding for algebraic and transcendental equations – Newton Raphson method – Simultaneous linear equations – Direct methods – Gauss elimination and Gauss Jordan methods – Iterative methods – Jacobi and Gauss Seidal methods - Matrix Inversion by Gauss-Jordan method – Eigen values of a matrix by Power method.

UNIT II INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Difference table – equal intervals: Newton's forward and backward interpolation – unequal intervals: Newton's divided differences (case) – Lagrange's interpolation – Differentiation formulae for equal and unequal intervals– Trapezoidal, Simpson rules and Gaussian-Quadrature formulae.

UNIT III INITIAL VALUE PROBLEMS FOR DIFFERENTIAL EQUATIONS 9+3

Taylor Series and Euler methods, Fourth order Runge-Kutta method for First order, Second and simultaneous Differential Equations – Predictor-corrector method – Milne and Adam-Bashforth methods.

UNIT IV EMPIRICAL STATISTICS 9+3

Types of Sampling - Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot- Correlation and regression analysis.

UNIT V TESTING OF HYPOTHESIS 9+3

Sampling distributions– Type I and Type II errors – Tests based on Normal, t, chi-square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Solution of algebraic and transcendental equations
2. Newton-Raphson method
3. Iterative methods of Gauss-Jacobi and Gauss-Seidel
4. Matrix Inversion by Gauss-Jordan method
5. Eigen values of a matrix by Power method and by Jacobi's method
6. Interpolation with equal and unequal intervals
7. Numerical differentiation and integration
8. Solution of ODE by Taylor series and 4^{th} order R-K method
9. Data exploration using R
10. Correlation and regression analysis
11. Testing of hypothesis in R programming
12. Chi square goodness of fit test in R.

OUTCOMES:

CO1: Understand the various methods used for the numerical solution of scientific problems.
CO2: Solve system of linear equations and initial value problems of ordinary differential equations numerically.
CO3: Understand the value of probability and Statistics in acquiring knowledge and making decisions.
CO4: Apply statistical tests in experiments, as well as to analyze and interpret data.
CO5: Use the statistical tools for their Project work and their future research.

TEXT BOOKS:

1. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2020
2. Grewal, B.S. and Grewal,J.S., "Numerical Methods in Engineering and Science (C, C++, and MATLAB)", Stylus Publishing, LLC, 2018..
3. Miller, I. and Miller, M., "John E. Freund's Mathematical Statistics", Pearson, Eighth Edition, Harlow, 2013.

REFERENCES:

1. Chapra, S. C. and Canale, R. P., "Numerical methods for Engineers", McGraw-Hill Higher Education, 7^{th} Edition, New York, 2014.
2. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, Boston, 2017.
3. Johnson R.A., "Miller and Freund's Probability and Statistics for Engineers", PHI Learning Pvt. Ltd., 8th Edition, New Delhi, 2011.
4. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K., "Probability ad Statistics for Engineers and Scientists", Pearson Education 9th Edition, New Delhi, 2011.
5. Woodford, C and Phillips, C., "Numerical Methods with Worked Examples: Matlab", Springer, Dordrecht, 2012.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PE23301	FLUIDS AND SOLID OPERATIONS	L	T	P	C
		3	0	2	4

OBJECTIVES

To teach the classifications of fluids and their properties and demonstrate the techniques of solid – fluid separation.

UNIT I PROPERTIES OF FLUID 9

Introduction – Physical properties of fluids – Types of fluids – Fluid statics and its applications NewtonianfluidsClassificationoffluidmotionFluidstatics–equilibriumoffluidelement–pressure variation in a static fluid – Differential analysis of fluid motion – continuity, Euler's and Bernoulli equation.

LIST OF EXPERIMENTS 6

1. Calibration of constant and variable head meters
2. Open drum orifice and draining time

UNIT II FLOWTHROUGH PIPES & BOUNDARY LAYER CONCEPTS 9

Reynolds number regimes, Flow through pipes — pressure drop under laminar and turbulent flow conditions; boundary layer concepts; different types of flow meters; Valves, pumps, compressors – characteristics and sizing; Agitation and Mixing; Correction for pump work - Velocity potential - Reynolds experiment and significance.

LIST OF EXPERIMENTS 6

1. Flow through straight pipe
2. Flow through annular pipe
3. Characteristic curves of pumps

UNIT III DIMENSION /SIZE ANALYSIS 9

General characteristics of solids, techniques of size analysis; Laws of size reduction, equipment's for size reduction- 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.

LIST OF EXPERIMENTS 6

1. Sieve analysis
2. Reduction ratio in Jaw Crusher
3. Reduction ratio in Ball mill
4. Reduction ratio of Roll Crusher

UNIT IV FLOW THROUGH FLUIDIZED BEDS 9

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

LIST OF EXPERIMENTS 6

1. Pressure drop studies in packed column
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press

UNIT V CLASSIFIERS **9**

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

LIST OF EXPERIMENTS **6**

1. Separation characteristics of Cyclone separator
2. Characteristics of batch Sedimentation

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamental properties of fluids, stress-strain relationship in fluids and its characteristics under static conditions

CO2: Apply Bernoulli's principle, Navier – Stokes' equation and differentiate pressure variation in static fluid.

CO3: Implement the knowledge about the size reduction techniques.

CO4: Analyse the flows of fluids in their beds.

CO5: Assess various separation and purification techniques employed in solid particles.

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers "Second Edition, McGraw-Hill, 3 rd Edition (2004).
2. S. Pushpavanam, "Introduction to Chemical Engineering" PHI learning private limited, 2012

REFERENCE BOOKS:

1. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 6 th Edition", John Wiley, 2009
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", 7 th edition, McGraw Hill, V Edition, 2004
3. Coulson, J.M. and Richardson, J.F., " Chemical Engineering & quot; Vol. I, 7th Edn., Butterworth-Heinemmann, Elsevier, 2017.

Course Articulation Matrix:

Course Outcomes	Statement	Programme Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	Understand the fundamental properties of fluids, stress-strain relationship in fluids and its characteristics under static conditions	3	3	3	3	3							2	3	3	-
CO2	Apply Bernoulli's principle, Navier – Stokes' equation and differentiate pressure variation in static fluid.	3	3	3	3	3							2	3	3	-
CO3	Implement the knowledge about the size reduction techniques.	3	3	3	3	3							2	3	3	-
CO4	Analyse the flows of fluids in their beds.	3	3	3	3	3							2	3	3	-
CO5	Assess various separation and purification techniques employed in solid particles.	3	3	3	3	3							2	3	3	-
Overall CO		3	3	3	3	3	-	-	-	-	-	-	2	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23302	STOICHIOMETRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To teach the application of mass and energy balance equations for single and network of units.

UNIT I **9**

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

UNIT II **9**

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

UNIT III **9**

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

UNIT IV **9**

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

UNIT V **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOME: (COs)

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

CO1: Understand the fundamentals of the system of units and apply ideal gas law in pure components and mixtures.

CO2: Apply stoichiometric principles in material balance for different process equipment.

CO3: Implement the basics of humidity in humidification and other processes.

CO4: Familiarize the basics of energy balance concepts in different chemical processes.

CO5: Illustrate the basics of fuels and combustion.

TEXT BOOKS:

1. Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, EEE Sixth Edition, Prentice Hall Inc., 2003
2. Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes”,3rdEdn., John Wiley & Sons, New York, 2000.
3. Bhatt, B.L., Vora, S.M., “Stoichiometry “, 4thEdition,Tata McGraw-Hill (2004)

REFERENCE BOOKS:

1. Hougen O A, Watson K M and Ragatz R A, “Chemical process principles” Part I, CBS publishers (1973).
2. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam “ Process Calculations” Printice Hall of India, New Delhi,
3. K.V.Narayanan, B.Lakshmipathy, ‘Stochiometry and Process Calculation”, PHI Learning Ltd.(2013).

Course Articulation Matrix:

Course Outcome	Statement	STOICHIOMETRY														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the fundamentals of the system of units and apply ideal gas law in pure components and mixtures.	3	3	1	1	-	-	-	-	-	-	-	1	-	2	3
CO2	Apply stoichiometric principles in material balance for different process equipment.	3	3	1	2	-	-	-	-	-	-	-	1		-	3
CO3	Implement the basics of humidity in humidification and other processes.	3	3	1	2	-	-	-	-	-	-	-	1	-	2	-
CO4	Familiarize the basics of energy balance concepts in different chemical processes.	3	3	1	1	2	-	-	-	-	-	-	1		2	-
CO5	Illustrate the basics of fuels and combustion.	3	3	1	2	2	-	-	-	-	-	-	1		2	-
Overall CO		3	3	1	1.6	2	-	-	-	-	-	-	1	-	2	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

GY23C02	PETROLEUM GEOLOGY	L	T	P	C
		3	0	2	4

OBJECTIVE:

To teach structural geology, origin and formation of petroleum, petrophysics, depositional systems and biostratigraphy

UNIT I GEOMORPHOLOGY AND SEDIMENTOLOGY 9

Introduction to Geology, Internal structure of Earth, Geomorphic landforms – Alluvial and Marine Landforms; Mineralogy - properties of common rock forming minerals; Petrology - Classification of rocks – Sedimentation process – Description of sedimentary rocks.

LIST OF EXPERIMENTS 6

Identification of major rock forming minerals – Differentiating igneous, sedimentary and metamorphic rocks - Identification of sedimentary rocks such as conglomerate, breccia, sandstone, shale and limestone

UNIT II STRATIGRAPHY AND STRACTURAL GEOLOGY 9

Geological time scale – Stratigraphic cycles -Litho and Biostratigraphy- study of planktic and benthic foraminifera -paleobathymetry analysis - applications of Palynofossils in oil exploration, Structural Geology –strike and dip - classification of folds, faults, joints and unconformities – Geological maps and importance in oil exploration.

LIST OF EXPERIMENTS 6

Measurement of strike and dip using Brunton compass and clinometer - Strike, true dip and apparent dip problems - Measurement of thickness / true width of beds from borehole data.

UNIT III ORIGIN AND PROCESSES OF PETROLEUM FORMATION 9

Concepts of organic and inorganic theories of hydrocarbon - accumulation of organic matter-diagenesis, catagenesis and metagenesis of organic matter – source and reservoir rocks - generation, primary and secondary migration of oil – short and long migration - accumulation of oil and gas in various traps.

LIST OF EXPERIMENTS 6

Maps – map scale, toposheets, study of topographic features, interpretation of contour maps, geomorphological maps, lineament maps and drainage maps –Geological map – symbols – interpretation of geological maps.

UNIT IV GEOPHYSICAL EXPLORATION 9

Introduction to geophysical prospecting – Electrical, seismic, gravity, magnetic and radioactive methods - Seismic profiles interpretation techniques - seismic reflection patterns to decipher the depositional and structural features. Well logging principles – Different types logging and their importance - Well site geological operations - Well construction - drilling fluids and their significance.

LIST OF EXPERIMENTS 6

Exposure to electrical resistivity survey – Demonstration in the field - sounding and profiling Wenner and Schlumberger method problems - problems on gravity and magnetic methods

UNIT V GEOSPATIAL TECHNIQUES AND PETROLIFEROUS BASINS 9

Introduction to photogrammetry - Remote sensing and GIS – Data acquisition and interpretation – Introduction to GPS – Applications of geospatial techniques in oil exploration - Plate tectonic processes– Onshore and coastal basins – Oil deposits in offshore - Petroliferous basins of India - Future prospect of India's petroleum and natural gas resources.

LIST OF EXPERIMENTS 6

Visual interpretation of Aerial photos and Satellite images – Demonstration of stereoscopes – FCC images - Measurement using GPS

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the origin of earth and processes involved in formation of minerals and rocks
CO2: Gain knowledge about the structural geology and formation of petroleum characteristics.
CO3: Perform geophysical exploration studies.
CO4: Comprehend biostratigraphy studies and its application in oil exploration
CO5: Carryout well site geological operations

TEXT BOOKS:

1. A. T. Levorsen Geology of Petroleum CBS publishers and distributors, Delhi, II Edition 1999.
2. Tissor and D. H. Welte Petroleum formation and occurrence Springer Velag, Tokyo, 1984.
3. D. W. Lewis and Mc Conchie Analytical Sedimentology Chapman & Hall, New york, 1994.

REFERENCES:

1. J. H Doveton Geological log interpretation Society of sedimentary geology, Tulsa 1994.
2. G. Henery Geophysics of sedimentary basins, Technip, Rue Ginoux, Paris 1994.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the origin of earth and processes involved in formation of minerals and rocks	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO2	Gain knowledge about the structural geology and formation of petroleum characteristics.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO3	Perform geophysical exploration studies.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO4	Comprehend biostratigraphy studies and its application in oil exploration	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO5	Carryout well site geological operations	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
Overalls		3	3	3	3	3	-	-	-	-	-	-	2	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23303	THERMODYNAMICS FOR PETROLEUM ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVE:

To achieve knowledge on the basic laws of thermodynamics and its application.

UNIT I ZEROTH AND FIRST LAWS, PROPERTIES OF PURE SUBSTANCES 9

Definitions and Concepts. Property, Thermodynamic State. Equilibrium, Energy, Work. Zeroth Law of Thermodynamics, Temperature Scale. Pure substance, Phase, Simple compressible substance, Ideal gas Equation of State, Law of corresponding states, Compressibility chart, Pressure –Volume and Temperature-volume Phase diagrams. Mollier diagram. First Law of Thermodynamics and its consequences.

UNIT II APPLICATION OF I LAW TO STEADY- STATE PROCESSES, II LAW 9

Application of I Law of Thermodynamics for Flow PSteady-statedy state processes. II Law of Thermodynamics and its Applications: Limitations of the I Law of Thermodynamics, Heat Engine, HeatPump/ Refrigerator.II Law of Thermodynamics — Kelvin Planck and Clausius statements. Reversible and irreversible processes, Criterion of reversibility, Carnot cycle and Carnot principles, Thermodynamic Temperature scale, Clausius inequality, Entropy.

UNIT III POWER CYCLES, THERMODYNAMIC POTENTIALS, EQUILIBRIA AND STABILITY 9

Power and Refrigeration Cycles. Thermodynamic Potentials. Maxwell relations. Thermodynamic relations. Equilibria and stability. Maxwell construction, Gibbs Phase Rule. Clapeyron equation and vapor pressure correlations.

UNIT IV PROPERTIES OF PURE COMPONENTS AND MIXTURES 9

Pure component properties: Equation of state. Ideal gas heat capacities, fundamental equations from experimental data, fugacity and corresponding states. Mixture Properties: Mixing function. Gibbs-Duhem relation for mixtures, partial molar quantities. Ideal gas mixtures and fugacities, ideal mixtures and activities, excess functions. Gibbs free energy models, infinite dilution properties. Henry's Law

UNIT V PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA 9

Phase Equilibria of Mixtures. Osmotic pressure and Osmotic coefficients. Boiling point elevation and freezing point depression. Chemical Reaction Equilibria. Reaction extent and Independent reactions. Equilibrium criteria and equilibrium constant. Standard enthalpies and Gibbs free energy, temperature and pressure effects on reactions, heterogeneous reaction, multiple chemical reactions

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the fundamental concepts of thermodynamics and its related functions.

CO2: Classify PVT behavior of fluids and define the real gas behavior.

CO3: Implement the second law and analyse the feasibility of systems.

CO4: Analyse the thermodynamic property relations and choose their application to fluid flow.

CO5: Understand the significance of thermodynamic potentials and their use in various processes.

TEXT BOOKS:

1. Sonntag, Borgnakke. C., “Fundamentals of Thermodynamics”, 9 th Edition, Wiley India, 2016.
2. Smith, van Ness and Abbott, Swihart., “Chemical Engineering Thermodynamics”, 8 th Edition, McGraw Hill, 2017.

REFERENCES BOOKS:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 5 th edition, Wiley, 2017
2. Narayanan K.V., “A textbook of Chemical Engineering Thermodynamics”, 2 nd edition, PHI Learning Pvt.Ltd, 2013
3. Pradeep Ahuja,” Chemical Engineering Thermodynamics”, PHI Learning Ltd (2009).
4. Gopinath Halder,” Introduction to Chemical Engineering Thermodynamics”, 2 nd edition, PHI Learning Ltd, 2014

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	Apply the fundamental concepts of thermodynamics and its related functions.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO2	Classify PVT behavior of fluids and define the real gas behavior.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO3	Implement the second law and analyse the feasibility of systems.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO4	Analyse the thermodynamic property relations and choose their application to fluid flow.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
CO5	Understand the significance of thermodynamic potentials and their use in various processes.	3	3	3	3	3	-	-	-	-	-	-	2	3	3	-
Overall CO		3	3	3	3	3	-	-	-	-	-	-	2	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23304	RESERVOIR ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about the properties of reservoir fluids, reservoir rock properties, material balance equation, reservoir fluid coning and their techniques.

UNIT I FUNDAMENTALS OF RESERVOIR AND RESERVOIR FLUIDS 9

Classification of Reservoirs and Reservoir Fluids - Properties of Natural Gases - Behaviour of Ideal Gases - Behaviour of Real Gases- Properties of Crude Oil Systems - Properties of Reservoir Water.

UNIT II FUNDAMENTALS OF ROCK PROPERTIES 9

Porosity — Saturation — Wettability - Surface and Interfacial Tension - Capillary Pressure —Permeability and Relative Permeability Concepts - Rock Compressibility - Net Pay Thickness –Reservoir Heterogeneity-Areal Heterogeneity.

UNIT III FUNDAMENTALS OF RESERVOIR FLUID FLOW 9

Types of Fluids - Flow Regimes - Reservoir Geometry - Fluid Flow Equations - Steady-State Flow —Unsteady State Flow - Constant-Terminal-Pressure Solution - Constant-Terminal-Rate Solution -Horizontal and Vertical Oil Well Performance and Horizontal and Vertical Gas Well Performance.

UNIT IV RECOVERY MECHANISM AND MATERIAL BALANCE EQUATION 9

Oil Reservoirs- Primary Recovery Mechanism-Material Balance Equation— Reservoir Performance prediction Methods and Relating Reservoir Performance to Time. Gas Reservoirs –Volumetric Method and the Material Balance Equations as a Straight Line.

UNIT V CONING, DECLINE CURVE ANALYSIS AND NATIONAL POLICY ON EXPOLARTION 9

Gas and Water Coning–Decline Curve Analysis (Exponential, Harmonic, Hyperbolic)-Vapor-Liquid Phase Equilibria– Well Testing Concepts (Pressure Transient Tests). National Exploration Policy (NELP, HELP, OELP).

TOTAL: 45 PERIODS.

COURSE OUTCOMES:

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

CO1:Understand about the reservoir fluids and their properties.

CO2:Analyse the reservoir rocks present over the reservoir.

CO3: Evaluate the flow behavior of the reservoir fluids.

CO4:Estimate the amount of oil and gas recovery using MBE technique.

CO5:Assess the coning in reservoir and analyse the various production curves.

TEXT BOOKS:

1. Ahmed,T,"Reservoir Engineering Handbook",4th Edition(2010).
2. Craft, B.C. and Hawkins M.F. revised by Ronald E. Terry and J. Brandon Rogers, "Applied Petroleum Reservoir Engineering" third edition, Prentice-Hall (2014)
3. DjebbarTiab and Erle C. Donaldson "Theory and practice of measuring Reservoir rock and fluid Transport properties" fourth edition, Gulf Professional Publishing (2015)

REFERENCE BOOKS:

1. Hydrocarbon Phase Behaviour by Tarek Ahmed.
2. The practice of Reservoir Engineering: Volume36 by L PDake (2001).
3. Amyx, J.W., Bass D.M. & Whiting., R.L., “Petroleum Reservoir Engineering” McGraw Hill 1998.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO1	Understand about the reservoir fluids and their properties.	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO2	Analyse the reservoir rocks present over the reservoir.	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO3	Evaluate the flow behaviour of the reservoir fluids.	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO4	Estimate the amount of oil and gas recovery using MBE technique.	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO5	Assess the coning in reservoir and analyse the various production curves.	3	3	3	3	3	–	–	–	–	–	–	3	3	3	-
Overalls		3	3	3	3	3	-	-	-	-	-	-	3	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23305	INSTRUMENTAL METHODS OF ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To integrate a fundamental understanding of the underlining principles of physics as they relate to specific instrumentation used for gas analyzers and pollution monitoring instruments.
- To impart knowledge on the important measurement in many chemical processes and laboratories handling liquids or solutions.

UNIT I INTRODUCTION TO SPECTROSCOPIC METHODS OF ANALYSIS 9

Electromagnetic radiation - Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Jablonski diagrams, Various electronic transitions in organic and inorganic compounds effected by UV and Visible radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Choice of solvents, cut off wavelengths for solvents, Effects of auxochromes and effects of conjugation on the absorption maxima, Different shifts of absorption peaks (Bathochromic, hypsochromic, hypochromic, hyperchromic),

UNIT II UV AND VISIBLE SPECTROSCOPY 9

Qualitative Spectroscopy- Lamda max and epsilon max rules, , Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Fieser and kuhn rules - Instrumentation for UV and Visible spectrophotometer (source, optical parts and detectors)-Applications of UV and Visible spectroscopy.

UNIT III QUANTITATIVE SPECTROSCOPY 9

Beer-Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer-Lambert's Law. Multicomponent analysis (no overlap, single way overlap and two way overlap), Photometric titration (Experimental set-up and various types of titrations and their corresponding curves).

UNIT IV IR SPECTROSCOPY 9

Theory of IR spectroscopy, various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques. Qualitative analysis of alkanes, alkenes and carbonyl compounds.

UNIT V CHROMATOGRAPHIC METHODS 9

Classification of chromatographic methods, column, thin layer, paper, gas, High Performance Liquid Chromatographical methods (principle, mode of separation and techniques).

TOTAL : 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand the fundamental principles of selective analytical instruments used in medical diagnosis, quality assurance & control and research studies.

CO2: Assess and suggest a suitable analytical method for a specific purpose, and evaluate sensitivity, important sources of interferences and errors, and also suggest alternative 32 analytical methods for quality assurance.
CO3: Critically evaluate the strengths and limitations of the various instrumental methods.
CO4: Develop critical thinking for interpreting analytical data.
CO5: Understand the working principle, types and applications of NMR and Mass spectroscopy.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis, CENGAGE Learning, India, 7th Edition, 2007.
2. Willard H.H, Merritt L.L, Dean J.A and Settle F.A, Instrumental method of analysis, 7th edition,Wadsworth Publishing Company, 1988.
3. Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House, 24th Edition.
4. Eli Grushka-Nelu Grinberg., Advances in chromatography –Volume 52.
5. Gurdeep R. Chatwal, Sharma K. Anand, Instrumental methods of Chemical Analysis, Himalaya Publishers, New Delhi, 2014
6. John R Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice-hall of India Pvt. Ltd., 2012
7. Robert M.Silverstein, Francis X.Webstrer, David Kiemle, David L.Bryce, Spectrometric Identification of Organic Compounds, Wiley, 8th Edition

Course Articulation Matrix:

Course Outcome	Statements	Programme Outcome													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Gain knowledge in different analytical techniques to analyse the chemical and petroleum products.	3	3	2	2	2	-	-	-	-	-	-	3	3	-	1
CO2	Evaluate the structure of unknown compounds using lambda max values in qualitative analysis.	3	3	2	2	2	-	-	-	-	-	-	3	3	-	1
CO3	Analyse the multi components and to assess the photometric titrations in quantitative analysis.	3	3	2	2	2	-	-	–	-	-	-	3	3	-	1
CO4	Understand the stretching and vibrational modes and to predict the linear and non-linear molecules in IR spectral analysis.	3	3	2	2	2	-	-	-	-	-	-	3	3	-	1
CO5	Compare the chromatographic techniques for the separation of finished product.	3	3	2	2	2	-	-	-	-	-	-	3	3	-	1
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**		**3**	**3**	**3**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23401	PROCESS HEAT TRANSFER	L	T	P	C
		3	0	2	4

OBJECTIVE:

- To study about conduction, radiation, and convection heat transfer; analytical, numerical, experimental results for solids, liquids, gases and heat exchanger design.

UNIT I **9**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction –one-dimensional steady state heat conduction equation for flat plate, hollow cylinder, - Heat conduction through a series of resistances - Thermal conductivity measurement; effect of temperature on thermal conductivity; Heat transfer in extended surfaces.

LIST OF EXPERIMENTS **6**

1. Heat transfer in composite wall

UNIT II **9**

Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, flow through packed beds.

LIST OF EXPERIMENTS **6**

1. Heat transfer by Forced / Natural Convection
2. Heat Transfer through Packed Bed

UNIT III **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.

LIST OF EXPERIMENTS **6**

1. Performance studies on Cooling Tower
2. Boiling Heat Transfer
3. Heat Transfer in a Condenser

UNIT IV **9**

Theory of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzmann law, Plank's law, radiation between surfaces.

LIST OF EXPERIMENTS **6**

1. Batch drying kinetics using Tray Dryer
2. Heat transfer in Open Pan Evaporator
3. Heat Transfer by Radiation – Determination of Stefan Boltzmann constant
4. Heat Transfer by Radiation – Emissivity measurement

UNIT V **9**

Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors.

LIST OF EXPERIMENTS **6**

1. Heat Transfer in a Double Pipe Heat Exchanger

2. Heat Transfer in a Bare and Finned Tube Heat Exchanger
3. Heat Transfer in Agitated Vessels

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

CO1: Familiarize the students with the fundamental concepts of heat transfer and heat transfer conduction in solids under steady state.

CO2: Understand the convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows

CO3: Calculate and use overall heat transfer coefficients in designing heat exchangers

CO4: Gain knowledge about heat transfer with phase change (boiling and condensation) and evaporation.

CO5: Implement the radioactive heat transfer including blackbody radiation and Kirchhoff's law

TEXT BOOKS:

1. Holman, J. P., 'Heat Transfer ', 10th Edn., McGraw Hill, 2009.
2. Ozisik, M. N., "Heat Transfer: A Basic Approach", McGraw-Hill, 1984
3. Kern, D.Q., "Process Heat Transfer ", Echo point books and Media, United states, 2017.

REFERENCE BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2004.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering "Vol. I, 7th Edn, Butterwoth-Heinemmann, 2013.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	Familiarize the students with the fundamental concepts of heat transfer and heat transfer conduction in solids under steady state.	3	2	2	2	-	-	1	-	-	-	-	3	3	2	-
CO2	Understand the convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows	3	2	2	1		-	-	-	-	-	-	3	3	2	-
CO3	Calculate and use overall heat transfer coefficients in designing heat exchangers	3	2	2	2	-	-	-	–	-	-	-	3	3	2	-
CO4	Gain knowledge about heat transfer with phase change (boiling and condensation) and evaporation.	3	2	2	-	-	-	-	-	-	-	-	3	3	2	3
CO5	Implement the radiative heat transfer including blackbody radiation and Kirchhoff's law	3	2	2	-	-	-	-	-	-	–	-	3	3	2	3
Overall CO		3	2	2	1.7	-	-	1	-	-	-	-	3	3	2	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23402	DRILLING OPERATIONS	L	T	P	C
		3	0	2	4

OBJECTIVES

To provide the knowledge about the process, components, problems and troubleshooting method involved in drilling operations.

UNIT I **9**

Drilling operations – Location to Rig. Release Well Bore Diagram, Crews – Operator – Drilling, contractor – Third Party Services – Rig Types – Land Types – Marine types.

LIST OF EXPERIMENTS **6**

Determination of Mud Properties

1. Mud weight

UNIT II **9**

Components- Overall Drilling Rig, Drilling Sub systems – Power – Hoisting Line – speeds and Loads Power – Loading Components – Drill Pipe, Heavy Weight Drill Pipe (HWDP), Drill String Loads Uniaxial.

LIST OF EXPERIMENTS **6**

Determination of Mud Properties

1. Practical related to the setting point and the consistency of cement slurry

UNIT III **9**

Preparation of GTO, Vertical and Directional Drilling, Well Planning, Two Dimensional, Horizontal, Tools, Techniques, MWD, surveying – Radius of Curvature, Long's Method – Errors, Muds, Mud Use, Property measurements, Types, - Pneumatic (Air, Gas, Mist, Foam), Water based, Oil based, solids Control, Definitions, Equipment, Problems, Contaminations Effect, Cement- Chemistry of Cement, Principle and Types of Cementing.

LIST OF EXPERIMENTS **6**

Determination of Mud Properties

1. Plastic viscosity
2. Gel strength

UNIT IV **9**

Hydraulics, Classifications of Fluids, Rheological Models – Rotary Drilling Hydraulics – Jet Hydraulic Optimizing and Maximizing – Circulations Rate Selection – Drill Bit – Jet Sizing – Equivalent Circulations Density, Hole Cleaning. Theory – Vertical and Deviated Holes, Annular Velocities – Carrying Capacity – Pills and Slugs.

LIST OF EXPERIMENTS **6**

Determination of Mud Properties

1. Filtration loss

UNIT V **9**

Origin of Overpressure, Kick Signs, shut –in Procedures, Kill sheets, Kill Procedures, Driller's Methods – Engineer's Method (Wait and Weight)

LIST OF EXPERIMENTS **6**

Determination of Mud Properties

1. Sand content
2. Salt contents etc.

TOTAL: 75 PERIODS

COURSE OUTCOME

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

CO1: Understand the rig crews and recognize the rig types.
CO2: Analyse on-site drill systems and its components
CO3: Implement drilling techniques and study of drill mud
CO4: Assess hydraulic techniques in drilling and hole cleaning criteria
CO5: Estimate the risk behind the rig accident.

TEXT BOOKS:

1. 'Oil Well Drilling Engineering, Principles And Practices' Rabia.H, Graham And Trotman Ltd. 1985.
2. "Cementing Technology" Powel Schlumberger Publication 1984.

REFERENCE BOOKS:

1. Mc.Cray. A.W and Cole.F.W. 'Oil Well Drilling Technology' University of Oklahoma Press, Norman 1959.
2. Standard Handbook of petroleum and Natural Gas Engineering. 2 nd Edition. William C Lyons, Gary C Plisga. Gulf Profession.
3. J.J Azar and Robello Samuel, 'Drilling Operations', Uniersity of Tulsa.
4. SPE Petroleum Engineering Handbook, Volume IV.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the rig crewsand recognize the rig types.	3	3	3	3	2	-	-	-	-	-	-	3	3	2	1
CO2	Analyse on-site drill systems and its components	3	3	3	3	2	-	-	-	-	-	-	3	-	3	1
CO3	Implement drilling techniques and study of drill mud	3	3	3	3	2	-	-	-	-	-	-	3	3	-	1
CO4	Assess hydraulic techniques in drilling and hole cleaning criteria	3	3	3	3	2	-	-	-	-	-	-	3	-	3	1
CO5	Estimate the risk behind the rig accident.	3	3	3	2	2	-	-	-	-	-	-	3	3	-	1
Overall CO		3	3	3	2.8	2	0	0	0	0	0	0	3	3	2.7	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23403	PETROLEUM REFINING AND PETROCHEMICALS	L	T	P	C
		3	0	2	4

OBJECTIVES

To teach about the basic refining units, various reaction mechanisms in refineries and production methods in various petrochemical products.

UNIT I **9**

Exploration and Refining of Crude Oil: Introduction, Indian and world reserve of crude oil and its processing capacity, Market demand & supply of petroleum Fractions, engineering data of crude and fractions. Characterization factor, Key Fraction Number and correlation index methods for evaluation of crude & fractions. TBP, ASTM, EFV, and their inter-convertibility, yield Curve etc.

LIST OF EXPERIMENTS **6**

1. Density of crude oil by hydrometer
2. Characterization of formation waters

UNIT II **9**

Desalting of crude, Atmospheric and vacuum distillation units, different types of Reflux arrangements, Test methods and specifications, Different Hydro treatment (Hydro desulfurization processes, Meroxprocess, Doctor's sweetening, DHDS, Claus process, Amine treatment)

LIST OF EXPERIMENTS **6**

1. Distillation of crude oil
2. Determination of salacity of oil field waters
3. Water content in crude oil
4. Moisture content in crude oil and products
5. BS&W in crude oil

UNIT III **9**

Thermal conversion Processes: Thermal cracking processes-visbreaking, thermal cracking, coking operations. Catalytic Conversion Processes: Catalytic cracking processes, Different FCC operating modes, Catalytic reforming operations, Hydrocracking, Naphtha cracking, Polymerization- Thermal, catalytic. Isomerization processes

LIST OF EXPERIMENTS **6**

1. Determination of flash point
2. Pour point of crude oil and petroleum products
3. Determination of calorific value of fuels

UNIT IV **9**

Steam reforming, Hydrogen, Synthesis gas, cracking of gaseous and liquid for stocks, Olefins, Diolefins, Acetylene and Aromatics and their separation, Alkylation, Oxidation, Dehydrogenation, Nitration, Chlorination, Sulphonation and Isomerization

LIST OF EXPERIMENTS **6**

1. Carbon residue determination of petroleum products

UNIT V **9**

Modes and techniques, Production of Polyethylene, PVC, Polypropylene, SAN, ABS, SBR, Polyacrylonitrile, Polycarbonates, Polyurethane, Nylon, PE

LIST OF EXPERIMENTS **6**

1. Determination of refractive index of the petroleum products
2. Determination of viscosity capillary viscometer

TOTAL: 75 PERIODS

COURSE OUTCOME:

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

CO1: Classify the crude oil and define their techniques economically.
CO2. Compare the sulphur removal techniques and list their causes.
CO3. Understand the concepts about catalytic refining units
CO4. Synthesize the various petrochemicals with the different production process.
CO5: Prepare various petrochemical products from various refinery units.

TEXT BOOKS:

1. J.H. Gary et al, “Petroleum Refining”, CRS press, New York, 5th ed., 2007, 6th edition, 2019
2. B.K. Bhaskara Rao, “Modern Petroleum Refining Processes”, Oxford & IBH Publishing Co. Pvt. Ltd., 5th ed., 2008
3. Bhaskara Rao, B. K. “A Text on Petrochemicals”, 5th Edn., Khanna Publishers, New Delhi, 2004

REFERENCE BOOKS:

1. Kayode Coker, A., “Petroleum Refinery Engineering Design and Applications”, John Wiley Publishing Company Limited, 2018.
2. Kiran Pashikanti, Ai-Fu Chang., “Refinery Engineering: Integrated process modelling and optimization”, Wiley-VCH, 2012.
3. Gopal Rao, M., “Dryden’s Outlines of Chemical Technology for the 21st century”, 3rdedn,Affiliated East-West press, Pvt.Ltd-New Delhi, 2006.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Classify the crude oil and define their techniques economically.	3	2	2	2	2	-	-	-	-	-	-	2	-	3	
CO2	Compare the sulphur removal techniques and list their causes.	3	2	2	2	2	-	-	-	-	-	-	2	-	3	-
CO3	Understand the concepts about catalytic refining units	3	2	2	2	2	-	-	-	-	-	-	2	-	3	-
CO4	Synthesize the various petrochemicals with the different production process.	3	2	2	2	2	-	-	-	-	-	-	2	-	3	-
CO5	Prepare various petrochemical products from various refinery units.	3	2	2	2	2	-	-	-	-	-	-	2	-	3	-
Overall CO		3	2	2	2	2		-	-	-	-	-	2	-	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23404	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- The course is aimed to gain knowledge about chemical kinetics of homogeneous reactions, ideal reactors for multiple reaction, gas solid catalytic reaction and their mechanisms

UNIT I CHEMICAL KINETICSAND IDEAL REACTORS 9

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, Design of continuous reactors –stirred tank and tubular flow reactor

UNIT II DESIGN FORMULTIPLEREACTIONS 9

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

UNIT III TEMPERATUREANDPRESSURE EFFECTS 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 IV BASICS OF NON-IDEAL FLOW 9

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

UNIT V HETEROGENEOUSCATALYTICAND NON-CATALYTICREACTIONS 9

Catalysis and adsorption 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. Fluid solid non-catalytic reactions. Rate controlling steps; time for complete conversion for single and mixed sizes, fluidized and static reactors. Kinetics of fluid–fluid reactions, Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand the kinetics of homogenous reaction.
CO2: Develop performance equation and determine the conversion for different reactors.
CO3: Familiarize the reactor arrangement in series and parallel configuration.
CO4: Understand the basics of non-ideal flow
CO5: Evaluate the concepts of effectiveness factor, Thiele modulus and design of catalytic reactor for gas solid reaction.

TEXT BOOKS

1. Levenspiel O,“Chemical Reaction Engineering”,Wiley Eastern Ltd.,II Edition,2000.
2. Smith,J.M,“Chemical Engineering Kinetics”,McGraw Hill, III Edition,1981.
3. Fogler.H.S., “Elements of Chemical Reaction Engineering”, Prentice Hall of India Ltd., 4th Edition,2005.

REFERENCE BOOKS:

1. Froment. G.F. &K.B.Bischoff, “Chemical Reactor Analysis and Design”, II Edition, WileyNew York,(2011).

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the kinetics of homogenous reaction.	3	3	2	2	-	-	-	-	-	-	-	3	3	1	
CO2	Develop performance equation and determine the conversion for different reactors.	3	3	3	3	-	-	-	-	-	-	-	2	2	1	-
CO3	Familiarize the reactor arrangement in series and parallel configuration.	3	3	2	-	-	-	-	-	-	-	-	3	3	1	-
CO4	Understand the basics of non-ideal flow	3	3	-	3	-	-	-	-	-	-	-	2	2	1	-
CO5	Evaluate the concepts of effectiveness factor, Thiele modulus and design of catalytic reactor for gas solid reaction.	3	3	-	2	-	-	-	-	-	-	-	3	3	1	-
Overall CO		3	3	2.3	2.5	-	-	-	-	-	-	-	2.6	2.6	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

UC23U01 UNIVERSAL HUMAN VALUES L T P C

1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction (3L,6P)

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

Module II: Harmony in the Human Being (3L,6P)

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

Module III: Harmony in the Family and Society (3L,6P)

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and

differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives*

Module IV: Harmony in the Nature and Existence (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

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

SEMESTER V

PE23501	PETROLUEM FORMATION EVALUATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To provide the knowledge of petroleum formation, logging techniques and its interpretations.

UNIT I **9**

Importance of formation evaluation-Various logging techniques-Petro physical measurements to sub-surface engineering.

UNIT II **9**

Indirect Methods: Spontaneous potential and resistivity logs, radioactive logs, acoustic logs (principles, types of tools, limitation and applications). Evaluation of Cement Bond Log/ variable density log, Ultra-Sonic Imaging tool, Selective Formation Tester, repeat formation tester (RFT).

UNIT III **9**

Production Logging: Introduction, type of tools, principles, limitations and applications. Reservoir Surveillance and Management.

UNIT IV **9**

Special Type of Logging Tools: Casing inspection tools (principles, application and limitation), Formation micro scanner (FMS), Dipole Sonic Imager Tool, Nuclear magnetic resonance logging principles. Logging in high-angle wells.

UNIT V **9**

Log Interpretation and Analysis Techniques. Standard log interpretation methods, Cross-plotting methods: neutron- density, sonic-density and sonic- neutron etc. Clean sand interpretation Concepts of invasion–RXO, Tornado charts, Shaly sand interpretation.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Evaluation of subsurface formations.
CO2: Analyze the principles of indirect methods of logging techniques.
CO3: Understand the production logging techniques.
CO4: Assess the various logging tools.
CO5: Interpret the data from various logging techniques.

TEXT BOOKS:

1. Standard Handbook of petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing (2004).
2. D.P Helander 'Fundamentals of Formation Evaluation'(1983).
3. Dewan.J.T 'Essentials of Modern Open-Hole Log Interpretation' Pen Well Books, 1983, ISBN0878142339.

REFERENCE BOOKS:

1. Serra.O 'Fundamentals of Well log Interpretation' Volume1. Elsevier Science Publisher, New York,1988, ISBN04441327.

Course Articulation Matrix:

Course Outcomes	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Evaluation of subsurface formations.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Analyse the principles of indirect methods of logging techniques.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Understand the production logging techniques.	3	2	3	2	3	-	-	-	-	-	-	2	2	3	-
CO4	Assess the various logging tools.	3	2	2	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Interpret the data from various logging techniques.	3	2	3	2	3	-	-		-	-	-	2	3	3	-
Overall CO		3	2	3	2	3	-	-	-	-	-	-	2	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23502	WELL COMPLETION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide the knowledge on completion process, equipments, types, perforation and tubing performance.

UNIT I **9**

Well design: Prediction of formation pore pressure and stress gradients-Determination of safety mud weight bounds for different in-situ stress conditions-Design and planning well trajectory- Surveying tools and methods.

UNIT II **9**

Design of drill string including bottom hole assembly- (BHA) Drilling methods and equipment for directional, horizontal and multilateral wells-Selection of casing shoes, material properties and design of casing Programme.

UNIT III **9**

Well Completion and Stimulations: Well completion design, types of completion, completion selection and design criteria-Interval selection and productivity considerations, workover and completion fluids.

UNIT IV **9**

Well stimulation and workover planning-Tubing-packer movement and forces-Tubing design: graphical tubing design and simplified tensional strength design-Selection of down-hole equipment, tubing accessories and wellhead equipment.

UNIT V **9**

Basics of perforation, selection of equipment and procedure for perforation oil and gas wells- Technology of sand control: gravel packing-Fundamentals of well stimulation technologies.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand the concept of well completion basics
CO2: Gain knowledge about the drill string designing.
CO3: Analyse well completion types and design criteria
CO4: Compare the concepts of pressure maintaining and material properties
CO5: Familiarize with perforation techniques

TEXT BOOKS:

1. “Advanced Well Completion Engineering”, by Renpu Wan, Gulf Professional Publishing, 2011
2. Rabia. H., ”Well Engineering and Construction”, Entrac Petroleum, 2001

REFERENCE BOOKS:

1. “Standard Hand Book of Petroleum & Natural Gas Engineering” – 3nd Edition 2015- William C.Lyons& GaryJ.Plisga-Gulf professional publishing comp (Elsevier).
2. “Well Completion and Servicing: Oil and Gas Field Development Techniques” by Denis Perrin – Institut Francais du Petroleum publications
3. Well Control Problem Solutions- N.J Adams
4. Well Design Drilling and Production- Craft, Holden and Graves.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the concept of well completion basics	3	2	-	-	3	-	-	-	-	-	-	2	3	3	1
CO2	Gain knowledge about the drill string designing.	2	3	3	2	3	-	-	-	-	-	-	2	3	3	1
CO3	Analyse well completion types and design criteria	3	-	2	-	3	-	-	–	-	-	-	2	3	3	1
CO4	Compare the concepts of pressure maintaining and material properties	3	-	3	3	3	-	-	-	-	-	-	2	3	3	1
CO5	Familiarize with perforation techniques	3	-	-	-	3	-	-	-	-	-	-	2	3	3	1
Overall CO		2.8	2.5	2.7	2.5	3.0	-	-	-	-	-	-	2	3	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23503	MASS TRANSFER	L	T	P	C
		3	0	2	4

OBJECTIVE:

- To gain knowledge in mass transfer rates under different conditions and separation processes.

UNIT I DIFFUSION AND MASS TRANSFER COEFFICIENTS. 9

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion. Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, interphase mass transfer, relationship between individual and overall mass transfer coefficients.

LIST OF EXPERIMENTS 6

1. Measurement of diffusivity

UNIT II 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.

LIST OF EXPERIMENTS 6

1. Demonstration Gas–liquid Absorption
2. Estimation of mass/heat transfer coefficient for cooling tower.

UNIT III DISTILLATION 9

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

LIST OF EXPERIMENTS 6

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

UNIT IV 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

LIST OF EXPERIMENTS 6

1. Liquid-liquid extraction
2. Estimation of mass/heat transfer coefficient for cooling tower

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; electrodialysis; ultra-filtration.

LIST OF EXPERIMENTS 6

1. Adsorption experiment
2. Drying characteristics of Vacuum Dryer
3. Drying characteristics of Tray dryer
4. Drying characteristics of Rotary dryer

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamentals, types and mechanism of mass transfer operations
CO2: Familiarize with the theories of mass transfer and the concept of inter- phase mass transfer
CO3: Implement the basics of distillation process and its application
CO4: Describe core principles of extraction, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation.
CO5: Understand the concept of adsorption techniques, various isotherms, membrane separation Techniques and ion exchange process.

TEXT BOOKS:

1. Wankat,P.,"Equilibrium Stage Separations",PrenticeHall,1993.
2. Treybal,R.E., "Mass Transfer Operations", 3rdEdn.,McGraw-Hill, 2017.
3. Geankoplis,C.J.,"Transport Processes and Unit Operations",4thEdition,PrenticeHallInc.,New Jersey,2003.

REFERENCES:

1. Seader,J.D.and E.J. Henley, "Separation Process Principles",2ndEd.,JohnWiley,2006.
2. McCabe,W.L., Smith,J.C., and Harriot,P.,"Unit Operations in Chemical Engineering",7th Edition.,McGraw-Hill,2005.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the fundamentals, types and mechanism of mass transfer operations	3	2	-	-	3	-	-	-	-	-	-	3	-	2	-
CO2	Familiarize with the theories of mass transfer and the concept of inter-phase mass transfer	3	3	-	1	3	-	-	-	-	-	-	3	-	2	-
CO3	Implement the basics of distillation process and its application	3	3	2	1	3	-	-	–	-	-	-	3	-	2	3
CO4	Describecoreprinciplesofextraction,settingupmassbalances,usegraphicalmethods to Estimate the number of ideal stages in leaching operation..	3	2	2	1	3	-	-	-	-	-	-	3	-	2	3
CO5	Understand the concept of adsorption techniques, various isotherms, membrane separation Techniques and ion exchange process.	3	2	2	1	3	-	-	-	-	-	-	3	-	2	3
Overall CO		3	2.4	2	1	3	-	-	-	-	-	-	3	-	2	3

1,2 and 3 are correlation levels with weightings as Slight(Low),Moderate(Medium)and Substantial (High) respectively

PE23504	PETROLEUM PRODUCTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the students with the knowledge of petroleum production equipment, techniques and investigate production problems.

UNIT I **9**

Well Head Equipment: Christmas tree, valves, hangers, flow control devices, packers, tubular and flow lines- Well activation, use of compressed air & liquid Nitrogen- Down-hole equipment: selection, servicing, installation & testing, smart wells- Intelligent completions.

UNIT II **9**

Production System Analysis & Optimization- Self flow wells: PI & IPR of self flowing and artificial lift wells- Production testing - back pressure test, flow after flow test & isochronal test-Surface layout, test design & analysis of test data-Production characteristics of Horizontal and multilateral wells- coning, IPR & skin factor. Multiphase flow in tubing and flow-lines. Production Optimization – Nodal System analysis.

UNIT III **9**

Well Production Problems and mitigation: Scale formation, paraffin deposition, formation damage, water production, gas production, sand deposition etc. Designing Gravel Pack for Sand Control- Sand control techniques- Formation Sand Size analysis-Optimum gravel - sand ratio-Gravel pack thickness-Gravel selection-Gravel packing fluid-Gravel pack techniques

UNIT IV **9**

Well Stimulation Techniques - Type & description of stimulation techniques-Design of matrix acidization and acid fracturing-Design of hydraulic fracturing, Multistage Fracturing-Wave technology & microbial stimulation

UNIT V **9**

Artificial Lift Techniques: Sucker Rod Pump-Gas Lift Techniques-Hydraulic Piston Pump-Hydraulic Jet Pump-Plunger Lift-Progressive Cavity Pump- Electrically Submersible Pump

TOTAL: 45 PERIODS

COURSE OUTCOME

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

CO1: Demonstrate working principle and design of separators
CO2: Illustrate various equipment and processes for the treatment of produced emulsion
CO3: Analyse the mechanism, factors of oil field corrosion and prevention methods.
CO4: Understand and apply production logging operations.
CO5: Analyse the new techniques in sustain production rates, comprehend emerging and peripheral technologies.

TEXT BOOKS:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, William C. Lyons, Ali Ghalambor, Elesevier Science & Technology Books, 2007.
2. Petroleum Production Systems, M.J. Economides, A.Daniel Hill &C.E.Economides, Prentice Hall, 1994.

REFERENCE BOOKS:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.
3. The Technology of Artificial Methods by Kermit E.Brown (1982).

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Demonstrate working principle and design of separators	3	2	3	2	2	-	-	-	-	-	-	3	3	-	3
CO2	Illustrate various equipment and processes for the treatment of produced emulsion	3	2	3	2	3	-	-	-	-	-	-	3	3	-	3
CO3	Analyse the mechanism, factors of oil field corrosion and prevention methods.	3	2	2	-	-	-	-	–	-	-	-	3	3	-	-
CO4	Understand and apply production logging operations.	3	2	-	-	2	-	-	-	-	-	-	3	3	3	3
CO5	Analyse the new techniques in sustain production rates, comprehend emerging and peripheral technologies.	3	3	2	3	3	-	-	-	-	-	-	3	3	3	-
Overall CO		3	2.2	2.5	2.3	2.5	-	-	-	-	-	-	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23505	SUMMER INTERNSHIP I	L	T	P	C
		0	0	2	1

OBJECTIVES

To acquire industrial exposure.

COURSE OUTCOME

On completion of the course students are expected to

CO1: Show competence in identifying relevant information, defining and explaining topics under discussion.

CO2: Demonstrate depth of understanding, use primary and secondary technical sources.

CO3: Demonstrate complexity, independent thought, relevance, and persuasiveness

CO4: Compile and comprehend technical documents

CO5: Ability to give oral presentations related to the review or research output.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Show competence in identifying relevant information, defining and explaining topics under discussion.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO2	Demonstrate depth of understanding, use primary and secondary technical sources.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO3	Demonstrate complexity, independent thought, relevance, and persuasiveness.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO4	Compile and comprehend technical documents	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO5	Ability to give oral presentations related to the review or research output.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
Overall CO		3	3	3	3	3	3	2	2	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1 Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition

2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.

3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.

4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business

5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch

6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

SEMESTER VII

		L	T	P	C
PE23701	**WATER FLOODING AND ENHANCED OIL RECOVERY**	**3**	**0**	**0**	**3**

OBJECTIVES:

To teach the concept of enhanced oil recovery, mechanism involved in flooding.

UNIT I **9**

Definition of EOR - Target Oil Resource for EOR - Idealized Characteristics of an EOR Process -General Classifications and Description of EOR Process - Potential of the Different Processes –Screening Criteria for Process. Challenges faced in EOR - latest technological development-recommendations.

UNIT II **9**

Capillary Forces - Viscous Forces - Phase Trapping - Mobilization of Trapped Phases - Alteration of Viscous / Capillary Force Ratios. Areal sweep efficiency, vertical sweep efficiency, Volumetric displacement efficiency, mobility ratio, well spacing.

UNIT III **9**

Sampling and analysis of Oil Field Water flooding performance calculations: Frontal advance method, viscous fingering method, Stiles method, Dykstra-Parsons Method.

UNIT IV **9**

Flooding–miscible, polymer, alkaline, surfactants, steam. Carbon capture and storage, CO_2 for EOR and gas flaring reduction.

UNIT V **9**

Gasinjection, in-situ combustion technology, microbial method Precipitation and Deposition of Asphaltenes and Paraffins, Scaling Problems, Formation of Damage Due to Migration of Fines, Environmental factors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of enhanced recovery process.
CO2: Analyze the concept of capillary force, viscous force and mechanism of oil trapping.
CO3: Estimate and interpret the oil recovery through water flooding.
CO4: Evaluate the various flooding mechanisms.
CO5: Investigate the problems encountered during flooding operations.

TEXT BOOKS:

1. Enhanced Oil Recovery by Don W Green&G .PaulWillhite (2018).
2. Donaldson, E.C. and G.V.Chilingarian, T.F. Yen, “Enhanced oil Recovery–I&II”(1989),

REFERENCE BOOKS:

1. Fundamentals and Analysis, Elsevier Science Publishers, New York,(1985).
2. Lake,L.W., “Enhanced oil recovery”, Prentice Hall,(1996).
3. Schumacher, M.M., “Enhanced oil recovery: Secondary and tertiary methods”, Noyes Data Corp.,(1982).
4. Van Pollen,H.K. “Fundamentals of enhanced oil recovery”, Penn Well Books,(1980).

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basics of enhanced recovery process.	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO2	Analyze the concept of capillary force, viscous force and mechanism of oil trapping.	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO3	Estimate and interpret the oil recovery through water flooding.	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO4	Evaluate the various flooding mechanisms.	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO5	Investigate the problems encountered during flooding operations.	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
Overall CO		3	2	3	3	2	-	-	-	-	-	-	3	3	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23702	PROCESS DYNAMICS AND CONTROL	L	T	P	C
		3	0	2	4

OBJECTIVE:

- To provide knowledge about open and closed loop systems, its responses, control loop components and stability of control systems.

UNIT- I FIRST ORDER SYSTEMS: 9

Physical examples of first order systems, Linearization technique for a non linear valve, Derivation of the transfer function for a standard first order system, Response of a first order system to pulse, step and sinusoidal inputs, Self regulating and non self regulating first order systems, First order systems in series, Non interacting and interacting systems. Derivation of transfer functions of these systems. Second order systems: General form of the transfer function of a second order system, Response of a second order system to pulse, step and sinusoidal inputs.

LIST OF EXPERIMENTS 6

1. Characteristics of different types of control valves
2. Flow co-efficient of control valves

UNIT-II THE FEEDBACK CONTROL SYSTEM: 9

Block diagram for a chemical reactor control system, Description of the system. Transfer function representation of the various components in the feedback loop, Transportation lag and its Pade approximation, Set point and regulatory control problems, Closed loop transfer function and block diagram reduction.

LIST OF EXPERIMENTS 6

1. Open loop study on a level system
2. Open loop study on a flow system
3. Open loop study on a thermal system

UNIT-III TRANSIENT RESPONSE OF CLOSED LOOP: 9

Proportional and Proportional-Integral action controllers on the dynamics of the closed loop, Measurement lag and its effect on the closed loop dynamics. Stability of a closed loop: Derivation of the characteristic equation for a closed loop, Concept of poles and zeros of a transfer function, The role of poles and zeros on the dynamics of a system, Right hand side zeros and the concept of inverse response, Concept of stability, Stability criteria based on the location of closed loop poles, How right hand side zeros limit the stability of a closed loop, Routh test to test the stability of a system.

LIST OF EXPERIMENTS 6

1. Closed loop study on a level system
2. Closed loop study on a flow system
3. Closed loop study on a thermal system

UNIT – IV INTRODUCTION TO FREQUENCY RESPONSE 9

Bode plots for common transfer functions, Bode stability criteria, The concept of gain and phase margins, Ziegler-Nicholas tuning rules for controller system design, Cohen-Coon settings for controller design.

LIST OF EXPERIMENTS **6**

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System

UNIT-V ADVANCED CONTROL STRATEGIES AND CONTROL VALVES: **9**

Cascade control, Feedforward control, Ratio control, Dead time compensation using Smith predictor, Internal model control. Control valve construction, Air to open and air to close valve functioning, Valve characteristics, Valve sensitivity, Linear valves, Equal percentage valves, Square root valves.

LIST OF EXPERIMENTS **6**

1. Response of Interacting level System
2. Tuning of a level system
3. Tuning of a flow system
4. Tuning of a thermal system

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand working principles, types and applications of various process instruments used in chemical and petrochemical industries.
CO2: Develop transient models for processes using material and energy balance equations using Laplace Transforms.
CO3: Familiarize with the principles of controllers, control elements, closed loop control systems to determine the transient response, offset and their stability.
CO4: Understand Frequency response of control systems and tune the PID controllers.
CO5: Analyze the performance of various advanced control strategies.

TEXT BOOKS:

1. Coughnowr, D., " Process Systems Analysis and Control ", 3rdEdn., McGraw Hill, New York, 2008.
2. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003

REFERENCE BOOKS:

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp , Process dynamics and control *I* -2nd ed. John Wiley & Sons, Inc.
2. Marlin, T. E., " Process Control ", 2ndEdn, McGraw Hill, New York, 2000.
3. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control", 2ndEdn., John Wiley, New York, 1997.
4. Jason L. Speyer, Walter H. Chung, "Stochastic Processes, Estimation, and Control", PHI Ltd (2013).

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand working principles, types and applications of various process instruments used in chemical and petrochemical industries.	3	3	1	-	1	-	-	-	-	-	-	3	3	1	
CO2	Develop transient models for processes using material and energy balance equations using Laplace Transforms.	3	3	1	1	1	-	-	-	-	-	-	3	3	1	
CO3	Familiarize with the principles of controllers, control elements, closed loop control systems to determine the transient response, offset and their stability.	3	3	2	2	2	-	-	-	-	-	-	3	3	1	
CO4	Understand Frequency response of control systems and tune the PID controllers.	3	3	2	2	2	-	-	-	-	-	-	3	3	1	
CO5	Analyze the performance of various advanced control strategies.	3	3	2	-	2	-	-	-	-	-	-	3	3	1	
Overall CO		**3**	**3**	**1.6**	**1.7**	**1.6**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**1**	**-**

1, 2 and 3 are correlation levels with weightings as Slight(Low), Moderate(Medium)and Substantial (High) respectively.

PE23703	COMPLIANCES IN OIL AND GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To impart knowledge on the concepts of social compliance and provide insight on eco process and ethical practices

UNIT I SCOPE AND NEED OF SOCIAL COMPLIANCE 9

Social Compliance - concept, need, benefits for industry, workers, society; social accountability and Corporate Social responsibility - scope and need; social compliance in material procurement, production, supply chain management; social compliances applied to garment manufacturing and other oil and gas industryproduv

UNIT II GENERAL NORMS ON LABOUR AND WAGE COMPLIANCE 9

Conventions on discrimination, forced labour, child labour, ILO convention on child labour; working hours-norms, code of conduct; remuneration-minimum wages, compensation - norms applicable in India; freedom of association, trade union, collective bargaining agreements, related laws in India

UNIT III HEALTH AND ENVIRONMENT COMPLIANCE 9

Environment and climate, health and safety – norms and measures to be taken for safe working environment; Global Reporting Initiatives (GRI), sustainability reporting guide line; Organization for Economics Co-operation and Development (OECD) guide lines for multinational discrimination.

UNIT IV BANNED AND HAZARDOUS SUBSTANCES 9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment; banned and hazardous substances (Alkyl phenolethoxylates (APEO), Nonylphenol ethoxylates (NPEO) and Octyl phenolethoxylates (OPEO)) - types, its harmful effects; MRSL (Manufacturing Restricted Substance List) and RSL(Restricted Substance List)- definition, importance; carbon and water foot print

UNIT V MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989 AND MAJOR ACCIDENT HAZARD CONTROL RULES AND AMENDMENT 9

Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets. Major Accident Hazard Control Rules. Hazardous Wastes (management, handling and Transboundary Movement) Rules 2016.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Recognize the importance of need of social complaisance
CO2: Discuss the general norms of labour and wage compliance
CO3: Analyse the health and welfare provisions given in factories act.
CO4: Discuss about the circular economy.
CO5: Construct emergency plan for accidents for process industries

TEXT BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2. Indian Boilers Act and Regulations.

REFERENCE BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd.,New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd.,New Delhi.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Recognize the importance of need of social complaisance	1	1	1	1	1	2	3	1	-	-	-	3	-	-	2
CO2	Discuss the general norms of labour and wage compliance	2	2	2	2	2	3	3	2	-	-	-	3	-	-	2
CO3	Analyse the health and welfare provisions given in factories act.	2	2	2	2	2	3	3	2	-	-	-	3	-	-	3
CO4	Discuss about the circular economy.	2	2	2	2	2	3	3	2	-	-	-	3	-	-	2
CO5	Construct emergency plan for accidents for process industries	1	1	1	1	1	2	3	1	-	-	-	3	-	-	2
Overall CO		**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**2.6**	**3**	**1.6**	-	-	**-**	**3**	**-**	**-**	**2.2**

1, 2 and 3 are correlation levels with weightings as Slight(Low), Moderate(Medium)and Substantial (High) respectively.

PE23704	PETROLEUM EQUIPMENT DESIGN	L	T	P	C
		3	1	0	4

OBJECTIVES

The course is aimed to

- To learn about heat transfer operations, separation equipment, mass transfer process, storage and reactor vessel equipment's.
- To analyse about plant layout and construction.

UNIT I HEAT TRANSFER OPERATIONS **12**

Fired heaters, Heat Exchangers, Condensers, Evaporators, Re-boilers,

UNIT II DESIGN OF PHASE SEPARATION EQUIPMENT **12**

Design of physical separation equipment such as cyclones, centrifuges, thickeners, filtration equipment

UNIT III MASS TRANSFER OPERATIONS **12**

Absorption column, Distillation Column, Extraction Column, Cooling tower, Dryer, Crystallizer

UNIT IV REACTORS AND STORAGE VESSELS **12**

Packed bed Reactors, FCC units, Pressure Vessel, Storage Vessel

UNIT V MATERIALS OF CONSTRUCTION AND PLANT LAYOUT **12**

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

TOTAL: 60 PERIODS

COURSE OUTCOME:

On completion of the course students are expected to

CO1: Understand the piping fundamentals, codes and standards
CO2: Learn pipe fittings, selections, drawings and dimensioning
CO3: Remember Pipe Material specifications
CO4: Analyze pressure design of pipe systems
CO5: Evaluate the materials of constrictions and plant layout.

TEXT BOOKS:

1. Baranan, C.R., "Rules of Thumb for Chemical Engineers", 3rd Edition, Gulf Professional Publishing Co, Texas, 2002.
2. R. K. Sinnott, "Coulson & Richardson's Chemical Engineering Design ", Vol. 6, IV Edition Butterworth Heinermann, Oxford, 2005.

REFERENCE BOOKS:

1. Dawande, S. D., "Process Design of Equiments", IV Edition, Central Techno Publications, Nagpure, 2005.
2. Green D. W., "Perry's Chemical Engineer's Handbook", VIII Edition McGraw Hill, 2007.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the piping fundamentals, codes and standards	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO2	Learn pipe fittings, selections, drawings and dimensioning.	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO3	Remember Pipe Material specifications.	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO4	Analyze pressure design of pipe systems.	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO5	Evaluate the materials of constrictions and plant layout.	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23705	SUMMER INTERNSHIP II	L	T	P	C
		0	0	2	1

OBJECTIVES:

To acquire industrial exposure.

COURSE OUTCOME

On completion of the course students are expected to

CO1: Show competence in identifying relevant information, defining and explaining topics under discussion.

CO2: Demonstrate depth of understanding, use primary and secondary technical sources.

CO3: Demonstrate complexity, independent thought, relevance, and persuasiveness

CO4: Compile and comprehend technical documents

CO5: Ability to give oral presentations related to the review or research output.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Show competence in identifying relevant information, defining and explaining topics under discussion.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO2	Demonstrate depth of understanding, use primary and secondary technical sources.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO3	Demonstrate complexity, independent thought, relevance, and persuasiveness.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO4	Compile and comprehend technical documents	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO5	Ability to give oral presentations related to the review or research output.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
Overall CO		3	3	3	3	3	3	2	2	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

SEMESTER VIII

		L	T	P	C
PE23801	**PROJECT WORK / INTERNSHIP CUM PROJECT WORK**	**0**	**0**	**16**	**8**

OBJECTIVES

To make the students do their own research and arrive with practical solutions for the problems encountered during the project work.

COURSE OUTCOME

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

CO1: Apply the fundamental concept learnt during the theory courses to solve industrial problems.
CO2: Design a manufacturing petrochemical process industry and wet laboratory analysis.
CO3: Analyze the solutions for the design proposed.
CO4: Investigate the data obtained in the laboratory or industry.
CO5: Compile clear concise project reports with the help of grape, charts and pictorial representation.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Apply the fundamental concept learnt during the theory courses to solve industrial problems.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO2	Design a manufacturing petrochemical process industry and wet laboratory analysis.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO3	Analyze the solutions for the design proposed.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO4	Investigate the data obtained in the laboratory or industry.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
CO5	Compile clear concise project reports with the help of grape, charts and pictorial representation.	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
Overall CO		**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

VERTICAL I: UPSTREAM PROCESSING

PE23001	OIL AND GAS WELL TESTING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To educate the students on fundamentals of testing of drill string in oil and gas well.

UNIT I: **9**

Principles of Fluid Flow for steady state, semi steady state & unsteady state conditions. Diffusivity Equation Derivation & Solutions, Radius of investigation, principle of superposition, Horner's approximation.

UNIT II: **9**

Pressure Transient Tests: Drawdown and build up-test analysis, determination of permeability and skin factor, Analysis of pressure-build-up tests distorted by phase redistribution, Well-test interpretation in hydraulically fractured wells, Interpretation of well-test data in naturally fractured reservoirs, Wellbore effects, Multilayer reservoirs, Injection well testing, Multiple well testing, Wire line formation testing. Wire line while drilling formation testing. Interference testing, Pulse testing,

UNIT III: **9**

Drill Stem Testing: Equipment, DST chart observation and preliminary interpretation. Well preparation for testing, Multiple well testing. Effect of reservoir heterogeneities & Wellbore conditions, fractured reservoir application.

UNIT IV: **9**

Well-test analysis by use of type curves: Fundamentals of type curves, Ramey's type curve, McKinleTy's and Gringartenetal type curves.

UNIT V: **9**

Gas well testing: Basic theory of gas flow in reservoir, Flow-after-flow test, Isochronal test, etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the basic concepts and explain various principles of fluid flow and superposition.
CO2: Perform the various experiments on wells and data analysis.
CO3: Use the equipment for DST and its characterization.
CO4: Learn the different types of curves for well tests.
CO5: Discuss and illustrate the basic concepts of gas well testing.

TEXT BOOKS:

1. Oil Well Testing Handbook Amanat U. Chaudhry (2004)
2. Gas Well Testing Handbook Amanat U. Chaudhry (2003)

REFERENCE BOOKS:

1. Well Testing by John Lee (2017)
2. Bourdet, D.: Well Test Analysis: The Use of Advanced Interpretation Models,Elsevier, Amsterdam, 2002.
3. Earlougher, R. C. Jr.: Advances in Well Test Analysis. SPE of AIME, Dallas,Monograph, 1977.
4. Matthews, C. S. and Russell, D. G.: Pressure Buildup and Flow Tests in Wells, Monograph Series, SPE of AIME, Dallas, 1967.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the basic concepts and explain various principles of fluid flow and superposition.	2	3	2	3	2	-	-	-			-	3	3	3	2
CO2	Perform the various experiments on wells and data analysis	2	3	3	3	2	-	-	-			-	3	3	3	2
CO3	Use the equipment for DST and its characterization.	2	3	2	3	2	-	-	-			-	3	3	3	2
CO4	Learn the different types of curves for well tests.	2	2	3	3	2	-	-	-			-	3	3	3	2
CO5	Discuss and illustrate the basic concepts of gas well testing.	2	3	2	3	2	-	-	-	-	-	-	3	3	3	2
Overall CO		**2**	**2.8**	**2.4**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23002	OFFSHORE DRILLING AND PRODUCTION PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To teach the students about the equipment and platform involved in offshore drilling and the storage of hydrocarbon.

UNIT: I **9**

Introduction to offshore oil and gas operations – Sea States and Weather-Meteorology, oceanography, ice, seabed soil.

UNIT: II **9**

Buoyancy and stability - Offshore Fixed Platforms: Types, description and operations.

UNIT: III **9**

Offshore Mobile Units: Types, description and installation-Station keeping methods like conventional mooring and dynamic positioning system.

UNIT: IV **9**

Offshore Drilling-Difference in drilling from land, from fixed platform, jackup, ships and semisubmersibles-Use of conductors and risers-Deep Sea Drilling-Offshore Well Completion- Platform sand subsea completions-Deep water applications of subsea technology.

UNIT V **9**

Offshore Production: Oil processing platforms, gas processing platforms, water injection platforms, storage, SPM and SBM, transportation and utilities-Deep water technology: Introduction, definition & prospects-Deep water regions-Deep water drilling rig: selection and deployment- Deep water production system-Emerging deep-water technologies: special equipment and systems, Remote operation vessels(ROV).

TOTAL: 45 PERIODS

COURSE OUTCOME:

On successful completion of this course, the students will be able to
CO1: Understand the basic concepts of offshore drilling.
CO2: Identify the off-shore platforms.
CO3: Learn about the installation of equipment.
CO4: Familiarize about the subsea technologies.
CO5: Assess the equipment involved in the Production practices.

TEXT BOOKS:

1. Standard Hand Book of Petroleum & Natural Gas Engineering" – 2nd Edition 2005-William C.Lyons& Gary Gulf-Gulf professional publishing comp (Elsevier).
2. Wellsite Geological Techniques for petroleum Exploration by Sahay.B et al.

REFERENCE BOOKS:

1. Handbook of Offshore Engineering by Subrata K. Chakrabarti (2005).
2. Petroleum Exploration Hand Book by Moody, G.B.
3. Handbook of Offshore Oil and Gas operations by James G Speight, Gulf Professional Publishing.
4. Offshore Petroleum Drilling and Production by Sukumar Lai

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basic concepts of offshore drilling.	3	-	-	-	3				-	-	-	-	3	2	-
CO2	Identify the off-shore platforms.	3	-	-	2	2				-	-	-	-	3	2	-
CO3	Learn the Installation of the Equipment.	3	-	3	-	3				-	-	-	-	3	2	-
CO4	Familiarize about the subsea technologies.	3	-	3	3	2				-	-	-	-	3	2	-
CO5	Assess the equipment involved in the Production practices.	3	-	3	2	3				-	-	-	-	3	2	-
Overall CO		**3**	**-**	**3**	**2.3**	**2.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23003	MUD ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To teach the use of mud in the planning and implementation of drilling operations and mud chemistry.

UNIT I DRILLING FLUIDS 9

Overview of drilling fluids: functions, types, compositions, properties of mud. Drilling fluid, Rheology, annular hydraulics, filtration, and volume calculation. Mud calculations, Hydrostatic pressure, Volume, Weight related calculations during drilling.

UNIT II DEVELOPMENT OF DRILLING FLUID TECHNOLOGY 9

Drilling fluid technology: Water base mud system, oil base/ invert emulsion mud system, overview, formulation, preparation& maintenance, Drilling Fluids Reporting & its preparation. Development of mud types or systems. Field test and its procedure (API standard) for water base and oil base/ invert emulsion mud system or synthetic base mud systems, Equipment used in lab for testing drilling fluids for e.g., high pressure high temperature fluid loss, dynamic fluid loss, shale testing equipment etc. Study of analytical testing methods involved in mud engineering. Current updates on research and development.

UNIT III BASIC CHEMISTRY OF DRILLING FLUIDS AND RHEOLOGY 9

Mud chemistry, Clay mineralogy and the colloid chemistry of Drilling Fluids, polymers used in drilling fluids, types, uses and applications, filtration properties of drilling fluids, static filtration, dynamic filtration, surface chemistry of drilling fluids: surfactants, emulsions, oil wetting agents etc. Rheology: flow regimes, rheological models, hydraulics, rheological properties required for optimum performance.

UNIT IV MUD PROBLEMS 9

Hole problems related to drilling fluids, Hole cleaning, Stuck pipe, Lost Returns, differential sticking of the drill string, shale stability, key seating, cuttings accumulation, loss circulation corrosion and lubricity, PH & Alkalinity, Contamination etc.

UNIT V DRILLING FLUID WASTE MANAGEMENT 9

Significance of waste management in drilling operations processes used for controlling and disposing of drilled cuttings such as land farming, annular injection, and offshore requirements. Drilling fluid toxicity and testing. Toxic components in drilling fluid. The international recommendations for handling non-aqueous fluids are also covered.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Learn about the use of drilling and completion fluids and environmental issues associated with them.
CO2: Carry out the dynamics of drilling mud by various equipment.
CO3: Identify, formulate, and solve simple engineering problems related to drilling and completion fluids problems etc.
CO4: Evaluate the failure of drilling operation.
CO5: Assess the toxicity of drilling fluids and perform the environmental impact assessment.

TEXT BOOKS:

1. ASME, 2005, Drilling Fluids Processing Handbook, Gulf Professional Publishing,696 pp.
2. Rabia H, 1985, Oil Well Drilling Engineering, Graham Trotman Ltd.,

REFERENCE BOOKS:

1. RyenCaenn, H. C. H. Darley and George R. 2011, Gray, Composition and properties of Drilling and Completion Fluids, Sixth edition, Gulf Professional Publishing, 701 pp.
2. Skalle, 2011, Drilling Fluids Engineering, Ventus Publishing, 132 pp
3. Whittakar, Alun, 1985, Theory and Application of Drilling Fluid Hydraulics, The EXLOG Series of Petroleum Geology and Engineering Handbooks, Reidel Publishing Company, 210 pp.
4. Drilling Mud & Fluid Additives by John Me, Dermott.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	ProgrammeOutcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Learn about the use of drilling and completion fluids and environmental issues associated with them.	-	1	-	-	-	2	3	-	-	1	1	-	1	-	-
CO2	Carry out the dynamics of drilling mud by various equipment.	1	-	1	1	-	-	-	-	1	1	1	1	1	-	-
CO3	Identify, formulate, and solve simple engineering problems related to drilling and completion fluids problems etc.	1	2	1	1	-	-	-	-	-	1	1	-	1	-	-
CO4	Evaluate the failure of drilling operation.	1	-	-	2	-	-	-	-	1	1	-	-	1	-	-
CO5	Assess the toxicity of drilling fluids and perform the environmental impact assessment	-	1	-	-	-	2	3	1	-	1	-	1	1	-	-
Overall CO		**1**	**1.3**	**1**	**1.3**	**-**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23004 INTEGRATED OIL AND GAS RESERVOIR MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVE:

- To teach the students about the fundamentals of oil and gas reservoir management and risk evaluation.

UNIT I **9**

Introduction-Scope and Objectives- Reservoir management concepts: Definition and history-Fundamentals of reservoir management, synergy and team-Integration of geosciences and engineering-Integration of exploration and development technology. Roles and responsibility of DGH

UNIT II **9**

Reservoir management process-Setting goals, developing plans and economics, surveillance and monitoring, evaluation Data acquisition, analysis and management-Classification of data, acquisition, analysis and application, validation, storing and retrieval.

UNIT III **9**

Reservoir model-Role of reservoir model in reservoir management- Integration of G&G and reservoir model.

UNIT IV **9**

Reservoir performance analysis and prediction-Naturally producing mechanism, reserve sand role of various forecasting tools-Volumetric method, MBE, Decline curve and mathematical simulation.

UNIT V **9**

Matured field reservoir Management-Reservoir Management Economics-Evaluation, risk and uncertainties Reservoir management plans-Strategy for newly developed field, Secondary and EOR operated field. Field Development Plan (FDP)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Familiarize the basic concepts of reservoir management and explain about its development.
CO2: Analyse the data classification and illustrate the application of reservoir management process.
CO3: Formulate the gas reservoir model and its integration.
CO4: Conduct the mathematical simulation of reservoir performance.
CO5: Predict the cost value for newly developed fields through reservoir management plans.

TEXT BOOKS:

1. Hydrocarbon Exploration and Production by Frank John.
2. Hydrocarbon Reservoir and Well Performance - T.E.W. Nind

REFERENCE BOOKS:

1. Katz D.L. et al. (1991). "Natural Gas Engineering (Production & Storage)". McGraw-Hill, Singapore.
2. William C. Lyons, Gary C. Plisga (2004). "Standard Handbook of Petroleum and Natural Gas Engineering, 2nd Edition". Gulf Professional Publishing.
3. A.W. McCray, F.W. Cole (1981). "Oil Well Drilling Technology". University of Oklahoma Press, Norman.
4. Boyun Guo, William C. Lyons, Ali Ghalambor (2007). "Petroleum Production Engineering". Gulf Professional Publishing. ISBN 10: 0750682701 / ISBN 13: 9780750682701.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Familiarize the basic concepts of reservoir management and explain about its development.	3	-	-	3	3	-	-	2	-	-	3	-	3	-	2
CO2	Analyse the data classification and illustrate the application of reservoir management process.	2	-	3	2	2	-	-	3	-	-	2	-	3	2	2
CO3	Formulate the gas reservoir model and its integration.	3	3	-	2	3	-	-	2	-	-	3	-	3	3	-
CO4	Conduct the mathematical simulation of reservoir performance.	2	-	-	3	2	-	-	3	-	-	3	-	2	2	3
CO5	Predict the cost value for newly developed fields through reservoir management plans.	2	3	2	2	3	-	-	2	-	-	2	-	3	2	2
Overall CO		2.4	3	2.5	2.4	2.6	-	-	2.4	-	-	2.6	-	2.8	2.3	2.3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23005	FLOW ASSURANCE	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To teach the fundamentals in flow assurance, hydraulics, transfer of heating flow assurance, formation, removal and prevention measures of organic deposits.

UNIT I INTRODUCTION TO FLOW ASSURANCE 9

Flow Assurance concerns and challenges; Economic impact of Flow Assurance problems, components of typical Flow Assurance process; Composition and Properties of Hydrocarbons; Equations of State; Phase behavior of hydrocarbons, Compositional and Physical Characterization of Crude oil.

UNIT II HYDRAULICS IN FLOW ASSURANCE 9

Hydrocarbon flow, single phase and multiphase flow, Two phase flow correlations; Slugging and Liquid Handling, Types of slugs, Slug prediction, detection and control systems; Pressure surge analysis; Hydraulic/Pressure drop calculations- Analyzing the problems of slugging in multiple wells.

UNIT III HEAT TRANSFER IN FLOW ASSURANCE 9

Buried pipeline heat transfer, Temperature prediction along the pipeline in steady state and transient modes; Thermal management strategy like external coating systems, direct heating, pipeinpipe,etc.;Insulation performance.

UNIT IV CHARACTERIZATION AND FORMATION MECHANISMS FOR ORGANIC DEPOSITS 9

Characterization, Formation mechanism, prediction and models for deposition and stability for wax (Paraffins), Asphaltenes and Gas Hydrates.

UNIT V ORGANIC DEPOSITS REMOVAL AND PREVENTION METHODS 9

Mechanical Removal Methods like Coiled Tubing, Pigging, Pressurization Depressurization.; Chemical Solvents and Dispersants, Other techniques like Ultrasonic, Laser Technology, etc., Bacterial Removal Methods. Heating in Wellbore and Piping; Cold flow methods; Chemical inhibitors for waxes, asphaltenes and hydrates; Dehydration of Natural Gas; Special Materials and Coatings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the students will be able to
CO1: Understand the phase behavior of hydrocarbons under different operating conditions.
CO2: Perform slug handling and pressure surge analysis
CO3: Implement a thermal management strategy in pipelines transporting hydrocarbons
CO4: Analyse the formation of paraffin waxes, asphaltenes and hydrates in crude oil
CO5: Select the appropriate method for prevention and removal of organic deposits.

TEXT BOOKS:

1. Bai, Y and Bai, Q. (2005). Subsea Pipelines and Risers. I Edition. Elsevier.
2. Danesh, Ali. (1998). PVT and Phase Behavior of Petroleum Reservoir Fluids. I Edition, Elsevier.

REFERENCE BOOKS:

1. Frenier, W. W., Zainuddin, M., and Venkatesan, R. (2010). Organic Depositsin Oil and Gas Production Society of Petroleum Engineers.
2. Katz, Donald. (1959). Handbook of Natural Gas Engineering. I Edition McGraw Hill Higher Education.

3. Yen, T.F and Chilingarian, G.V. (2000). Asphaltenes and Asphalts, 2 from Developments in Petroleum Science. Volume 40 B, Elsevier.
4. Dendy Sloan, Carolyn Ann Koh, Amadeu K. Sum, Norman D. McMullen, George Shoup, Adam L. Ballard, and Thierry Palermo (Editors), 2011, Natural Gas Hydratesin Flow Assurance, Gulf Professional Publishing, 213 pp.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the phase behavior of hydrocarbons under different operating conditions.	2	-	1	3	3	1	1	-	1	2	1	-	2	3	-
CO2	Perform slug handling and pressure surge analysis.	2	2	1	2	2	2	1	-	-	1	-	-	1	2	1
CO3	Implement a thermal management strategy in pipelines transporting hydrocarbons.	3	2	2	1	3	-	1	-	-	1	2	-	2	-	1
CO4	Analyse the formation of paraffin waxes, asphaltenes and hydrates in crude oil.	1	3	2	1	2	-	-	-	-	-	2	-	2	-	1
CO5	Select the appropriate method for prevention and removal of organic deposits.	1	3	3	1	3	-	-	-	-	2	2	-	3	-	1
Overall CO		**1.8**	**2.5**	**1.8**	**1.6**	**2.6**	**1.5**	**1**	**-**	**1**	**1.5**	**1.8**	**-**	**2**	**2.5**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23006	RESEVOIR MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To enable the students to understand the economics of petroleum recovery and effective modeling approaches to establish development strategies for futuristic predictions.

UNIT I INTRODUCTION OF RESERVOIR MODELING & SIMULATION & MBE 9

Introduction of Reservoir Modeling and Simulation, Understanding the concept and Limitation of MBE Approach to Reservoir Performance Evaluation Introduction of Reservoir Rock Properties and Its use in Simulation. Fluid In homogeneity and its applications.

UNIT II REVIEW OF OIL AND GAS FLOW THROUGH PETROLEUM RESERVOIR 9

Single Phase Flow, Two-Phase and Multi Phase Flow Equations for One Dimensional Model, Two-Phase and Multi Phase Flow Equations for Two Dimensional Models and Two-Phase and Multi Phase Flow Equations for Three Dimensional Models**.**

UNIT III FINITE DIFFERENCE EQUATIONS 9

Finite Difference Equations: Explicit Equations, Implicit Equations, Coefficient Matrix. Iterative Solution. Stability Criteria, Solution Methods and Uses of Different Software, MBAL, Petrel and CMG.

UNIT IV BUILDING FIRE SAFETY 9

Discretization- Implicit Pressure Explicit Saturation (IMPES), Implicit Pressure Implicit Saturation (IMPIS), Iterative Processes -Jacobi, Relaxation and Gauss Seidel Methods), ADIP, Strongly Implicit Procedure, Point Iterative**.**

UNIT V HISTORY MATCHING AND PERFORMANCE PREDICTION OF RESERVOIRS 9

Decline Curve Analysis, History Matching, Performance Prediction of Reservoirs Case studies of Indian Fields and Case Studies of Foreign Fields, Coning Phenomenon, Compositional Model**.**

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the reservoir properties and acquainted reservoir simulation techniques.
CO2: Calculate reserves of oil and gas by volumetric and material balance.
CO3: Analyze the multiphase flow in porous media.
CO4: Calculate the dynamic simulation of reservoir through finite difference equations, discretization &iterative processes.
CO5: Generate the performance predictions profiles of reservoirs by history matching and predict the coning problems.

TEXT BOOKS:

1. Petroleum Exploration Hand Book by Moody, G.B. McGraw-Hill Inc
2. WellsiteGeologicalTechniquesforpetroleumExplorationbyShay'setal.

REFERENCE BOOKS:

1. Standard Hand Book of Petroleum & Natural Gas Engineering"–2nd Edition2005-William C. Lyons & Gary J.Plisga-Gulf professional publishing comp(Elsevier).

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the reservoir properties and acquainted reservoir simulation techniques.	3	2	-	2	1	-	1	-	-	1	2	3	3	3	3
CO2	Calculate reserves of oil and gas by volumetric and material balance.	2	2	1	2	1	-	2	-	2	1	2	3	3	3	3
CO3	Analyze the multiphase flow in porous media.	-	2	1	1	2	1	2	-	1	2	1	2	2	2	2
CO4	Calculate the dynamic simulation of reservoir through finite difference equations, discretization & iterative processes.	2	2	1	-	3	1	-	-	-	2	1	2	2	1	2
CO5	Generate the performance predictions profiles of reservoirs by history matching and predict the coning problems.	1	3	1	-	3	2	-	1	2	3	2	2	2	2	2
Overall CO		**2**	**2.2**	**1**	**1.7**	**2**	**1.3**	**1.7**	**1**	**1.7**	**1.8**	**1.6**	**2.4**	**2.4**	**2.2**	**2.4**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23007	NATURAL GAS ENGINEERING AND PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To teach the properties of natural gas and the salient features of a gas reservoir, natural gas treating and recovery techniques.

UNIT I PROPERTIES AND COMPOSITION OF NATURALGAS 9

Natural gas origin – Composition of natural gas – Sources of Natural gas–Thermodynamics properties – Compressibility factor and chart for natural gas – Heating value and flammability limit of natural gas.

UNIT II ESTIMATIONANDPRODUCTIONOF NATURALGAS 9

Estimation of gas reserves by volumetric method – Production of natural gas –Pressure declinemethod–Problemsintheproductionofnaturalgas–Fieldseparation.

UNIT III GAS FROMCONDENSATEOIL FIELDS 9

Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns –Katy cycling plant.

UNIT IV ACID GASTREATING OF NATURAL GAS 9

Acid gas removal: Metal oxide process – Slurry process – Amine process – Carbonate washingprocess–Methanolbasedprocessandotherprocess–Sulphurrecoveryprocess.

UNIT V DEHYDRATIONOF NATURALGASANDNGLRECOVERY 9

Dehydration: Glycol dehydration – Solid desiccant dehydration. NGL Recovery: Refrigeration process–Leanoilabsorptionprocess–Solidbedadsorption and membrane separation process–NGL fractionation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the properties of natural gas.
CO2: Apply different measures in the recognition of reservoir performance.
CO3: Analyse flow behaviour of gas in production tubing.
CO4: Compare different methods of processing of gas.
CO5: Apply gas compression fundamentals.

TEXT BOOKS:

1. KatzandLee “Hand Book of Natural Gas Engineering” McGraw Hill, 1968.
2. Lyons, W.C.,“StandardHandbookofPetroleumandNaturalGasEngineering”,Vol.2,Gulf Professional Publishing, ElsevierInc.,2006.

REFERENCE BOOKS:

1. Katz, D. L. and Lee, R.L., “Natural Gas Engineering”, McGraw Hill, 1990.
2. Dring,M.M., “The Natural Gas Industry–A Review of World Resources and Industrial Applications”,Butterworth,1974.
3. Saied Mokha tab, William A. Poe, and James G. Speight, “Hand book of Natural Gas Transmission and Processing”, Gulf Professional Publishing, ElsevierInc.,2006.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the properties of natural gas.	3	3	3	3	2							3	3	2	1
CO2	Apply different measures in the recognition of reservoir performance.	3	3	3	3	2							3	-	3	1
CO3	Analyse flow behaviour of gas in production tubing.	3	3	3	3	2							3	3	-	1
CO4	Compare different methods of processing of gas.	3	3	3	3	2							3	-	3	1
CO5	Apply gas compression fundamentals.	3	3	3	2	2							3	3	-	1
Overall CO		**3**	**3**	**3**	**2.8**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3.0**	**2.7**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23008	ADVANCED DRILLING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE

Considerable research is going on throughout the world to develop new methods of drilling and excavating rocks. Knowledge of the developing technology is a necessary pre requisite to growth of any Industry.

UNIT I DIRECTIONAL DRILLING TECHNIQUE & APPLICATION 9

Define directional drilling- purposes of directional drilling-factors that govern planning of directional drilling project. Classify the directional drilling. Concept on built – up chart. Requirements of surface and downhole equipment for directional drilling projects. Common deflecting tools used in oil well directional drilling. Directional drilling terminology. Directional drilling techniques in oil well drilling. Basic methods of orientation of deflection tools -Bottomhole assemblies. Well bore survey calculations. Survey Instruments used in directional drilling. Derive a formula to calculate the Bottomhole position of directional drilling. Work out some problems on above. State and explain the common deflecting tools used for directional drilling at diamond drill holes. State the factors influencing structures and nature of the formation for deviation of diamond drill hole.

UNIT II HORIZONTAL DRILLING TECHNOLOGY 9

Define horizontal drilling. Advantage of horizontal drilling and field of application. Considerations for planning a horizontal well. Bottom hole assemblies for horizontal drilling. Measuring while drilling in horizontal drilling. Logging while drilling in horizontal drilling.

UNIT III BORE HOLE SURVEYING 9

State the necessity of bore hole surveying. State the various causes of deviation of bore holes. State the factors that increase or decrease the deviation of bore hole. Explain the methods of controlling deviations of bore holes. State the general classes of instruments used for surveying bore holes. Explain the methods of testing inclination of bore holes by Hydrofluoric acid method. Mass compass. Gyroscopic clinograph.

UNIT IV ROTARY DRILLS WITH DOWN HOLE MOTORS 9

Compare the result of Turbo drill with conventional rotary system. Explain the merits and demerits of Turbo drilling over Rotary method. Specify the main operating characteristics of a give Turbo Drill. State the different basic drilling mechanism of down hole motors. Give a concept on Dyna drill. Explain how to achieve the require amount of hole deviation with dyna drill State the special field of application of Dyna drills. State the main differences between various turbo drills. Explain the working principle of down hole motor with hydro dynamic characteristics. Explain the working principle of positive displacement motor drill. Explain of structure of down the hole Electo motor drill. Classify the types of Turbo drills according to their design features. Explain the performance characteristics of turbo drill. Derive the formula for power output of turbo drill.

UNIT V DRILLING PROBLEMS 9

Pipe sticking, lost circulation, Sloughing shale, formation damage, fatigue failure of drill string, Bit failure, and wire line failure. Well control and hydrodynamic pressure, well control techniques Non-conventional drilling methods Special Drilling Methods: Foam, under balanced, overbalanced, plasma, electrical, top drive, re-entry, extended reach, jet, multilateral, slim-hole and coil tubing drilling methods; Drilling HPHT wells, Drilling fluids for HPHT environment, Case study of HPHT drilling.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, students will be able to:
CO1: Generalize the history of drilling technology and its rapid progressing development.
CO2: Develop the basic concept of Down Hole Motors and its progressing R & D.
CO3: Recognise the application of development method of drilling technology.
CO4: Explain the mechanism and technology of different surface exploratory drilling techniques, tools, and equipment.
CO5: Evaluate drilling problems.

TEXT BOOKS:

1. Rotary Drilling Hand Book by J.E. Brantly
2. Exploratory Drilling by B.O.A.
3. Manual of Drilling Technology by C.P.Chugh
4. Diamond Drilling by C.P.Chugh 5. Petroleum Engineering by Carl Gatlin

REFERENCE BOOKS:

1. Malcom Rider, Second Edition, 2002: The Geological Interpretation of well logs, Rider-French Consulting limited
2. Oeberto Serra & Lorenzo Serra, 2004 : Well logging - data acquisition and applications, Edition Serralog,France
3. Jorden J R and Campbell F. L., , SPE, New York, 1986: Well Logging Vol. 1 and 2
4. Ellis, D. V. and Singer, J. M. 2nd edition, 2007: Well logging for Earth Scientist, Springer
2. Toby Darling, Well logging and Formation Evaluation, Gulf Professional Publishing, Elsevier Science.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Generalize the history of drilling technology and its rapid progressing development	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO2	Develop the basic concept of Down Hole Motors and its progressing R & D	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO3	Recognise the application of development method of drilling technology	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO4	Explain the mechanism and technology of different surface exploratory drilling techniques, tools, and equipment	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
CO5	Evaluate drilling problems	3	2	3	3	2	-	-	-	-	-	-	3	3	-	-
Overall CO		**3**	**2**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

VERTICAL II: PETROCHEMICAL PROCESS TECHNOLOGY

PE23009 PETROCHEMICAL UNIT PROCESSES

L	T	P	C
3	0	0	3

OBJECTIVE:

- To enable the students to know about the feed stock and source of petrochemicals, synthesis gas production and impart knowledge on unit processes.

UNIT I FEED STOCK AND SOURCE OF PETROCHEMICALS 9

Overview of Petrochemical Industry – The key growth area of India, Economics – Feed stock selections for Petrochemicals – Steam cracking of Gas and Naphtha to produce Olefins, Diolefins and Production of Acetylene.

UNIT II SYNTHESIS GAS PRODUCTION 9

Steam reforming of Natural gas – Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas – Production of Methanol – Oxo process.

UNIT III PRIMARY UNIT PROCESSES 9

Fundamental and Technological principled involved in Alkylation – Oxidation – Nitration and Hydrolysis.

UNIT IV SECONDARY UNIT PROCESSES 9

Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerization.

UNIT V TERTIARY UNIT PROCESSES 9

Fundamental and Technological principles involved in Halogenation and Esterification**.**

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the principles of various unit processes in the petrochemical industry.
CO2: Analyse the design for the production of methanol and oxo process.
CO3: Understand the unit operations involved in petrochemical unit processes.
CO4: Apply the process involved in sulphonation, sulfation and isomerization.
CO5: Review the unit process and operations involved in halogenation and esterification.

TEXT BOOKS:

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Sukumar Maiti, “Introduction to Petrochemicals”, 2 nd Edition, Oxford and IBH Publishers, 2002.

REFERENCE BOOKS:

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2 nd Edition, Ash Gate Publishing Limited.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2 nd Edition, Gulf Publishing Company, 2000.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd Edition, Affiliated East-West Press, 1993.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Apply the principles of various unit processes in the petrochemical industry.	3	3	2	2	2	-	-	-			-	3	3	-	2
CO2	Analyze the design for the production of methanol and oxo process.	2	2	3	2	3	-	-	-			-	3	3	2	1
CO3	Understand the unit operations involved in petrochemical unit processes.	3	3	2	3	2	-	-	-			-	3	3	3	2
CO4	Apply the process involved in sulphonation, sulfation and isomerization.	2	2	3	2	3	-	-	-			-	3	3	2	3
CO5	Review the unit process and operations involved in halogenation and esterification.	3	3	2	3	2	-	-	-			-	3	3	3	2
Overall CO		**2.6**	**2.6**	**2.4**	**2.4**	**2.4**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2.5**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23010	CORROSION IN OIL AND GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To teach the basic concept of corrosion mechanism, forms of corrosion, corrosion testing and monitoring techniques in oil and gas industry.

UNIT I **9**

Corrosion fundamentals, Corrosion in oil Industry, Cost of corrosion in the industry, Corrosivity of hydrocarbon fluids: - Water-oil emulsion and multiphase flow regime, Wettability of metal surface., Corrosivity of aqueous phase in hydrocarbon fluids; Sulphur and H2S in hydrocarbon fluids; Influence of oil chemistry on the Corrosivity of the aqueous phase. Pipeline corrosion; Kinetics of electrochemical surface reactions; Cathodic reduction reactions; Anodic dissolution reactions; Transport of species; Transport from the bulk solution to the steel surface; Transport through the porous surface scales. Corrosion products; Kinetics of corrosion products precipitation and corrosion products growth.

UNIT II **9**

Modes of internal corrosion attack: -Uniform corrosion; Localized corrosion; Pitting corrosion; Erosion corrosion; Galvanic corrosion; Intergranular corrosion; Stress corrosion cracking; Hydrogen damage; hydrogen embrittlement; Hydrogen-induced cracking; Formation of hydride. Pipeline flow Corrosivity: Effect of water wetting; Effect of multiphase flow regime; Effect of multiphase velocity; Effect of water phase characteristics; Significance of salinity; Significance of CO2 pressure; Significance of H2S; Significance of O2; Significance of pH; Effect of temperature. Materials selection: -Significance of alloying composition; Significance of steel microstructure.

UNIT III **9**

Experimental setups, methods, and standards: - Multiphase flow loop; Autoclave; Horizontal rotating cylinder; High velocity rig; Glass cell; Goniometer/Tensiometer; Moisture content measurements; Slow strain rate test. Corrosivity and corrosion rate determination: - Weight loss measurements; Potentiodynamic polarization and polarization resistance; Electrochemical impedance spectroscopy; Potentiation polarization;

UNIT IV **9**

Pipeline Corrosion control; Environment control; Gas-phase contaminants and degasification; Water presence and dehydration/dewatering; Pipe cleaning; Pigging; Internal coating/liner; Chemical treatment and corrosion inhibitors: -Corrosion control by industrial inhibitors, Application methods; Influence of operating conditions; Solubility, partitioning, and compatibility. Biocides.

UNIT V MECHANICAL MATERIAL HANDLING **9**

Inspection and corrosion monitoring. Oil treatment corrosion - crude oil properties – desalting sweetening processes. Corrosion in oil storage tank corrosion- oilfield and oil treating facilities-oil/gas pipelines -offshore platforms- subsea systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basic mechanism of corrosion process, thermodynamic and kinetics.
CO2: Classify the types of corrosion and its mechanism.
CO3: Assess the influencing factors of pipeline corrosion.
CO4:Evaluate the procedure of corrosion testing in oil and gas industry.
CO5: Practice the preventive measures of corrosion in oil and gas industry.

TEXT BOOKS:

1. Papavinasam, S (2013) Corrosion control in oil and gas industry, Elsevier.
2. Cicek, Volkan. 'Corrosion in Petroleum Industry'; Cathodic Protection: Industrial Solutions for Protecting Against Corrosion: 231-245.
3. Nathan, Charles Carb. 'Corrosion inhibitors'; C. C. Nathan, Editor, published 1973 by NACE, 260 (1973).

REFERENCE BOOKS:

1. Standard Handbook of Petroleum and Natural Gas Engineering. 3 rd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing (2015)

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	To Understand the basic mechanism of corrosion process, thermodynamic and kinetics.	3	3	3	2	2	3	1	-				3	3	3	1
CO2	Classify the types of corrosion and its mechanism.	3	3	3	3	3	2	1	-				3	3	3	1
CO3	Assess the influencing factors of pipeline corrosion.	3	3	3	3	2	3	1	-				3	3	3	1
CO4	Evaluate the procedure of corrosion testing in oil and gas industry.	3	3	3	3	3	2	1	-				3	3	3	-
CO5	Practice the preventive measures of corrosion in oil and gas industry.	3	3	3	3	3	2	1	-				3	2	3	-
OVERALL CO		**3**	**3**	**3**	**2.8**	**2.6**	**2.4**	**1**	**-**	**-**	**-**	**-**	**3**	**2.8**	**3**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23011	PROCESS EQUIPMENT AUXILIARIES AND UTILITIES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To give an overview of various equipment auxiliaries involved in the chemical processes

UNIT I ELECTRICAL MOTORS AND STARTERS 9

Electrical motors – Induction –Synchronous – Electrical Starters.

UNIT II ROTARY EQUIPMENTS 9

Pumps –Turbines – Blowers – Compressors – Fans – Concept – Working and application.

UNIT III INDUSTRIAL VALVES 9

Needle valve – Globe, gate and ball valves – Butterfly valve – Check valve – Piping system.

UNIT IV INDUSTRIAL DRYERS 9

Rotary fluid bed – Spray and freeze dryers – Electro osmotic dryers – Rotary dryer – Case Studies.

UNIT V PROCESS UTILITY EQUIPMENTS 9

Vacuum devices – Filters – Cooling towers – Refrigeration systems – Flare system – Equipment for waste water treatment systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. CO1: Explain the working principle, types, operation, selection and applications of Electrical motors and starters.
2. CO2: Illustrate applications of rotary equipment such as pumps, blowers, turbines, compressors and fans.
3. CO3: Understand the working principle, types, operation, selection and applications of industrial valves.
4. CO4: Solve troubleshoots in auxiliary equipment used in petrochemical and chemical industries dryers.
5. CO5: Explain the working principle, types, operation, selection and applications of vacuum devices, filters, cooling towers, refrigeration systems, flares and waste water systems.

TEXT BOOKS:

1. Walas, S.M., “Chemical Process Equipment”, Butterworth – Heinemann Oxford Publishing Ltd., 1999.
2. Thomas, C.E., “Process Technology – Equipment and systems”, Uhai Publishing, Inc., 2002.

REFERENCE BOOKS:

1. Ludwig, E.E., “Applied Process Design for Chemical and Petrochemical Plants”, Vol.I and III, Gulf Professional Publishing, 2002.
2. Perry, R.H. and Green, D.W., “Perry’s Chemical Engineer’s Hand Book”, 7th Edition, McGraw Hill – International, 1997.
3. Sahu, G.K., “Hand Book of Piping Design”, New Age International Publishers, 2005.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Explain the working principle, types, operation, selection and applications of Electrical motors and starters.	3	3	2	3	2	_	_	_	_	_	_	_	3	3	1
CO2	Illustrate applications of rotary equipment such as pumps, blowers, turbines, compressors and fans.	3	3	2	3	2	_	_	_	_	_	_	_	3	3	1
CO3	Understand the working principle, types, operation, selection and applications of industrial valves.	3	3	2	3	2	_	_	_	_	_	_	_	3	3	1
CO4	Solve troubleshoots in auxiliary equipment used in petrochemical and chemical industries dryers.	3	3	2	3	2	_	_	_	_	_	_	_	3	3	1
CO5	Explain the working principle, types, operation, selection and applications of vacuum devices, filters, cooling towers, refrigeration systems, flares and waste water systems.	3	3	2	3	2	_	-	_	_	_	_	_	3	3	1
OVERALL CO		**3**	**3**	**2**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**1**

PE23012	POLYMER TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

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

UNIT I INTRODUCTION 9

Basic concepts of macromolecules – Monomers – Polymers – Natural and Synthetic polymers - structure of natural products like cellulose, rubber and proteins - Chemistry of Olefins and Dienes – double bonds - Functionality - degree of polymerization-Classification and nomenclature of polymers – Thermoplastic and thermosetting polymerization.

UNIT II ADDITION AND CONDENSATION POLYMERIZATION 9

Addition Polymerization: free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Copolymerization concepts – Condensation polymerization.

UNIT III MOLECULAR WEIGHTS OF POLYMERS 9

Molecular weight of polymer: Number average and Weight average molecular weights – Degree of polymerization – molecular weight distribution – Polydispersity – Molecular weight determination. – Gel Permeation Chromatography, Osmometry and Light Scattering.

UNIT IV GLASS TRANSITIONS TEMPERATURE 9

Glass transition Temperature: significance and experimental study – Melting Point of polymer - significance and experimental study – Relationship between Tg and Tm – Crystallinity in polymers – effect of crystallization– factors affecting crystallization - Polymer Density / Apparent Density, Viscosity measurements.

UNIT V PLASTICS PROCESS – MOULDING TECHNIQUES 9

Injection molding: Principle, Types and advantages - Blow molding: Principle, Types and advantages - Thermoforming: Principle, Types and advantages - Compression molding: Principle, Types and advantages - Extrusion: Principle, Types and advantages – Calendaring: Principle, Types and advantages.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Know about the fundamentals of monomer and types of polymers.
CO2: Illustrate the addition and condensation polymerization mechanism.
CO3: Assess the molecular weight of polymers and its significance.
CO4: Recognize knowledge on polymers glass transition temperature and melting point.
CO5: Understand the different moulding techniques for various applications.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 6th edition, CRC Press, 2014.
3. Seymour. R.B., and Carraher.C.E., Jr., Polymer Chemistry, 2nd Ed., Marcel Dekker, 1988.
4. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Know about the fundamentals of monomer and types of polymers	3	1	1	1	-	-	-	-	-	-	-	-	-	-	1
CO2	Illustrate the addition and condensation polymerization mechanism.	3	2	2	2	1	-	2	-	-	-	-	3	3	3	1
CO3	Assess the molecular weight of polymers and its significance	3	3	3	3	2	3	1	-	1	2	1	3	3	3	1
CO4	Recognize knowledge on polymers glass transition temperature and melting point	3	3	3	3	3	2	1	-	1	2	1	3	3	3	1
CO5	Understand the different moulding techniques for various applications.	3	3	3	3	2	3	1	-	1	3	2	3	2	3	1
Overall CO		**3**	**2.4**	**2.4**	**2.4**	**2**	**2.7**	**1.3**	**-**	**1**	**2.3**	**1.3**	**3**	**2.8**	**3**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23013	CARBON CAPTURE STORAGE AND SEQUESTRATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

1. To teach about the carbon sequestration process against global warming and the future technology advances in the field of oil and gas industries.

UNIT I **9**

The green-house effect. The United Nations Framework Convention on Climate Change (UNFCCC). The Intergovernmental Panel on climate change (IPCC), the Kyoto Protocol, the Clean Development Mechanism (CDM). Afforestation and Reforestation projects, Reduced Emissions from Deforestation and Degradation (REDD). CDM projects, finance, project development. Conservation of natural carbon sinks. National inventory management system in India (NIMS).

UNIT II **9**

Carbon capture from power generation: Introduction, Pre-combustion Capture, Post-combustion Capture, Oxy- fuel Combustion Capture, Chemical Looping Capture Systems, Capture-Ready and Retrofit Power Plant, Approaches to Zero-Emission Power Generation. Carbon capture from industrial processes: Cement Production, Steel Production, Oil Refining, Natural Gas Processing. Absorption capture systems: Chemical and Physical Fundamentals, Absorption Applications in Post Combustion Capture, Absorption Technology RD&D Status."

UNIT III **9**

Adsorption capture systems: Physical and Chemical Fundamentals, Adsorption Process Applications, Adsorption Technology RD&D Status. References and Resources. Membrane separation systems: Physical and Chemical Fundamentals, Membrane Configuration and Preparation and Module Construction, Membrane Technology RD&D Status, Membrane Applications in Pre-combustion Capture, Membrane and Molecular Sieve Applications in Oxy-fuel Combustion, Membrane Applications in Post-combustion CO2 Separation, Membrane Applications in Natural Gas Processing.

UNIT IV **9**

Cryogenic and distillation systems: Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO2 – CH4 separation, RD&D in cryogenic and distillation technologies. Mineral carbonation: Physical and chemical fundamentals, Current state of technology development, Demonstration and deployment outlook.

UNIT V **9**

Ocean storage: Introduction, Physical, chemical, and biological fundamentals, Direct CO2 injection, Chemical sequestration, biological sequestration, Storage in terrestrial ecosystems: Introduction, Biological and chemical fundamentals, Terrestrial carbon storage options, Full GHG accounting for terrestrial storage, Current R&D focus in terrestrial storage. Other sequestration and use options: Enhanced industrial usage, Algal biofuel production.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the methodology of sequestration.

CO2: Assess the future of carbon capture storage technologies, formation mineral storage and its use in unconventional reservoirs.

CO3: Design the technology for carbon sequestration.

CO4: Evaluate the various processes in the latest trend in oil and gas industries such as carbon flooding.

CO5: Plan against global warming and calamities.

TEXT BOOKS:

1. Stephen A. Rackley, Carbon dioxide capture and storage, Butterworth-Heinemann, Elsevier Inc. 2010.
2. Ronald E. Hester, Roy M. Harrison, Carbon Capture: Sequestration and Storage, RSC publishing, 2010
3. Jay J Kachhot and Dr P K Mehta “Carbon Sequestration: A Method to Conserve Environment” Scholars' Press, 2021.

REFERENCE BOOKS:

1. Carbon Capture and Storage: Physical, Chemical, and Biological Methods Edited by Rao Y. Surampalli, Ph.D., P.E.; Tian C. Zhang, Ph.D., P.E.; R. D. Tyagi, Ph.D.; Ravi Naidu, Ph.D.; B. R. Gurjar, Ph.D.; C. S. P. Ojha, Ph.D.; Song Yan, Ph.D.; Satinder K. Brar, Ph.D.; Anushuya Ramakrishnan, Ph.D.; and C. M. Kao, Ph.D., P.E. 2015 (American Society of Civil Engineers ASCE library)
2. Jose Antonio Garcia, Maria Villen-Guzman, Jose Miguel Rodriguez-Maroto, Juan Manuel Paz-Garcia, ‘Technical analysis of CO2 capture pathways and technologies’, Journalof Environmental Chemical Engineering, Volume 10, Issue 5, 2022.
3. Malti Goel, M Sudhakar and R V Shahi, Carbon Capture, Storage, and Utilization, tery press, 2015.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the methodology of sequestration.	3	3	3	3	2	2	1	-	-	-	3	3	3	3	2
CO2	Assess the future of carbon capture storage technologies, formation mineral storage and its use in unconventional reservoirs.	3	3	3	3	2	2	1	-	-	-	2	3	3	3	1
CO3	Design the technology for carbon sequestration.	3	3	3	3	2	2	1	-	-	-	2	3	3	3	2
CO4	Evaluate the various processes in the latest trend in oil and gas industries such as carbon flooding.	3	3	3	3	2	2	1	-	-	-	2	3	3	3	3
CO5	Plan against global warming and calamities.	3	3	3	3	2	2	1	-	-	-	2	3	2	3	1
Overall CO		**3**	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**2.2**	**3**	**2.8**	**3**	**1.8**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23014	FERTILIZER TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To enable the students to learn about the fertilizer manufacturing including new or modified fertilizer products.

UNIT I NITROGENOUS FERTILISERS 9

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

UNIT II PHOSPHATIC FERTILISERS 9

Raw materials; phosphate rock, Sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III POTASSIC FERTILISERS 9

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 9

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitro phosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MISCELLANEOUS FERTILISERS 9

Mixed fertilizers and granulated mixtures; biofertilizers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the various manufacturing process involved in production of Nitrogenous fertilizers.
CO2: Demonstrate the concepts of phosphatic fertilizers types and their manufacturing methods.
CO3: Analyse the role of potassium in plants and the method of production.
CO4: Assess the complex and NPK fertilizers.
CO5: Illustrate the knowledge of bio fertilizers, fluid fertilizers, slow-release fertilizers and their applications.

TEXT BOOKS:

1. “Handbook of fertilizer technology”, Association of India, New Delhi, 1977.
2. Menno, M.G.; “Fertilizer Industry - An Introductory Survey”, Higginbothams Pvt. Ltd., 1973.

REFERENCE BOOKS:

1. Sauchelli, V.; “The Chemistry and Technology of Fertilizers”, ACS MONOGRAPH No.148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, “United Nations Industrial Development Organization”, United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the various manufacturing process involved in production of Nitrogenous fertilizers.	2	3	1	1	1	-	1	-	-	-	1	-	3	3	1
CO2	Demonstrate the concepts of phosphatic fertilizers types and their manufacturing methods.	2	3	1	1	1	2	1	-	-	-	1	-	3	3	-
CO3	Analyse the role of potassium in plants and the method of production.	2	3	1	1	1	2	1	-	-	-	1	-	3	3	-
CO4	Assess the complex and NPK fertilizers.	2	3	1	1	1	2	1	-	-	-	1	-	3	3	1
CO5	Illustrate the knowledge of bio fertilizers, fluid fertilizers, slow-release fertilizers and their applications.	2	3	1	1	1	2	1	-	-	-	1	-	3	3	2
Overall CO		**2**	**3**	**1**	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**3**	**3**	**1.3**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23015	PETROCHEMICAL DERIVATIVES	L	T	P	C
		3	0	0	3

OBJECTIVES

To enable the students to familiarize with the different generation of petrochemicals and their manufacturing process.

UNIT I PRECURSORS 9

Indian Petrochemical Industry - Sources of Petrochemicals - Classification of Petrochemicals - Classification of Hydrocarbons - Alternate routes with flow diagram for production of methane, ethylene, propylene, acetylene. Chemicals from methane, ethylene, propylene, acetylene.

UNIT II FIRST GENERATION PETROCHEMICALS 9

Alternate routes with flow diagram for production of butadiene, related dienes, aromatics – Benzene, toluene, xylene – Chemicals from butadiene, related dienes, aromatics – Benzene, toluene, xylene.

UNIT III SECOND GENERATION PETROCHEMICALS 9

Alternate routes with flow diagram for production of ethylene glycol, ethylene oxide, Ethyl benzene, VCM, acrylonitrile, phenol, adipic acid, hexamethylenediamine, DMT, TPA, maleic anhydride, styrene.

UNIT IV THIRD GENERATION PETROCHEMICALS 9

Polymerization – Modes and techniques – Production of polyethylene – LDPE, HDPE, polypropylene, SBR, SAN, ABS, PU.

UNIT V THIRD GENERATION PETROCHEMICALS 9

Polyacrylonitrile, polyvinyl chloride, polycarbonates, nylon 6, nylon 66, polyesters, resins, explosives, organic dyes.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand the techniques for the production of precursors of petrochemicals.
CO2: Understand the manufacturing process of first-generation petrochemicals
CO3: Explain the manufacturing process of third generation of petrochemicals and their alternate routes for production.
CO4: Classify polymers and elaborate its production processes.
CO5: Analyse the production processes of fibers, resins and explosives.

TEXT BOOKS:

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. SukumarMaiti, “Introduction to Petrochemicals”, 2nd Edition, Oxford and IBH Publishers 2002.

REFERENCE BOOKS:

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd Edition, Gulf Publishing company, 2000.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd Edition, Affiliated East-West Press, 1993.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the techniques for the production of precursors of petrochemicals.	2	3	1	1	2	2	1	-	-	-	-	2	-	2	1
CO2	Understand the manufacturing process of first-generation petrochemicals.	2	3	1	1	1	2	1	-	-	-	-	2	-	2	1
CO3	Explain the manufacturing process of third generation of petrochemicals and their alternate routes for production.	2	3	1	1	1	2	1	-	-	-	-	2	-	2	1
CO4	Classify polymers and elaborate its production processes.	2	3	1	1	1	2	1	-	-	-	-	2	-	2	1
CO5	Analyze the production processes of fibers, resins and explosives	2	3	1	1	1	2	1	-	-	-	-	2	-	2	1
	Overall CO	**2**	**3**	**1**	**1**	**1.2**	**2**	**1**	**0**	**0**	**0**	**0**	**2**	**-**	**2**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23016	REFINERY PROCESS DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVE:

To get acquainted with process design of distillation columns involving multicomponent and complex mixtures. To learn methodologies practiced in rating and designing heat transfer equipment used in refining and process industry.

UNIT I MULTICOMPONENT DISTILLATION 9

Dew point and bubble point for multi component mixtures. Design of multi component distillation column, Number of variables, Selection of key components, Selection of column pressure, Feed condition, Plate-to-plate calculations, Empirical short cut methods, Introduction to rigorous solution procedures.

UNIT II PETROLEUM REFINERY DISTILLATION 9

TBP, EFV, ASTM distillation curves and their relevance, Material balance and flash zone calculations for petroleum refinery distillation columns, Pump around and pump back calculations, Overall energy requirements, Estimation of number of equilibrium stages, Design using Packie charts and Watkins method, Introduction to rigorous solution procedure based on pseudo components.

UNIT III COLUMN DESIGN 9

Process design of distillation towers. Flooding charts. Trays and packings. Vacuum devices. Pressure drops. Height, diameter, supports. Piping requirements. Aspects of mechanical design. A typical P&ID for a distillation column.

UNIT IV FIRED HEATERS 9

Heat load calculations for furnace heaters used in crude refining, Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters, Introduction to manual calculations methods.

UNIT V PUMPS AND COMPRESSORS 9

Types of pumps and compressors. Selection criteria. Power rating calculations based on process duty. Use of operating curves of centrifugal pump. NPSHR and NPSHA. Pump Cavitation. Surge problem in compressors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course students are expected to

CO1: Understand the fundamentals of multicomponent distillation.
CO2: Learn petroleum refinery distillation.
CO3: Assess column design.
CO4: Analyze fired heaters.
CO5: Evaluate the pumps and compressors.

TEXT BOOKS:

1. Van Winkle M., “Distillation”, McGraw Hill, 1967.
2. Watkins, “Petroleum Refinery Distillation”, McGraw Hill, 1993 91

REFERENCE BOOKS

1. Sinnott R. K., “Coulson and Richardson’s Chemical engineering”, Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
2. Kern D. Q., “Process Heat Transfer”, McGraw Hill, 1965.
3. Cao Eduardo, “Heat Transfer in Process Engineering”, McGraw Hill,2010

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the fundamentals of multicomponent distillation	3	3	3	3	2	-	-	-	-	-	3	3	3	3	1
CO2	Learn petroleum refinery distillation	3	3	3	3	2	-	-	-	-	-	3	3	3	3	1
CO3	Assess column design	3	3	3	3	2	-	-	-	-	-	3	3	3	3	1
CO4	Analyze fired heaters	3	3	3	3	2	-	-	-	-	-	3	3	3	3	1
CO5	Evaluate the pumps and compressors	3	3	3	3	2	-	-	-	-	-	3	3	3	3	1
Overall CO		**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

VERTICAL III: HYDROCARBON TRANSPORTATION AND STORAGE

PE23017	PIPING ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To provide an insight into the design, operation and maintenance of pipes and piping networks.

UNIT I PIPING FUNDAMENTALS 9

Introduction to Piping — Pipe and tube, Classification of Pipes, Piping Materials and Selection criteria, Piping components — Valves, Joints and Fittings. Fluid Flow Problems — Estimation of Major and Minor Losses, Pumping requirements.

UNITII PIPING IN PRACTICE 9

Piping Network–Series and Parallel pipes, Pipe Network analysis using spread sheets. Piping for pumps and compressor.

UNIT III GENERIC PIPING DESIGNS 9

Usage of Standard and codes. Piping Design — material compatibility, estimation of optimum diameter, selection of valves and fittings, complexity factor, stress analysis, selection of pipe supports.

UNIT IV PIPING SYSTEMS 9

Design considerations for piping systems — water and waste water, steam, compressed air, industrial gases, oil, refrigeration, solid and slurry systems.

UNIT V OPERATION AND MAINTENANCE: 9

Inspection of Pipelines – Testing techniques and leak detection. Maintenance – Cleaning, coating, freeze prevention, drag reduction, insulation, Common failures and repair techniques, Piping Plan development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the fundamental principles of fluid mechanics to solve fluid flow problems
CO2: Interpret the piping symbols, code sand sketch a piping layout for a given problem.
CO3: Understand the concepts of generic piping design for optimal design of piping systems.
CO4: Explain the process of design of various pipelines systems
CO5: Assess the techniques involved in inspection and maintenance of pipelines

TEXT BOOKS:

1. Henry Liu,"Pipeline Engineering",2nd Edition,Lewis Publishers, United State of America, 2003. UnitI&II.
2. Mohinder L.Nayyar, "Piping Handbook", 7thEdition, Tata McGraw Hill Publishing Company Ltd, United States of America, 2000.UnitIII,IV&V

REFERENCE BOOK:

1. John J Mcketta, “Piping Handbook”, 3rd Edition, Marcel Dekker Inc, United States of America, 1992.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Apply the fundamental principles of fluid mechanics to solve fluid flow problems	3	2	-	3	2	-	-	-	-	-	-	1	3	3	-
CO2	Interpret the piping symbols, codes and sketch a piping layout for a given problem.	2	2	-	3	2	-	-	-	-	-	-	1	3	3	-
CO3	Understand the concepts of generic piping design for optimal design of piping systems.	2	2	-	3	2	-	-	-	-	-	-	1	3	3	-
CO4	Explain the process of design of various pipelines systems	2	2	-	3	2	-	-	-	-	-	-	1	3	3	-
CO5	Assess the techniques involved in inspection and maintenance of pipelines	2	2	-	3	2	-	-	-	-	-	-	1	3	3	-
Overall CO		2.2	2	0	3	2	0	0	0	0	0	0	1	3	3	0

1,2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23018	STORAGE TRANSPORTATION OF CRUDE OIL AND NATURAL GAS	L	T	P	C
		3	0	0	3

OBJECTIVES

To teach the natural gas regasification technology, storage and crude oil transportation.

UNIT I INTRODUCTION **9**

Crude oil Trade, Selection of Port Location, Ship Building/Ship yards.

UNIT II NATURAL GASREGASIFICATION TECHNOLOGY **9**

Commercial Sourcing of Natural Gas, Different Kinds of Regasification Techniques, Regasification Process & Cold Utilization, Synchronization of Degasified gas and Pipelines, Current Status in India.

UNIT III CRUDE OIL TRANSPORTATION **9**

Transportation techniques of crude oil, Pipeline specification, Corrosion Prevention techniques, Pressure drop, Pumps and Booster station, Waxde position and prevention, Chemical treatment.

UNIT IV DESIGN **9**

Basic Engineering Aspects of Terminal Design, Design of Liquefaction Train, Ship Building/ Shipyards, Storage Facilities.

UNIT V CHARTERTICS OF STORAGE **9**

Supply & Demand, Variation Gas Field & Aquifers, Technical Qualities and Storage, Properties of Storage Reservoir, Rocks &Fluids. Flow through Storage Reservoir; Inventory Concept, Pressure-Content Hysteresis, Inventory Verification, Gas Flow Performance, Gas Deliverability. Design &Development of Underground Storage Fields: Operation of Storage Fields. Threshold Pressure. Water Influx/Efflux Quantities. Aquifer Equilibrium Pressure. Error and Uncertainty. Gas Storage in Salt Cavity & Caverns: Thermodynamics, Temperature and Pressure Effect. Recent Developments Advanced Storage Techniques, Case Histories**.**

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Plan the layout for oil transportation.
CO2: Assess the storage systems.
CO3: Compute the different kinds of regasification techniques.
CO4: Evaluate the pipeline specification and corrosion prevention techniques.
CO5: Analyze the properties of storage reservoir, rocks and fluids.

TEXT BOOKS:

1. Oil field Processing: Crude Oil (Oil field Processing of Petroleum R.Solvay, PennwellBooks1995.
2. Advances in Environmental Control Technology: StorageTank Paul CheremisinoffGulf Professional Publishing;1st edition (May 9,1996)

REFERENCE BOOK:

1. Natural gas engineering handbook 2nd edition boyun guo ali ghalambor gulf publishing 2012.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Plan the layout for Oil transportation.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
CO2	Assess the storage systems.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
CO3	Compute the different kinds of regasification techniques.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
CO4	Evaluate the pipeline specification and corrosion prevention techniques.	3	3	3	1	1	-	-	-	-	-	-	2	2	2	2
CO5	Analyse the properties of storage reservoir, rocks and fluids.	3	3	3	3	3	-	-	-	-	-	-	2	2	2	2
Overall CO		**3**	**3**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weighting as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23019 DESIGN OF PRESSURE VESSELS AND STORAGE VESSLES

L	T	P	C
3	0	0	3

OBJECTIVES:

To teach the design of pressure vessels, storage vessels, pipe fittings and joints.

UNIT I DESIGN OF PIPE FITTINGS AND JOINTS 9

Stress-strain relationships of elastic materials subjected to tensile, compressive and shear forces; Membrane stresses in shells of revolutions; Theories of failures. Design and schematic of simple bolts and screws. Design and drawing of shafts and couplings.

UNIT II DESIGN OF PRESSURE VESSELS 9

Unfired pressure vessel: Pressure vessel codes; Design of cylindrical and spherical shells under internal and external pressures; Selection and design of flat plate, tori spherical, ellipsoidal, and conical closures; Shell design of all vertical vessels; Compensations of openings.

UNIT III DESIGN OF STORAGE VESSELS 9

Liquid storage tanks: Storage tank codes; Classification; Design of shell, bottom plates, self-supported, and column supported roofs; Wind girder; Nozzles and other accessories.

UNIT IV FABRICATIONAND MATERIALS 9

Fabrication of equipment: Major fabrication steps; Vessel lining; Materials used in fabrication of Chemical Equipment. Vessel Coatings— selection and application. Selection of process equipment's material. Material selection for process fluids.

UNIT V DESIGN OF SUPPORTS FOR VESSELS 9

Introduction – Types of Support – Design of Skirts, Brackets, Saddle and Leg supports. Special types of supports for vessels.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the principles of Stress-strain relationships of elastic materials, design and drawing of shafts and couplings

CO2: Enhance the knowledge on design of cylindrical and spherical shells under internal and external pressures.

CO3: Study the design of storage vessels.

CO4: Evaluate the principles involved in material selection for process fluids.

CO5: Estimate and design the supports for vessels.

TEXT BOOKS:

1. R.S. Khurmi, "Text book of Machine design". S.Chand & Company, XXV Edition, 2005.
2. M.V. Joshiand V.V.Mahajan, "Design of Process Equipment Design", McMillan India III Edition, 1994.
3. Bhattacharyya, B.C., "Introduction to chemical Equipment Design: Mechanical aspects", CBS Publishers & Distributors, New Delhi.

REFERENCE BOOKS:

1. S.D.Dawande,"ProcessDesignofequipment",CentralTechnoPublications,Nagpur,2000.
2. IndianStandardSpecificationsIS-803,1962;IS-4072,1967;IS-2825,1969.ISI, New Delhi.
3. R.H. Perry, "Chemical Engineers' Hand book", Mc Graw-Hill.
4. Ludwig, E.E., Applied Process Design for Chemical and Petrochemical Plants", Volume I,II,and III, Gulf Publishing Co.
5. J.M. Coulsonand J. Richardson, "Chemical Engineering", Vol. 6, Asian Books Printers Ltd.

COURSE ARTICULATION MATRIX:

Course Outcomes	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	Understand the principles of Stress-strain relationships of elastic materials, design and drawing of shafts and couplings	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	Enhance the knowledge on design of cylindrical and spherical shells under internal and external pressures.	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	Study the design of storage vessels.	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO4	Evaluate the principles involved in material selection for process fluids.	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	Estimate and design the supports for vessels.	3	3	3	2	2	-	-	-	-	-	-	2	2	2
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23020	PIPELINE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

To have knowledge on pipeline design, specifications of various valves and also to discuss on corrosion and its preventions.

UNIT I **9**

Modes and comparison among different modes of transportation of petroleum products, Advantages and limitations of pipelines modes, Introduction to pipeline project, Economics and cost structure of Pipeline project, Economic pipe diameter.

UNIT II **9**

Introduction to outline for Design & construction of onshore-offshore pipelines, Pipeline codes and standards, Overview of O& G field Processes, Types of Onshore/ Offshore Pipelines, Factors affecting pipeline design (External, fluid properties, pipeline parameters and Fluid flow considerations. Loop- lines

UNIT III **9**

Design of Liquid pipelines: Hydraulic Analysis, Relevant Pipeline Parameters, Types of fluids, Pressure Loss calculations, Maximum allowable operating Pressure, Pipeline sizing, Diameter sizing, Determination of wall Thickness, Station Spacing

UNIT IV **9**

Pumping Power calculations, Design of Gas Pipelines: Factors affecting Gas Pipeline Design, Pressure Loss calculations, Gas pipeline Hydraulic Calculations, as Compression / Power requirement. Construction Of pipelines: Introduction, Onshore & Offshore pipeline Construction. Commissioning of pipeline. Pipeline Operations,

UNIT V **9**

Pigging, integrity assessment by Intelligent pigging and Instrumentation, Monitoring and Control Thru SCADA application, Corrosion and control/ Cathodic Protection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the roles and responsibilities of a pipeline engineer in the oil and gas industry.
CO2: Apply pipeline codes, regulations and standards in both offshore and onshore environments.
CO3: Attribute pipeline terminology, various components and materials used and the fluid properties affecting the pipeline transportation.
CO4: Evaluate forces acting on a pipeline system in operating conditions.
CO5: Analyse the processes involved in the prevention of corrosion and the inspection of pipeline and its components.

TEXT BOOKS:

1. Alkazraji Duraid, (2008) A quick guide to pipeline engineering WOODHEAD Publishing Limited
2. Vincent, Jecqes (2010) Fundamentals of Pipeline Engineering, Gulf Publishing

REFERENCE BOOKS:

1. Antaki, G. A. (2003) Piping and Pipeline Engineering, Marcell Dekker.
2. Modelling of oil and products and gas pipeline transportation by Mikhail V Luric
3. Pipeline Engineering by Henry Liu

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the roles and responsibilities of a pipeline engineer in the oil and gas industry.	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
CO2	Apply pipeline codes, regulations and standards in both offshore and onshore environments.	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
CO3	Attribute pipeline terminology, various components and materials used and the fluid properties affecting the pipeline transportation.	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
CO4	Evaluate forces acting on a pipeline system in operating conditions.	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
CO5	Analyse the processes involved in the prevention of corrosion and the inspection of pipeline and its components.	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**1**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23021	PETROLEUM ECONOMICS AND MERGER ACQUISITION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To teach the basic quantitative theories and methodologies in Petroleum economics.

UNIT I **9**

Supply and demand curves, the elasticity of supply and demand, public finance concepts such as consumer surplus, excise and export taxes. Forecasting techniques for the energy industry, including energy prices. Demand and supply for natural gas, cured oil and pipeline transportation, determinants of energy demand, energy markets, energy pricing, stability and performance of energy markets.

UNIT II **9**

The economics of investment, Discounted cash flow analysis, Cost Benefit Analyses, Internal Rate of Return, NPV, Profitability Index, Natural Monopoly theory, National competition Policy, Gas Market Regulation, taxation of the oil and gas industry, government policy and trade permits, Monte Carlo analysis, Net Back Pricing, Transfer Pricing and regulatory aspects.

UNIT III **9**

Application of petroleum engineering principles and economics to the evaluation of oil and gas projects, evaluation principles, time value of money concepts, investment measures, cost estimation, price and production forecasting, risk and uncertainty, project selection and capital budgeting inflation, escalation, operating costs, depreciation, costrecovery. Corporate finance & return on capital, economic appraisal methods for oil filed development, reservoir model costs and calculations.

UNIT IV **9**

Analysis of ongoing costs, analysis of field development investments, purchase / sale of producing property, financial reporting. Mergers and Acquisitions, overview of E & P acquisition environment. Petroleum Industry Accounting and types, Petroleum Auditing, Tax Analysis, Cost, Expenditure and revenues under different heads and their proportion in Asset. Depreciation, Depletion, Amortization Methods and their use in tax calculations.

UNIT V **9**

Reasons for development of a fiscal system for petroleum industry. Classification of Petroleum Fiscal Systems, Current distribution of exploration and production contract types, and their comparison with possible equivalence. National Oil Companies and International Oil Companies: comparative assessment Petroleum industry in India. Production fiscal system in India and abroad.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the concept of economics in a process plant, time value of money and cost indices.

CO2**:** Integrate knowledge about financial statements, depreciation and accounting**.**

CO3: Develop economic balance for petroleum engineering equipment's and determine the optimum cost for operation.

CO4: Evaluate the concept of inventory control and the role of control charts in quality control in industry.

CO5: Assess the work measurement technique, production planning and elements of production control in industry.

TEXT BOOKS:

1. Industrial Economics An Introductory Text book. R.R.Barthwal, 2nd Edition, New Age International Publisher**.**
2. ManagerialEconomics—D.N.Divedi.6thRevisedEdition.VikasPublishingHousePrivateLtd.
3. Standard Handbook of Petroleum and Natural GasEngineering.2ndEdition.WilliamCLyons,Gary, CPlisga. Gulf Professional Publishing.
4. Petroleum Engineering Handbook. Bradely, H.B.Society of Petroleum Engineers. Richardson. Texas.
5. Abdel A. A. Bakr A. B, and Al Sahlawi M. A., 1992, Petroleum Economics and Engineering, Decker Publications.

REFERENCE BOOKS:

1. The Encyclopedia Americana, International Edition Volume 9,Grolier Incorporated.
2. Johnston, D, 2003, International Exploration Economics, Risk, and Contract Analysis, Pennwell Books.
3. Nadine BRET-ROUZAUT and Jean-Pierre FAVENNEC, 2011, Oil and Gas Exploration and Production, Reserves, Costs and Contracts. Technip Publication, 336 pp.
4. Mian M A, 2011, Project Economics and Decision Analysis, Volume I and II, Pennwell Books; 2nd Revised edition, 461 pp and 411 pp.
5. Seba R.D., 1998, Economics of Worldwide Petroleum Production OGCL Publications, USA, 761 pp.
6. Silvana Tordo and D Johnston, Petroleum Exploration and Production Rights, World Bank Working Paper 179, Washington, 2010 , 126 pp.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMMEME OUTCOMES														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the concept of economics in a process plant, time value of money and cost indices.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO2	Integrate knowledge about financial statements, depreciation and accounting.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	**1**
CO3	Developeconomicbalance forpetroleumengineeringequipment'sanddeterminetheoptimumcost for operation.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO4	Evaluate theconceptofinventorycontrolandtheroleofcontrolchartsinqualitycontrolin industry.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO5	Assess the work measurement technique, production planning and elements of production control in industry.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
OVERALL CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23022	TRANSPORTATION AND MARKETING OF PETROLEUM AND PETROLEUM PRODUCTS	L	T	P	C
		3	0	0	3

UNIT I **9**

Indian and Global supply scenario of petroleum and petroleum products. Product quality control. Bulk distribution and handling-domestic, commercial and industrial. Storage of petroleum products in fixed installations. Pricing Mechanisms of crude oil and natural gas. Role of International oil companies and OPEC pricing mechanism. Spot and other market control mechanism

UNIT II **9**

Administered and market determined pricing mechanism in India. Conservation of petroleum & its products, Government & Industry regulatory norms influencing petroleum product marketing. Rules and Regulations for transportation of Crude oil, Natural Gas and other Petroleum products. Traffic management, Fire and safety rules.

UNIT III **9**

Mode of Transportation of petroleum & petroleum products. Basics of Pipeline construction, operation and protection.

UNIT IV **9**

Pump and compressor stations. Instrumentation and control. Metering and Measurements: Metering of oil & gas, Orifice and other metering devices and systems. Multiphase flow meter. Tank gauging. Sampling and Testing of crude oil. Water and sediment determination

UNIT V **9**

Product quality control. Marketing Organizations and Retail Infrastructure Bulk distribution and handling-domestic, commercial and industrial petroleum products, distribution network, marketing location management of petroleum products.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Remember overall idea on supply, consumption and distribution of petroleum and petroleum products Pricing Mechanisms of crude oil and natural gas

CO2: Understanding role of Govt. on price mechanisms of petroleum product Rules on safety issues of petroleum and petroleum products during storage and transportation

CO3: Applying transportation of petroleum & petroleum products Equipment and instruments associated with the transportation

CO4: Analysing metering of oil & gas

CO5: Evaluating quality control of oil & gas Distribution of petroleum products

TEXT BOOKS:

1. Production and transport of oil and gas, Volume 3: A P Szilas
2. Production and transport of oil and gas, Volume B : Gathering & Transportation (Developments in Petroleum Science) 2nd Edition: A P Szilas

REFERENCE BOOKS:

1. Petroleum Pipelines : A Handbook of Onshore and Gas Pipeline: Sanjoy Chanda
2. Petroleum Marketing and Transportation : New Ideas, New Method, New Developments Gulf Publishing Company
3. Petroleum Marketing Practices and Problems: William Henry Day

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Remember overall idea on supply, consumption and distribution of petroleum and petroleum products Pricing Mechanisms of crude oil and natural gas	3	2	3	3	2	-	-	-	3	-	3	3	-	-	1
CO2	Understanding role of Govt. on price mechanisms of petroleum product Rules on safety issues of petroleum and petroleum products during storage and transportation	3	2	3	3	2	-	-	-	3	-	3	3	-	-	1
CO3	Applying transportation of petroleum & petroleum products Equipment and instruments associated with the transportation	3	2	3	3	2	-	-	-	3	-	3	3	-	-	1
CO4	Analysing metering of oil & gas	3	2	3	3	2	-	-	-	3	-	3	3	-	-	1
CO5	Evaluating quality control of oil & gas Distribution of petroleum products	3	2	3	3	2	-	-	-	3	-	3	3	-	-	1
Overall CO		**3**	**2**	**3**	**3**	**2**	**-**	**-**	**-**	**3**	**-**	**3**	**3**	**-**	**-**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23023	CITY GAS DISTRIBUTION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide a fundamental understanding of the technical and business aspect of the City Gas Distribution network.

UNIT I INTRODUCTION OF NATURAL GAS AND ITS VALUE CHAIN 9

Properties of Natural Gas; Update on Gas Discoveries; Demand – Supply Gap; History of GCD in India; LNG, LPG, and CGD business. Gas Value Chain**:** Gas Transmission and Distribution System; City Gate Station (CGS); Gas Filtration and Pressure reduction skids; Odorizing unit; Common pressure reduction station (CPRS)/District Regulation Station (DRS); Metering system; Pipeline for CGD network; Steel and PE Pipelines; CNG infrastructure: Mother Station, Online Station, Daughter Station, Daughter Booster Station; SCADA System

UNIT II REGULATORY FRAMEWORK AND STANDARDS FOR CITY GAS DISTRIBUTION 9

Petroleum and Natural Gas Regulatory Board (PNGRB) era; Purpose, role, and functions of PNGRB; Challenges faced by PNGRB; Technical Standards including T4S.

UNIT III OPERATION AND MAINTENANCE 9

Annual O&M Plan; Steel Pipeline O&M (Cathodic Protection); Maintenance planning. QHSE**:** CNG Safety; Emergency Response Plan; Disaster Management Plan; Quality assurance concepts; Inspection and Surveillance; Risk Assessment in CGD Business.

UNIT IV BUSINESS SCENARIO 9

CGD Business Scenario – India and Abroad; Profile of Major Players; Gas Pricing in CGD; Customer Service Issues in CGD Business; Innovations in CGD; Accelerators and Retarders of CGD business; Case Studies – India and Abroad

UNIT V GAS RETAILING BUSINESS 9

Introducing Gas Retailing; Terminology used in CGD; Various components of CGD Network; CGD Business Segments; CGD Projects – Status in India; CGD Companies in India; Role of CNG and PNG in Gas Distribution; CGD Economics

TOTAL:45 PERIODS

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Summarize City Gas Distribution value chain and Natural Gas system.
CO2: Understand the roles, functions and objectives of PNGRB.
CO3: Practice the HSE measures for safety of CGD sector.
CO4: Classify the types of Compressed Natural Gas (CNG) Stations and explain the CNG infrastructure.
CO5: Assess the steps to be taken in financing the CGD measures.

TEXT BOOKS:

1. Natural Gas: A comprehensive study (Anirbid Sircar and Kriti Yadav).
2. City Gas Distribution: An Indian perspective (Anirbid Sircar, Shreya Sahajpal, Umang Modi).

REFERENCE BOOK

1. City Gas Distribution in India: Demystifying the Opportunity, Growth and Investment Potential (Infra line Energy)

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Summarize City Gas Distribution value chain and Natural Gas system.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO2	Understand the roles, functions and objectives of PNGRB.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO3	Practice the HSE measures for safety of CGD sector.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	3
CO4	Classify the types of Compressed Natural Gas (CNG) Stations and explain the CNG infrastructure.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
CO5	Assess the steps to be taken in financing the CGD measures.	3	3	3	2	2	-	-	-	-	-	2	2	2	2	1
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**1.4**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23024	PRODUCT DESIGN AND DEVELOPMENT FOR PETROCHEMICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVE:

The course is aimed to teach the concepts behind the product design.

UNIT I INTRODUCTION 9

Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer-behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements –Organization process management and improvement.

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 9

Plan and establish product specifications. Task - Structured approaches - clarification – search externally and internally-Explore systematically - reflect on the solutions and processes – concept selection-methodology-benefits. Implications-Product change-variety — component standardization-product performance–manufacturability.

UNIT III PRODUCT ARCHITECTURE 9

Product development management - establishing the architecture - creation - clustering - geometriclayoutdevelopment-Fundamentalandincidentalinteractions-related system level design issues secondarysystems-architectureofthechunks-creatingdetailedinterfacespecifications-PortfolioArchitecture.

UNIT IV INDUSTRIAL DESIGN 9

Integrateprocessdesign-Managingcosts-Robustdesign-IntegratingCAE, CAD, CAM tools—Simulating product performance and manufacturing processes electronically – Need for industrialdesign-impact–designprocess-investigationofcustomerneeds-conceptualization–refinementmanagementof the industrial design process.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimizesystemcomplexity-Prototypebasics-Principlesofprototyping–Planningforprototypes-EconomicAnalysis.

TOTAL: 45PERIODS

COURSE OUTCOMES

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

CO1: Know the basic concepts and importance of product design.
CO2: Understand the planning, selection criteria of the design and products.
CO3: Gain knowledge about the product management and architecture.
CO4: Understand the industrial design and tools for designs.
CO5: Analyze the economy of the design.

TEXT BOOK:

1. UlrichK.T.andEppingerS.D.,"ProductDesignandDevelopment"McGraw—HillInternational Editions,1999.

REFERENCE BOOKS:

1. BelzA., 36-HourCourse:"ProductDevelopment"McGraw-Hill, 2010.
2. RosenthalS.,"EffectiveProductDesignandDevelopment",BusinessOneOrwin,Homewood,1992,ISBN1-55623-603-4.
3. PughS.,"TotalDesign—IntegratedMethodsforsuccessfulProductEngineering",AddisonWesley.

COURSEARTICULATIONMATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Know the basic concepts and importance of product design	3	2	3	2	-	-	-	-	-	-	-	3	2	2	2
CO2	Understand the planning, selection criteria of the design and products.	3	2	3	2	-	-	-	-	-	-	-	3	2	2	2
CO3	Gain knowledge about the product management and architecture.	3	2	3	2	-	-	-	-	-	-	-	3	2	2	2
CO4	Understand the industrial design and tools for designs.	3	2	3	2	-	-	-	-	-	-	-	3	2	2	2
CO5	Analyse the economy of the design.	3	2	3	2	-	-	-	-	-	-	-	3	2	2	2
Overall CO		3	2	3	2	-	-	-	-	-	-	-	3	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

VERTICAL IV: HEALTH, SAFETY AND ENVIRONMENT

PE23025 PRINCIPLES OF SAFETY MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

- To introduce the definitions, concepts, methodologies used in management of occupational safety in industries and hence to make students to recognize and evaluate occupational safety and health hazards in the workplace, and to determine appropriate hazard controls following the hierarchy of controls.

UNIT I INTRODUCTION 9

Safety-Goals of safety engineering. Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. History of safety movement. Theories of accident causation. Safety organization-objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages

UNIT II ACCIDENT PREVENTION METHODS 9

Importance, Various training methods, Effectiveness of training, Communication purpose, barrier to communication. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping so housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

UNIT III MONITORING SAFETY PERFORMANCE 9

Frequency rate, severity rate, incidence rate, activity rate. Cost of accidents-Computation of Costs-Utility of Cost data. Plant safety inspection types, inspection procedure. Safety sampling techniques. Job safety analysis (JSA),

UNIT IV SURVEYS AND AUDITS 9

Safety surveys, Safety audits- documentation, interaction with people, questionnaires, etc.; use of audit checklists to conduct audits. Planning audits-Write inspection and audit reports. Safety Inventory Techniques.

UNIT V ACCIDENT INVESTIGATION 9

Why? When? Where? Who? &How? Basics-Man-Environment & Systems. Process of Investigation–Tools-DataCollection-Handlingwitnesses-Casestudy.Accidentanalysis–AnalyticalTechniques-SystemSafety-ChangeAnalysis-MORT-MultiEventsSequencing-TOR.

TOTAL : 45 PERIODS

COURSE OUTCOME

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

CO1: Illustrate the knowledge and understanding of basic terms in safety management.
CO2: Discuss the safety organizational requirements for effective safety management.
CO3: Evaluate the workplace hazards and apply controls measures using hierarchy of control.
CO4: Evaluate the safety performance of an organization.
CO5: Assess the accident investigation methodologies and apply systematic procedure to identify unearth the root cause of the incident

TEXT BOOKS

1. Safety and Health for Engineers by Roger L.Brauer John Wiley & Sons,Inc.
2. N.V.Krishnan, Safety Management in Industry, JaicoPublishingHouse,1997

REFERENCE BOOKS

1. AccidentPreventionManualforIndustrialOperations:NationalSafetyCouncil,Chicago
2. WillieHammer,OccupationalSafetyManagementandEngineering,PrenticeHall
3. TedS.Ferry,ModernAccidentInvestigationandAnalysis,JohnWiley&Sons
4. JohnV.Grimaldi and Rollin H. Simonds, Safety Management, All India Traveller Book Seller,Delhi.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Illustrate the knowledge and understanding of basic terms in safety management.	2	2	2	2	2	2	3	2				3	1	1	2
CO2	Discuss the safety organizational requirements for effective safety management.	2	2	2	2	2	2	3	2				3	1	1	3
CO3	Evaluatetheworkplacehazardsandapplycontrolsmeasuresusinghierarchyofcontrol.	3	3	3	2	3	3	3	3				3	1	1	3
CO4	Evaluate the safety performance of an organization.	3	3	3	3	3	3	3	3				3	1	1	2
CO5	Assess the accident investigation methodologies and apply systematic procedure to identify unearth the root cause of the incident	3	2	2	2	3	3	3	3				3	1	1	3
Overall CO		**2.6**	**2.2**	**2.2**	**2.2**	**2.6**	**2.6**	**3**	**2.6**				**3**	**1**	**1**	**2.6**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23026 INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT ACTS L T P C
3 0 0 3

OBJECTIVES:

- To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948 and learn about Environment act 1986 and rules framed under the act.

UNIT I FACTORIES ACT – 1948 9

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948. Forms, Registers and notices – Tamilnadu Safety Officer Rules 2005- with updated Amendments.

UNIT II ENVIRONMENT ACT – 1986 9

General powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules, 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board. Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution –fund – accounts and audit, penalties and procedures.

UNIT III MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989 AND MAJOR ACCIDENT HAZARD CONTROL RULES AND AMENDMENT 9

Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets. Major Accident Hazard Control Rules. Hazardous Wastes (management, handling and Trans boundary Movement) Rules 2016.

UNIT IV OTHER ACTS AND RULES 9

Indian Boiler (Amendments) Act 2007, static and mobile pressure vessel rules (SMPV), motor vehicle rules, The Mines and Minerals (Development & Regulation) Amendment Act, 2015, workman compensation act, rules – electricity act and rules – hazardous wastes (management, handling and trans boundary) rules, 2008 - the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules 2016, Explosives Act 1884 - Pesticides Act – E waste (management) rules 2016.

UNIT V INTERNATIONAL ACTS AND STANDARDS 9

Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – ISO 14001 – ISO 45001 , European Safety and Health Legislations, American Petroleum Institute (API) Standards, Oil Industry Safety Directorate (OISD) Standards, National Fire Protection Association (NFPA) Standards, Atomic Energy Regulatory Board (AERB), American National Standards Institute(ANSI).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1: Recognize the important legislations related to health, Safety and Environment.
CO2: Discuss the requirements mentioned in factories act for the prevention of accidents.
CO3: Analyse the health and welfare provisions given in factories act.
CO4: Define the statutory requirements for an Industry on registration, license and its renewal.
CO5: Construct onsite and offsite emergency plan.

TEXT BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2. Indian Boilers Act and Regulations.

REFERENCE BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd.,New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Recognize the important legislations related to health, Safety and Environment.	1	1	1	1	1	2	3	1				3			2
CO2	Discuss the requirements mentioned in factories act for the prevention of accidents.	2	2	2	2	2	3	3	2				3			2
CO3	Analyse the health and welfare provisions given in factories act.	2	2	2	2	2	3	3	2				3			3
CO4	Define the statutory requirements for an Industry on registration, license and its renewal.	2	2	2	2	2	3	3	2				3			2
CO5	Construct onsite and offsite emergency plan.	1	1	1	1	1	2	3	1				3			2
Overall CO		**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**2.6**	**3**	**1.6**			**-**	**3**	**-**	**-**	**2.2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23027 **FIRE ENGINEERING** **L T P C**

3 0 0 3

OBJECTIVE

- To prevent, control, and mitigate the risks associated with fires and explosions in various settings. It involves applying engineering principles, techniques, and measures to minimize the likelihood and severity of fire-related incidents and explosions.

UNIT I PHYSICS AND CHEMISTRY OF FIRE 9

Introduction to Fire, Classifications of fires, temperature, heat, specific heat, Fire Causation theories, Governing equations for calculation of heat flux of a fire Combustion Science of Solids, Liquids & Gases: flash point, fire point, ignition, combustion; Ignition- pilot ignition, spontaneous ignition, ignition sources; Types of combustion-rapid, spontaneous, explosion; Diffusion flames-zones of combustion, smoldering combustion, characteristics of diffusion flame; Premixed flames-burning velocity, limits of flammability, characteristics of premixed flame

UNIT II FUNDAMENTALS OF FRE 9

Incipient, Smoldering, Flame And Heat Stages; Products Of Combustion-Flame, Heat, Smoke, Fire Gases; Smoke – Constituents Of Smoke, Quantity And Rate Of Production Of Smoke, Quality Of Smoke, Smoke Density, Visibility In Smoke; Toxicity Of Smoke- Effect Of Harmful Agents Preventing Escape And Causing Injury Or Death - CO, CO2, HCN, SO2, NH3, Nitrogen Oxide. Effect Of Heat Exposure To Human Body, Body Burns.

UNIT III INDUSTRIAL FIRE PROTECTION SYSTEMS 9

Introduction, Definitions, Water As An Extinguishing Agent, Basic Components Of A Fire Protection System, Fire Water Supply Systems-Types, Design Philosophy Acc.To OISD, Foam, DCP & Other Gaseous Extinguishing Agents; Classification Of Fire Protection Systems-Active & Passive: Active FPS- Definitions, Classifications- Water Based (Vs) Non Water Based & Fixed (Vs) Portable/Mobile, Types:- Fire Extinguishers, Fire Hydrants, Sprinklers, Standpipe Systems, Fire Detectors, Water Spray Systems - Definitions, Types, Operation, Applications & Limitations, Selection, Installation & Maintenance As Per Relevant National And International Standards.

UNIT IV BUILDING FIRE SAFETY 9

Passive FPS- Fire Resistance: Basic Concepts(Philosophy), Materials Used & Their Fire Resistance Ratings, Fire Resistance Tests; Fire Proofing: Introduction, Materials Used In Coatings & Paintings, Concrete As A Fire Proofing Material; Exit & Egress Arrangements: Basic Definitions exit, Means Of Egress System, Exit Door, Refuge Area, Safe Area & Other Related As Per NFPA Codes & NBC

UNIT V EXPLOSION SCIENCE: 9

Explosion And Expansion Ratios, Deflagration And Detonation, Explosion- Physical Explosion, Chemical Explosion; Special Kinds Of Combustion- Flash Fire, Pool Fire, Deep Seated Fire, Spillover, Boil Over, Dust Explosion, BLEVE, UVCE; Case Studies – Flixborough, Mexico Disaster, Pasedena Texas, Piper Alpha, Bombay Victoria Dock Ship Explosions, Mahul Refinery Explosion, Nagothane Vapour Cloud Explosion And Vizag Refinery Disaster.

TOTAL: 45 PERIODS

COURSE OUTCOME

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

CO1: Illustrate about properties of fire and case studies related to fire
CO2: Classify of types, classes and chemicals used in fire extinguishers has been studied
CO3: Analyze about various fire suppression systems
CO4: Understand and construct about the safe building design, fire resistant materials and fire testing
CO5: Discuss and design about the principles of explosion and case studies

TEXT BOOKS:

1. “Industrial Fire Protection Handbook”, R.Craig Schrool – 2002.
2. “Accident Prevention manual for industrial operations” N.S.C., Chicago, 1982.

REFERENCE BOOKS:

1. “Fire safety management”, 3rd edition – Danial E.Della Giustina – 2014.
2. “Manual of fire safety “, N.Segha prakash – 2011.
3. “A hand book of fire technology”, R. S. Gupta – 2010.
4. “Dust explosion and fire prevention handbook”, Nicholas P. Cheremisinoff – 2014.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Illustrate about properties of fire and case studies related to fire	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3
CO2	Classify of types, classes and chemicals used in fire extinguishers has been studied	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
CO3	Analyse about various fire suppression systems	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO4	Understand and construct about the safe building design, fire resistant materials and fire testing	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
CO5	Discuss and design about the principles of explosion, and case studies	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
Overall CO		**2.4**	**2.2**	**2.2**	**2**	**2.4**	**2.4**	**3**	**2.4**	**3**	**3**	**2.4**	**3**	**2.4**	**2.4**	**2.4**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23028	SAFETY IN OIL & GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To prevent accidents, injuries, and occupational illnesses and ensure the well-being of workers, protect the environment, and maintain the integrity of operations in oil & gas industries.

UNIT I PETROLEUM PRODUCTS 9

Flash point - Classification of petroleum products – Class A, B, C& Excluded - LEL – UEL –Static Electricity – Earthing – Bonding – Flameproof Enclosure – ATEX - Case Studies – Jaipur Fire Incident – MB Lal Committee Recommendations - BP Texas incident - Hazira Fire Incident.

UNIT II UPSTREAM & DOWNSTREAM OPERATION 9

Onshore and off shore oil operation – Construction of Installation – Pipe line Construction –Maintenance and repair activities – Safety and associated hazards - transportation – Petroleum product storage.

UNIT III SAFETY HANDLING OF HYDROCARBON 9

Boil over phenomena - Hydro Carbon Detector (HCD) – Remote Operated Shut Off valves (ROSOV) – Firefighting techniques – Foam types – AFFF, ARAFFF, and Rim Seal Fire Protection System - Foam Pourer – Foam monitor – Medium Expansion Foam Generator (MEFG), High Volume Long Range (HVLR) Monitor.

UNIT IV SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN 9

Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves heat exchangers process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

UNIT V RULES & REGULATION 9

Oil Industry Safety Directorate – OISD-STD-105 - OISD-STD-118 - OISD-STD-144 - Jaipur Fire Incident - OISD-STD-244 - The Petroleum Rules, 2002.

TOTAL: 45 PERIODS

COURSE OUTCOME:

After completion of this course, the student is expected to be able to:

CO1: Understand the chemistry of petrochemical products and analyse the fire accidents.
CO2: Design and evaluate the pipeline constructional safety in oil transportation.
CO3: Learn the various safety techniques in handling of hydrocarbons.
CO4: Analyse the different aspects of safety in process and pressure system design
CO5: Understand various oil and natural gas legislation in India.

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.

REFERENCE BOOKS:

1. Basic Offshore Safety: Safety induction and emergency training for new entrants to the offshore oil and gas industry Hardcover – 4 Jul 2017.
2. Offshore Safety Management, 2nd Edition, Ian Sutton - 6th December 2013.
3. Safety of offshore oil and gas operations: Lessons from past accident analysis Michalis Christou and Myrto Konstantinidou 2012.
4. Guide to the Offshore Installations (Safety Case) Regulations 2005 (Legal) Paperback – December 1, by HSE (Author).

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	Understand the chemistry of petrochemical products and analyse the fire accidents.	3	1	2	1	-	–	–	–	–	–	–	2	2	–	2
CO2	Design and evaluate the pipeline constructional safety in oil transportation	3	1	3	1	3	–	–	–	–	–	–	2	2	-	1
CO3	Learn the various safety techniques in handling of hydrocarbons	3	1	2	2	3	-	-	-	-	-	-	2	2	-	1
CO4	Analyse the different aspects of safety in process and pressure system design	3	2	2	1	-	-	-	-	-	-	-	2	2	-	3
CO5	Understand various oil and natural gas legislation in India	3	2	1	3	-	–	–	–	–	–	–	2	3	–	2
Overall CO		**3**	**1.4**	**2**	**1.6**	**3**	**–**	**–**	**–**	**–**	**–**	**–**	**2**	**2.2**	**–**	**1.8**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23029 **INDUSTRIAL HYGIENE** **L T P C**
3 0 0 3

OBJECTIVE

To promote and maintain the health, safety, and well-being of workers in various industries and workplaces

UNIT I OCCUPATIONAL HAZARD AND CONTROL PRINCIPLES 9

Concept and spectrum of health- functional units and activities of occupational health services occupational and work related disease- Levels of prevention of diseases - notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, and anthrax - Lead-Nickel, chromium and manganese toxicity- gas poisoning (such as CO, ammonia, coal and dust), their effects and prevention - Industrial toxicology - local and systemic and chronic effects, temporary and cumulative effects - threshold limit values, calculation of TLVs - carcinogens, mutagens, teratogens. Instruments for Radiation detection and measurement. Early recognition of radiation hazard. Personal monitoring devices, Medical support. Hazards associated with the following radiations and preventive measures. Laser, infra-red, ultra violet and ELF

UNIT II PHYSICAL AND CHEMICAL HAZARD 9

Noise, properties of sound, occupational damage, risk factors, sound measuring instruments, industrial audiometry, hearing conservation programs- Vibration, types, effects, instruments,. Ionizing radiation, types, effects, non-ionizing radiations, effects, types, cold environments, hypothermia, wind chill index, control measures of hot environments, heat stress indices. Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. Dose, , Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments,Gas and Vapour monitors, dust sample collection devices, personal sampling methods of control - Engineering control,

UNIT III FIRST-AID PRACTICE IN INDUSTRY 9

The circulatory system-heat attack-chest compression- CPR. Shock -causes - signs and symptoms - management of shock. Eye-eye injuries-foreign body in eye-eye trauma-corrosive chemical in eyearc eye. Wounds-bleeding-classification-types of wounds-case of wounds- bleeding from special sites. Fractures-classification of fractures-principles of immobilisation- sprains and dislocation. Broad and narrow fold bandages-hand bandages-slings. The skin. Burns-rule of nines-pure thermal burns. Electric burns. Chemical burns. Radiation burns. Cold burns. Poisoning. Physical fitness. Lifting -casualty handling. Use of stretchers.

UNIT IV BIOLOGICAL AND ERGONOMICAL HAZARDS 9

Classification of Bio-hazardous agents– examples, bacterial agents, rickettsia and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Covid SARS- Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –Carpal Tunnel Syndrome CTS- Tendon pain disorders of the neck- back injuries.

UNIT V OCCUPATIONAL AND PSYCHOLOGICAL HAZARDS 9

Elements of Industrial Psychology-Mental Health in Industries- Organisational Behaviour, Motivational Theory , Job Satisfaction Value system, Habits, Drug Abuse-Alcoholism in Industry, Communications, Organising Health education and Training Programme for employees, Psychological Hazards - Workplace Stress- General Adaptation Syndrome Eustress –Distress Diseases/Disorders related to Work stress-Psychosomatic disorders. Managing Work-stress in industry- Individual responsibilities - Employers Responsibilities. Psychological Counseling of employees- Employees Assistance Programme, Behaviour based Safety.

TOTAL : 45 PERIODS

COURSE OUTCOME:

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

CO 1: Understand the concept and spectrum of health – functional units, activities of occupational health and cardio pulmonary resuscitation.

CO2: Identify physical &chemical hazards in the work environment and its control measures.

CO3: Demonstrate the principles of first aid.

CO4: Explain about carpal tunnel syndrome, tendon pain disorders of the neck.

CO5: Identify the decisions required to maintain protection of the environment, home and workplace as well as personal health and safety.

TEXT BOOKS:

1. Thomas P. Fuller, Hand book of "Essentials of industrial hygiene" National Safety Council Itasca IL, 2015 Edition.
2. Interim guidance "COVID-19: Occupational health and safety for health workers", WHO

REFERENCE BOOKS:

1. Fundamentals of Industrial Hygiene, 6th Edition National Safety Council; 6th Edition (August 10, 2012).
2. Essentials of Industrial Hygiene, 1st Edition National Safety Council (2015).
3. Barbara A.Plog, Patricia J.Quinlan, MPH, CIH and Jennifer Villareal Hand book of "Fundamentals of Industrial Hygiene, 6th edition 2012, National Safety Council, 2012.
4. Occupational Health Safety Management Practical Approach CRC Press Taylor & Francis group second Edition 2008.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the concept and spectrum of health – functional units, activities of occupational health and cardio pulmonary resuscitation.	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
CO2	Identify physical & chemical hazards in the work environment and its control measures.	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3
CO3	Demonstrate the principles of first aid.	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
CO4	Explain about carpal tunnel syndrome, tendon pain disorders of the neck.	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
CO5	Identify the decisions required to maintain protection of the environment, home and workplace as well as personal health and safety.	2	2	2	2	2	2	3	2	3	3	2	3	2	2	2
Overall		**2.2**	**2**	**2**	**2**	**2.2**	**2.2**	**3**	**2.2**	**3**	**3**	**2.2**	**3**	**2.2**	**2.2**	**2.2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23030	TRANSPORTATION SYSTEM AND SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the safe and secure movement of people, goods and vehicles across road transportation.

UNIT I TRANSPORTATION OF HAZARDOUS GOODS 9

Transport emergency card (TREM) – driver training-parking of tankers on the highways-speed of the vehicle – warning symbols – design of the tanker lorries -static electricity-responsibilities of driver – inspection and maintenance of vehicles-check list- loading and decanting procedures – communication.

UNIT II ROAD TRANSPORT 8

Introduction – factors for improving safety on roads – causes of accidents due to drivers and pedestrians-design, selection, operation and maintenance of motor trucks-preventive maintenance check lists-motor vehicles act – motor vehicle insurance and surveys.

UNIT III DRIVER AND SAFETY 9

Driver safety programme – selection of drivers – driver training-tacho-graph-driving test-driver's responsibility-accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act- driver relaxation and rest pauses – speed and fuel conservation – emergency planning and Haz mat codes.

UNIT IV ROAD SAFETY 10

Road alignment and gradient-reconnaissance-ruling gradient-maximum rise per k.m.- factors influencing alignment like tractive resistance, tractive force, direct alignment, vertical curves-breaking characteristics of vehicle-skidding-restriction of speeds-significance of speeds- Pavement conditions – Sight distance – Safety at intersections – Traffic control lines and guide posts-guard rails and barriers – street lighting and illumination overloading-concentration of driver. Plant railway: Clearance-track-warning methods-loading and unloading-moving cars-safety practices.

UNIT V SHOP FLOOR AND REPAIR SHOP SAFETY 9

Transport precautions-safety on manual, mechanical handling equipment operations-safe driving movement of cranes-conveyors etc., servicing and maintenance equipment-grease rack operation wash rack operation-battery charging-gasoline handling-other safe practices-off the road motorized equipment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Identify the transportation of hazardous goods and its procedure.
CO2: Analyze the design, selection, operation and maintenance of road transport
CO3: Analyze the safety involved in Emergency planning, HAZMAT codes and programs on driver safety.
CO4: Learn about information related to safety of road alignment and gradient.
CO5: Implement the application of servicing and maintenance of equipment.

TEXT BOOKS:

1. "Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1982.
2. Babkov, V.F., "Road Conditions and Traffic Safety" MIR Publications, Moscow, 1986.

REFERENCE BOOKS:

1. K.W.Ogden, "Safer Roads – A guide to Road Safety Engineering"
2. Kadiyali, "Traffic Engineering and Transport Planning" Khanna Publishers, New Delhi, 1983.
3. Motor Vehicles Act, 1988, Government of India.
4. Pasricha, "Road Safety guide for drivers of heavy vehicle" Nasha Publications, Mumbai, 1999.
5. Popkes, C.A. "Traffic Control and Road Accident Prevention" Chapman and Hall Limited, 1986.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Identify the transportation of hazardous goods and its procedure	2	2	2	2	2	2	3	2				2	1	1	2
CO2	Analyse the design, selection, operation and maintenance of road transport	2	2	2	2	2	2	3	2				3	1	1	**3**
CO3	Analyse the safety involved in Emergency planning, HAZMAT codes and programs on driver safety.	3	3	3	2	3	3	3	3				3	1	1	2
CO4	Learn about information related to safety of road alignment and gradient	2	2	2	2	2	2	3	2				3	1	1	2
CO5	Implement the application of servicing and maintenance of equipment.	3	2	2	2	3	3	3	3				3	1	1	2
OVERALL CO		**2.4**	**2.2**	**2.2**	**2**	**2.4**	**2.4**	**3**	**2.4**	**-**	**-**	**-**	**3**	**1**	**1**	**2.2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23031	DRILLING SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVE:

The course has been designed to make the students aware of safety cautions at every stage of oil well drilling, minerals exploration drilling.

UNIT I HEALTH HAZARDS FROM ROCK DRILLING 9

Define, classify and explain pneumonoconiosis- Preventive measures for hazards of rock drills. Different means of dust suppression during Blast hole drilling operation.

UNIT II SAFETY ASPECT 9

General safety precautions to be observed with electric motor driven machineries. Different types of I/C engines- pollution, health hazards safety precaution due to emissions of I/C engines. Procedure of starting of compressor prior to drilling operation-danger involved with receiver tank and valves of compressor-safety precautions to be taken against explosion of receiver tank of compressor. Daily checks, care and maintenance for weekly, monthly, half yearly and yearly.

UNIT III SAFETY PRECAUTIONS IN DIAMOND DRILLING 9

Causes of accidents involved in diamond rotary drilling -Training for a new worker to assist in diamond drilling operation- general rig operation rules to be observed by the operator as per 'Rig Safety Rules'.

UNIT IV RIG SAFETY RULES UNDER SAFETY RULES FOR THE USE OF MINING EQUIPMENT 9

Measures against elements of danger involved in operation of rig safe operation and organization of drilling rig safety rules under safety for the use of Mining Equipment.

UNIT V SAFETY PRECAUTION IN OIL WELL DRILLING 9

Causes of accidents occurred at oil well drill site- Preventive measures to eliminate accidents- safety measures have to be observed under oil well mast- fire triangle- different classes of fire- causes of fire at oil well drill site- different fire fighting extinguishers- statutory acts, rules and regulations applicable to oil mines.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Identify the health hazards from rock drilling.
CO2: Analyze the general safety precautions with electric motor.
CO3: Assess the safety precautions in Diamond drilling.
CO4: Learn about rig safety rules.
CO5: Implement the safety precaution in oil well drilling.

TEXT BOOKS:

1. William E. Jackson "Safety on the Rig", ISBN-10 : 0886981867; ISBN-13 : 978-0886981860, 1999.

REFERENCE BOOKS:

1. OGDCL, SAFETY HANDBOOK For Oil & Gas Well Drilling and ServicingOperations, API Recommended Practices.

Course Articulation Matrix:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Identify the health hazards from rock drilling	2	2	2	2	2	2	3	2	-	-	-	2	1	1	2
CO2	Analyze the general safety precautions with electric motor	2	2	2	2	2	2	3	2	-	-	-	3	1	1	**3**
CO3	Assess the safety precautions in Diamond drilling	3	3	3	2	3	3	3	3	-	-	-	3	1	1	2
CO4	Learn about rig safety rules	2	2	2	2	2	2	3	2	-	-	-	3	1	1	2
CO5	Implement the safety precaution in oil well drilling	3	2	2	2	3	3	3	3	-	-	-	3	1	1	2
OVERALL CO		**2.4**	**2.2**	**2.2**	**2**	**2.4**	**2.4**	**3**	**2.4**	**-**	**-**	**-**	**3**	**1**	**1**	**2.2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23032	PROCESS HAZARD ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To familiarize the students in identifying and assessing the potential hazards and risks associated with chemical processes in order to prevent accidents, protect human health and minimize environmental impacts.

UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT 9

Introduction, hazard, hazard monitoring-risk issue - Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), hazard operability studies (HAZOP).

UNIT II RISK QUANTIFICATION 9

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and Index (FEI)-fire explosion and toxicity index (FETI), various indices - Hazard analysis (HAZAN)-Failure Mode and Effect Analysis (FMEA)

UNIT III CHEMICAL PROCESS QUANTITATIVE RISK ANALYSIS 9

CPQRA Definitions-components Techniques of CPQRA-Scope of CPQRA- Applications of CPQRA-Utilization of CPQRA results. Hazard identification based on the properties of chemicals- Chemical inventory analysis- identification of hazardous processes - Estimation of source term, Gas or vapor release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire. Complex/risk CPQRA Characterization.

UNIT IV HAZARDS MONITORING AND EMERGENCY MANAGEMENT 9

Quantification of risk: QRA, Vulnerability analysis, accepted and imposed risk, perception of risk,risk indices, individual risk and societal risk, acceptance criteria for risk, ALARP, Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and societal risk. Technique for Human Error Rate Prediction (THERP), Accident Sequence Evaluation Program

(ASEP).

UNIT V CREDIBILITY OF RISK ASSESSMENT TECHNIQUES 9

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster(1966),Port Hudson disaster- convey report, hazard assessment of non-nuclear installation- Rijnmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report,Reactor safety study of Nuclear power plant

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of hazards and classification of its assessment.
CO2: Illustrate various advanced equipment and testing.
CO3: Obtain the knowledge on application of CPQRA and assessed
CO4: Quantify the risk involved in a process
CO5: Assess the risk associated with chemical processes.

TEXT BOOKS:

1. Methods in Chemical Process Safety, Volume 1 (1st Edition) - 7th April 2017.
2. Hazop and Hazan, Fourth Edition – IchemE 4th Edition- 2001.

REFERENCE BOOKS:

1. Guidelines for Process Hazards Analysis (PHA, HAZOP), Hazards Identification, and Risk Analysis (English, Paperback, Hyatt Nigel).
2. Quantitative Risk Assessment for Environmental and Occupational Health Hardcover – Import, 9 Jun 1993.
3. Lees' Loss Prevention in the Process Industries (3rd Edition) - 27th December 2004.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basics of hazards and classification of its assessment	2	2	2	2	2	2	3	2				3	2	2	2
CO2	Illustrate various advanced equipment and testing.	3	2	2	2	3	3	3	3				3	3	3	3
CO3	Analyse about the software knowledge on risk analysis.	3	3	3	2	3	3	3	3				3	3	3	3
CO4	Obtain the knowledge on application of CPQRA and assessed	3	2	2	2	3	3	3	3				3	3	3	3
CO5	Assess the risk associated with chemical processes.	3	3	3	3	3	3	3	3				3	3	3	3
Overall CO		**2.8**	**2.4**	**2.4**	**2.2**	**2.6**	**2.6**	**3**	**2.8**	**-**	**-**	**-**	**3**	**2.8**	**2.8**	**2.8**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

.VERTICAL V: PROCESS INTENSIFICATION

PE23033	MULTI COMPONENT DISTILLATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To provide the knowledge on thermodynamic principles of multicomponent mixtures and familiarize with design considerations of multicomponent distillation columns.

UNIT I THERMODYNAMIC PRINCIPLES 9

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

UNIT II THERMODYNAMIC PROPERTY EVALUATION 9

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM 9

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of R_m for multi component distillation – Underwood method – Colburn method.

UNIT IV VARIOUS METHODS OF MCD COLUMN DESIGN 9

Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method –Stage and reflux requirements – Short cut methods and simplified graphical procedures.

UNIT V VARIOUS TYPES OF MCD COLUMNS 9

Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamental thermodynamic principles involved in VLE
CO2: Familiarize with fundamental binary and multicomponent distillation.
CO3: Analyse the key components in distributed and non-distributed system.
CO4: Troubleshoot the various problems encountered in multi component distillation.
CO5: Design the various types of columns for multi component separation

TEXT BOOKS:

1. Holland, C.D., “Fundamentals of Multi Component Distillation”, McGraw Hill Book Company, 1981
2. Van Winkle, “Distillation Operations”, McGraw Hill Publications, 1987.

REFERENCE BOOKS:

1. King, C.J., “Separation Process Principles”, Mc Graw Publications, 1986.
2. Treybal, R.E., “Mass Transfer Operations”, 5th Edition, Mc Graw Hill publications. 1996.
3. Mc Cabe and Smith, J.C., Harriot, “Unit Operation of Chemical Engineering”, 6th Edition, McGraw Hill, 2001.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the fundamental thermodynamic principles involved in VLE.	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	Familiarize with fundamental binary and multicomponent distillation.	3	3	2	-	-	-	-	-	-	-	-	-	-	2	
CO3	Analyse the key components in distributed and non-distributed system.	3	3	2	-	-	-	-	-	-	-	-	1	-	-	2
CO4	Troubleshoot the various problems encountered in multi component distillation.	3	3	2	-	-	-	-	-	-	-	-	1	-	-	2
CO5	Design the various types of columns for multi component separation.	3	3	2	-	-	-	-	-	-	-	-	1	-	-	2
Overall CO		**3**	**3**	**2**	**-**	**-**	**-**		**-**	**-**	**-**		**1**	**-**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium)and Substantial (High) respectively.

PE23034	EMERGENCY RESPONSE AND DISASTER MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

To make the students effective and efficient while responding to emergencies, disasters, and crises to protect lives, minimize damage, and facilitate recovery.

UNIT I INTRODUCTION 9

Philosophy of Disaster management-Introduction to Disaster mitigation-Hydrological, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes- Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

UNIT II TECHNOLOGICAL & ENVIRONMENTAL DISASTERS 9

Technological Disasters - Case studies of Technology disasters with statistical details Emergencies and control measures- APELL- Onsite and Offsite emergencies- Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts- Biodiversity-. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches.

UNIT III POLLUTION ASPECTS 9

Products of fires - Marine pollution and control- Toxic, hazardous, and nuclear wastes-state of India's and Global environmental issues carcinogens- complex emergencies- Earthquake disasters- the nature-extreme event analysis- the immune system- proof and limits-Atmospheric pollution- Global warming and Ozone Depletion Destruction of Ecosystem-Eco-friendly products Green movements- Green philosophy - Environmental Policies- Environmental Impact Assessment- Life cycle

UNIT IV REPERCUSSIONS OF DISASTERS AND HAZARDS 9

Economic Damage, Loss of Human and Animal Life, and Destruction the of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides and Avalanches, Man-made disasters: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease and Epidemics, War And Conflicts.

UNIT V INCIDENT MANAGEMENT 9

Basic principles of disaster management-Disaster Management cycle- Disaster management policy, National and State Bodies for Disaster Management-Early Warming Systems-Building design and construction in highly seismic zones-The fundamentals of incident management Incident Command System; Emergency Leadership-Mutual Aid & Joint Operations; Crisis Organization & Management; Response Functions & Priorities- Clean-up & Restoration; and Incident Termination- Training and drills for disaster preparedness-Awareness generation program Usages of GIS and Remote sensing techniques in disaster management

TOTAL: 45 PERIODS

COURSE OUTCOME:

On successful completion of this course, the students will be able to
CO1: Understand the basic conceptual understanding of disasters.
CO2: Learn about the Onsite/ Offsite disaster & environmental disasters
CO3: Describe pollution from various aspects and its effects
CO4: Analyze effects of disaster in economically, environmentally and society.

CO5: Design incident management to prevent and mitigate disaster.

TEXT BOOKS:

1. Gilbert, M. Masters., “Introduction to Environmental Engineering and Science”, 3rd edition 2008.
2. Miller, G. Tylor., “Environmental Science”,14th edition 2012.
3. G. Tylor, Miller., “Environmental Science sustaining the earth”, 2005.

REFERENCE BOOKS:

1. Bagad Vilas. “Principles of Environmental Science and Engineering”, 2004.
2. Sivakumar.R., “Principles of Environmental Science and Engineering”, 2005.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the basic conceptual understanding of disasters	3	2	3	3	2	3	3	-	-	-	-	3	-	-	3
CO2	Learn about the Onsite/ Offsite disaster & environmental disasters	3	2	3	3	2	3	3	-	-	-	-	3	-	-	3
CO3	Describe pollution from various aspects and its effects	3	2	3	3	2	3	3	-	-	-	-	3	-	-	3
CO4	Analyze effects of disaster in economically, environmentally and society	3	2	3	3	2	3	3	-	-	-	-	3	-	-	3
CO5	Design incident management to prevent and mitigate disaster	3	2	3	3	2	3	3	-	-	-	-	3	-	-	3
Overall CO		3	2	3	3	2	3	3	-	-	-	-	3	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

CH23C02	OPTIMIZATION OF CHEMICAL PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVE:

To teach linear programming, geometric, dynamic, integer programming and genetic algorithms for solution to complex engineering problems.

UNIT I **9**

Introduction to optimization; applications of optimization in chemical engineering; classification of optimization problems; developing models for optimization.

UNIT II **9**

Continuity of Functions; NLP Problem Statement Convexity and Its Applications Interpretation of the Objective Function in Terms of its Quadratic Approximation Necessary and Sufficient Conditions for an Extremism of an Unconstrained Function; region elimination methods; interpolation methods; direct root methods.

UNIT III **9**

Methods Using Function Values Only -Random Search -Grid Search – Univariate Search – Simplex Search Method - Conjugate Search Directions; Methods That Use First Derivatives – Steepest Descent - Conjugate gradient Methods; Newton's Method and Quasi Newton's Method.

UNIT IV **9**

Introduction to geometric, dynamic and integer programming and genetic algorithms. Linear Programming – Solution of Problems using Excel SOLVER.

UNIT V **9**

Formulation of objective functions; fitting models to data; applications in fluid mechanics, heat transfer, mass transfer, reaction engineering, equipment design, reaction engineering, resource allocation and inventory control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Formulate optimization models for Petrochemical processes /equipment.
CO2: Solve single and multivariable optimization problems through various techniques.
CO3: Evaluate the unconstrained single variable optimization and multi variable optimization
CO4**:** Apply higher order techniques like geometric programming, dynamic and integer programming and genetic algorithms
CO5: Develop equality and inequality constraints for an optimization problem

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Venkataraman, P. (2009). Applied optimization with MATLAB programming. John Wiley & Sons.
2. Ferris, M. C., Mangasarian, O. L., & Wright, S. J. (2007). Linear programming with MATLAB (Vol. 7). SIAM.
3. J Nocedal and S J Wright (2006). Numerical Optimization. Springer Verlag.
4. Joshi, M. C., &Moudgalya, K. M. (2004). Optimization: theory and practice. Alpha Science Int'l Ltd.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Formulate optimization models for Petrochemical processes /equipment.	3	2	2	3	2	-	-	-	-	-	-	1	-	2	-
CO2	Solve single and multivariable optimization problems through various techniques.	3	2	2	3	2	-	-	-	-	-	-	1	-	2	-
CO3	Evaluate the unconstrained single variable optimization and multi variable optimization.	3	2	2	3	-	-	-	-	-	-	-	1	-	2	-
CO4	Apply higher order techniques like geometric programming, dynamic and integer programming and genetic algorithms	3	2	2	3	-	-	-	-	-	-	-	1	-	2	-
CO5	Develop equality and inequality constraints for an optimization problem	3	2	2	3	-	-	-	-	-	-	-	1	-	2	-
Overall CO		**3**	**2**	**2**	**3**	**2**	**-**		**-**	**-**	**-**		**1**	**-**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23035	MODERN SEPARATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVE :

- To teach the principle and technical concept of modern separation processes.

UNIT I BASICS OF SEPARATION PROCESS 9

Basic Concepts - Characteristics and Mechanism of Separation – Feasibility of separation process - Process concept, Theory and Equipment for filtration Process.

UNIT II MEMBRANE SEPARATIONS 9

Theory of Membranes Process, Types and choice of Membranes - Membrane Reactors and their relative merits

UNIT III APPLICATIONS OF MEMBRANE PROCESS 9

Principle and applications of Dialysis and Electrodialysis, Reverse Osmosis, Nanofiltration, Ultra filtration, Micro filtration and Pervaporation.

UNIT IV INORGANIC SEPARATIONS 9

Principle and applications of Ion Exchange Chromatography, Electrophoresis, Di electrophoresis, EDR.

UNIT V CURRENT TRENDS 9

Principle and applications of Supercritical fluid Extraction, lyophilization, zone melting, Adductive Crystallization, Oil spill Management, Cryoseparations.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Understand the key concepts of modern separation processes.
CO2: Apply various membrane separation processes with proper design considerations.
CO3: Design an absorber for specific separation.
CO4: Evaluate the separation system for multi-component mixtures.
CO5: Apply the innovative techniques for chemical and petrochemical process industries.

TEXT BOOKS:

1. King, C. J., “Separation Processes”, Tata McGraw Hill, 1982.
2. Seader, J.D., Ernest J., Henley, Keith Roper D., "Separation Process Principles", 3rd Edition, John Wiley & Sons, United States of America, 2010.

REFERENCE BOOKS:

1. Scott K., Hughes R, "Industrial Membrane Separation Technology", 1st Edition, Blackie Academic and Professional Publications, United State of America, 1996. Schoen, H.M., “New Chemical Engineering Separation Techniques”, Interscience Publishers,1972.
2. Coulson, J.M., Richardson, J.F, "Chemical Engineering", 4th Edition, Butterworth- Heinemann, United State of America, 1996.
3. Ronald W Rousseau, “Handbook of Separation Process Technology”, 1st Edition, Wiley India Pvt Ltd, 2008

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the key concepts of modern separation processes.	3	2	2	2	2	1	1	-	-	-	-	1	-	2	-
CO2	Apply various membrane separation processes with proper design considerations.	3	2	2	2	2	1	1	-	-	-	-	1	-	2	-
CO3	Design an absorber for specific separation.	3	2	2	2	2	1	1	-	-	-	-	1	-	2	-
CO4	Evaluate the separation system for multi-component mixtures.	3	2	2	2	2	1	1	-	-	-	-	1	-	2	-
CO5	Apply the innovative techniques for chemical and petrochemical process industries.	3	2	2	2	2	1	1	-	-	-	-	1	-	2	-
Overall CO		**3**	**2**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**-**	**1**	**-**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23036	FLUIDIZATION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To enable the students to learn the design aspects of fluidized beds.

UNIT I BASICS OF FLUIDIZATION 9

Packed bed – Velocity – Pressure drops relations – Correlations of Ergun, Kozneykarman – On set of fluidizations – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES 9

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

UNIT III DESIGN ASPECTS 9

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

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9

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

UNIT V OTHER TYPES OF FLUIDIZATIONS 9

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the completion of the course students are expected to

CO1: Understand the basics and governing equations of fluidization
CO2: Assess the fluidization conditions/behaviours as well as types of fluidizations
CO3: Design afluidization system for different applications
CO4: Assess the temperature and concentration gradient in the fluidization bed
CO5: Understand the various accessories used and stages of fluidization.

TEXT BOOKS:

1. Levenspiel, “Fluidization Engineering”, 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, “Perry’s Chemical Engineer’s Hand Book”, 7th Edition, Mc Graw Hill – International, 1997.

REFERENCE BOOKS:

1. Rowe and Davidson, “Fluidization”, Academic Press ,1971.
2. Leva, M., “Fluidization”, McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., “Handbook of Fluidization and Fluid-Particle Systems”, Marcel Dekker Inc, 2003.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basics and governing equations of fluidization.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO2	Assess the fluidization conditions/behaviours as well as types of fluidizations.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO3	Design a fluidization system for different applications.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO4	Assess the temperature and concentration gradient in the fluidization bed.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO5	Understand the various accessories used and stages of fluidization.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
Overall CO		**3**	**1**	**2**	**1**	**-**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**-**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High

PE23037	WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE:

To develop required skills in the students so that they are able to acquire following competency: Plan segregation, collection, transportation, recycling and disposal of municipal solid waste in such a way that its impact is minimal on environment, economy and community.

UNIT - I SOURCES AND COMPOSITION OF MUNICIPAL SOLID WASTE AND PROPERTIES OF MUNICIPAL SOLID WASTE 9

Introduction - Sources of solid waste - Types of solid waste - Composition of solid waste and its determination- Types of materials recovered from MSW.Physical properties of Municipal Solid Waste - Chemical properties of Municipal Solid Waste - Biological properties of Municipal Solid Waste - Transformation of Municipal Solid Waste.

UNIT-II SOLID WASTE GENERATION AND COLLECTION AND HANDLING, SEPARATION AND STORAGE OF SOLID WASTE 9

Quantities of Solid Waste - Measurements and methods to measure solid waste quantities - Solid waste generation and collection - Factors affecting solid waste generation rate - Quantities of materials recovered from MSW.Handling and separation of solid waste at site - Material separation by pick in, screens, float and separator magnets and electromechanical separator and other latest devices for material separation - Waste handling and separation at Commercial and industrial facilities - Storage of solid waste at the sources.

UNIT-III PROCESSING OF SOLID WASTE 9

Processing of solid waste at residence e.g. Storage, conveying, compacting, Shredding, pulping, granulating etc. Processing of solid waste at Commercial and industrial site.

UNIT- IV DISPOSAL OF MUNICIPAL SOLID WASTE 9

Combustion and energy recovery of municipal solid waste, effects of combustion, undesirable effects of Combustion. Landfill: Classification, planning, sitting, permitting, landfill processes, landfill design, landfill operation, use Of old landfill. Differentiate sanitary land fill and incineration as final disposal system for solid waste - Biochemical processes: Methane generation by anaerobic digestion, composting and other biochemical Processes.

UNIT-V HAZARDOUS SOLID WASTE 9

Definition, identification and classification of hazardous solid waste. Characteristics Hazardous waste toxicity, reactivity, infectiousness, flammability, radioactivity, corrosiveness, irritation, bio-concentration, genetic activity, explosiveness. Bio-medical waste, its sources, generation, storage, transportation and Disposal.

TOTAL: 45 PERIODS

COURSE OUTCOME:

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following Course Outcome.

CO1: Understand the basics municipal solid waste management systems.
CO2: Assess sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.
CO3: Select the appropriate method for solid waste collection, transportation, redistribution and disposal.
CO4: Describe methods of disposal of municipal solid waste.
CO5: Analyze disposal of hazardous solid waste.

TEXT BOOKS:

1. Levenspiel, “Fluidization Engineering”, 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, “Perry’s Chemical Engineer’s Hand Book”, 7th Edition, Mc Graw Hill – International, 1997.

REFERENCE BOOKS:

1. Rowe and Davidson, “Fluidization”, Academic Press ,1971.
2. Leva, M., “Fluidization”, McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., “Handbook of Fluidization and Fluid-Particle Systems”, Marcel Dekker Inc, 2003.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the basics municipal solid waste management systems.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO2	Assess sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO3	Select the appropriate method for solid waste collection, transportation, redistribution and disposal.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO4	Describe methods of disposal of municipal solid waste.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
CO5	Analyze disposal of hazardous solid waste.	3	1	2	1	-	-	-	-	-	-	-	1	-	2	-
	Overall CO	**3**	**1**	**2**	**1**	**-**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**-**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High)

PE23038	LNG & STORAGE OF NATURAL GAS	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To enable students to learn about the major components of liquefied natural gas (LNG) liquefaction plant, constructional features of LNG storage tanks and carriers, LNG receiving terminal, vaporizers used in LNG regasification and storage of natural gas.

UNIT I LIQUEFACTION TRAIN 9

Introduction, drivers, safety, properties & health hazards, industry standards & regulatory compliance for LNG safety. LNG value chain, Liquefaction Systems - Feed gas preparation technology. LNG plant capacity & commercial technologies. Advantages & Limitations of technologies, Selection of appropriate technology, Major components of LNG liquefaction plant. Design and Operational characteristic of Liquefaction Train. Thermodynamics of Gas Liquefaction & Heat Transfer Process.

UNIT II LNG STORAGE & TRANSPORTATION 9

LNG storage tanks. Single containment tanks. Double containment tanks. Storage volume, LNG Tankers. LNG Tankers.

UNIT III LNG RECEIVING TERMINALS & TRADE 9

Port Facilities. LNG Terminals. SPA features, shipping terms. Sourcing and Economics. Sales &purchase agreement, LNG Trade.

UNIT IV LNG REGASIFICATION & COLD UTILIZATION 9

Processes for LNG Regasification. Processes for LNG Regasification. LNG Cold Utilization. Synchronization of Regasified LNG & Pipe Lines.

UNIT V NATURAL GAS STORAGE 9

Line Pack, Underground Natural Gas Storage, Aquifers, Man made caverns.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Identify the major components of LNG liquefaction plant.
CO2: Analyze the constructional features of LNG storage tanks and carriers.
CO3: Identify the features of LNG receiving terminal.
CO4: Design vaporizers used in LNG regasification.
CO5: Analyze the types of natural gas storage.

TEXT BOOKS:

1. Negi B.S., “LNG-An Indian Scenario”, Technology Publications, 2008.
2. Rojey A. &Jaffret C., “Natural Gas-Production, Processing, Transport”, Editions Technip-Paris, 1997.

REFERENCE BOOKS:

1. Saeid. Mokhatab, William A. Poe & James G. Speight, “Handbook of Natural Gas Transmission and Processing”, Gulf Professional Publishing, 2006.
2. G. G. Nasr & N. E. Connor, “Natural Gas Engineering and Safety Challenges”, Springer, 2014.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome													
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Identify the major components of LNG liquefaction plant.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO2	Analyze the constructional features of LNG storage tanks and carriers.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO3	Identify the features of LNG receiving terminal.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO4	Design vaporizers used in LNG regasification.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO5	Analyse the types of natural gas storage.	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
Overall CO		**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**1**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23039	PROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

OBJECTIVE:

To enable the students with the knowledge of process modelling and simulation.

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 (R^2).

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 OUTCOME:

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: Assess the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods.

CO3: Implement the mathematical models for different unit operations equipment.

CO4: Analyse 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 initial and/or boundary conditions.

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, 2011, Prentice Hall India Pvt. Ltd, 2011.

REFERENCE BOOKS

1. Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, Second Edition,1996.
2. Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, Elsevier Science, 1997.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics.	3	3	2	1	2	-	-	-	-	-	-	3	-	2	-
CO2	Assess the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods.	3	3	2	1	2	-	-	-	-	-	-	3	-	2	-
CO3	Implement the mathematical models for different unit operations equipment.	3	3	2	1	2	-	-	-	-	-	-	3	-	2	-
CO4	Analyse the principles of steady state/unsteady state lumped systems and steady state/ unsteady state distributed systems.	3	3	2	2	2	-	-	-	-	-	-	3	-	2	-
CO5	Apply relevant solution methods for the mathematical models with initial and/or boundary conditions.	3	3	2	2	2	-	-	-	-	-	-	3	-	2	-
Overall CO		**3**	**3**	**2**	**1.4**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**-**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

VERTICAL VI: ENERGY ENGINEERING

PE23040	RENEWABLE AND NON-RENEWABLE ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is designed to provide knowledge in capturing and applying forms of renewable and non-renewable energy and the challenges associated with the development, implementation and distribution of unconventional hydrocarbons with emphasis on Indian resources.

UNIT I ENERGY SOURCES & AVAILABILITY 9

Conventional, Non-conventional, renewable, nonrenewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non-conventional source of energy - solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermo-electric power.

UNIT II SOLAR & WIND ENERGY 9

Solar constant, solar radiation geometry, local solar time, day length, solar radiation measurement, radiation on inclined surface, solar radiation data & solar charts. Wind Energy: Wind as a Source of Energy, Characteristics of wind, wind data. Horizontal & Vertical axis wind Mills.

UNIT III BIOMASS ENERGY 9

Introduction to biomass, biofuels & their heat content, biomass conversion technologies. Aerobic & anaerobic digester, Factors affection biogestion, biogas plants - types & description. Utilization of biogas - Gasifiers, direct thermal application of Gasifiers. Advantages & problems in development of Gasifiers, use in I.C. engines.

UNIT IV OTHER ENERGY SOURCES 9

Geothermal Energy: Status & estimates, geothermal sources, geothermal systems & their characteristics. Fuel Cells. Principle & Classification, types conversion efficiency, polarization & advantages MHD power generation - principle, types closed & open cycle system materials. Energy form thermo nuclear fusion, OTEC, hydrogen, thermonic generation & tidal waves.

UNIT V UNCONVENTIONAL NON-RENEWABLE ENERGY 9

Introduction to Unconventional Hydrocarbon resources- Coal Bed Methane: Geological controls in CBM**,** Indian Scenario, Gas Hydrates: Structure of gas hydrates and their stability, producibility of gas hydrates and challenges, Indian scenario of gas hydrates, Shale Gas / oil: production techniques applied for shale gas**,** Indian basins for shale gas/oil potential.

TOTAL:45 PERIODS

COURSE OUTCOME

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

CO1: Gain knowledge in capturing and applying forms of energy sources and its availability
CO2: Demonstrate the working of various energy sources like solar, wind, biomass, geothermal, nuclear energy, hydrogen and fuel cells
CO3: Analyse the challenges associated with implementation of various renewable energy sources.
CO4: Identify, locate and estimate the bio-based energy sources and technologies involved in it
CO5**:** Assess the challenges associated with the development of unconventional hydrocarbons and distribution of unconventional hydrocarbons with emphasis on Indian resources.

TEXT BOOKS:

1. Fundamentals and applications of renewable energy by Mehmet Kanoglu (Author), Yunus A. Cengel , John M. Cimbala -2020, MC GRAW HILL
2. Text book of renewable energy by S.C. Bhatia, R. K. Gupta -2019, WPI publishing

REFERENCE BOOKS:

1. Unconventional Hydrocarbon Resources, Techniques for Reservoir Engineering Analysis By Reza Barati, Mustafa M. Alhubail · 2020 Publisher: Wiley
2. Energy Resources Availability, Management, and Environmental Impacts By Kenneth J. Skipka, Louis Theodore · 2014, CRC Press.
3. Solar Energy Engineering Processes and System By SoterisKalogirou · 2009, Elsevier Science.
4. Renewable Energy Sources And Emerging Technologies By D.P. Kothari, K. C. Singal, Rakesh Ranjan · 2011, Prentice Hall India Pvt., Limited

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Gain knowledge in capturing and applying forms of energy sources and its availability	3	2	2	1	1	3	3	-	-	-	-	2	2	2	2
CO2	Demonstrate the working of various energy sources like solar, wind, biomass, geothermal, nuclear energy, hydrogen and fuel cells.	3	2	2	1	1	3	3	-	-	-	-	2	2	2	2
CO3	Analyse the challenges associated with implementation of various renewable energy sources.	3	2	2	1	1	3	3	-	-	-	-	2	2	2	2
CO4	Identify, locate and estimate the bio-based energy sources and technologies involved in it	3	2	2	1	1	3	3	-	-	-	-	2	2	2	2
CO5	Assess the challenges associated with the development of unconventional hydrocarbons and distribution of unconventional hydrocarbons with emphasis on Indian resources.	3	2	2	1	1	3	3	-	-	-	-	2	2	2	2
Overall CO		**3**	**2**	**2**	**1**	**1**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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PE23041	ENERGY CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course is designed to provide a framework for regulating energy consumption and promoting energy efficiency and conservation.

UNIT I INTRODUCTION 9

Energy - Power – Past & Present scenario of World; National Energy consumption Data –Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II ELECTRICALSYSTEMS 9

Components of EB billing –HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination –Lux, Lumens, Types of lighting ,Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III THERMALSYSTEMS 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV ENERGYCONSERVATIONINMAJORUTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets

UNIT V ECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyse and audit the energy data of industries
CO2: Calculate and evaluate energy accounting and balancing
CO3: Understand the principles of boilers and thermal fluid systems
CO4: Predict methodologies of energy conservation
CO5: Choose available resources for utilization in optimal ways

TEXT BOOKS:

1. Energy Manager Training Manual (4Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Energy Management and Conservation, 1/e K V Sharma & P Venkataseshaiah,2011.

REFERENCE BOOKS:

1. Witte.L.C.,P.S. Schmidt, D.R.Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
3. Dryden.I.G.C.,“TheEfficientUseofEnergy”Butterworths,London,1982
4. Turner.W.C.,“EnergyManagementHandbook”,Wiley,NewYork,1982.
5. Murphy.W.R.andG.McKAY,“EnergyManagement”,Butterworths,London1987

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	PROGRAMME OUTCOME														
		PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Analyse and audit the energy data of industries	3	3	3	3	2	3	1	-	1	2	3	3	3	3	2
CO2	Calculate and evaluate energy accounting and balancing	3	3	3	3	2	3	1	-	1	2	2	3	3	3	2
CO3	Discuss the priciples of boilers and thermal fluid systems	3	3	3	3	2	3	1	-	1	2	1	3	3	3	2
CO4	Describe and predict methodologists of energy conservation	3	3	3	3	2	3	1	-	1	2	1	3	3	3	2
CO5	Choose available resources for utilization in optimal ways	3	3	3	3	2	3	1	-	1	3	2	3	2	3	2
OVERALL CO		**3**	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**1**	**2**	**2**	**3**	**3**	**3**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23042	ENERGY AUDITING AND DEMAND SIDE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the students to have knowledge on the concepts of Current energy scenario, energy management, auditing.

UNIT I ENERGY AUDITING: 9

Energy Situation — World and India, Energy Consumption, Conservation, Codes, Standards and Legislation Energy Audit- Definitions, Concept, Types of Audit, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes. Measurements in Energy Audits, Presentation of Energy Audit Results.

UNIT II ENERGY EFFICIENT MOTORS 9

Energy Efficient Motors, Factors Affecting Efficiency, Loss Distribution, Constructional Details, Characteristic- Variable Speed, Variable Duty Cycle Systems, RMS - Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit.

UNIT III POWER FACTOR IMPROVEMENT 9

Power Factor — Methods of Improvement, Location of Capacitors, Pf with Non Linear Loads, Effect of Harmonics on P.F., P.F Motor Controllers.

UNIT IV LIGHTING AND ENERGY INSTRUMENTS 9

Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tongue Testers, Application of PLC's

UNIT V ENERGY ECONOMIC ANALYSIS& DEMAND SIDE MANAGEMENT 9

The Time Value of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes and Tax Credit — Numerical Problems. Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM — Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Understand the growing worldwide concern for conservation of energy.
CO2: Analyse the better ways to conserve the energy from energy audit concepts, representations and energy conservation schemes.
CO3: Understand the Power facto improvement methods
CO4: Estimate Various operational problems and remedies of motor and electrical devices.
CO5: Evaluation of life time of machine based on time value money and demand, economic analysis with respect to demand side management.

TEXT BOOKS:

1. Industrial Energy Management Systems, Array C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York
2. Fundamentals of Energy Engineering, Albert Thuman, Prentice Hall lnc, Englewood Cliffs, New Jersey.

REFERENCE BOOKS:

1. Albert Thumann, Terry Niehus, William J Younger, 'Handbook of energy audits', 9th edition.
2. S Babu, M Karthikkaruppu, 'Energy audit approach for beginners'.

Course Articulation Matrix:

Course Outcome	STATEMENT	PROGRAMME OUTCOME														
		PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy.	3	2	2	1	3							2	2	2	
CO2	Analyse the better ways to conserve the energy from energy audit concepts, representations and energy conservation schemes.	3	2	2	1	3							2	2	2	
CO3	Apply management skills and communication of energy manager.	3	2	2	1	3							2	2	2	
CO4	Estimate Various operational problems and remedies of motor and electrical devices.	3	2	2	1	3							2	2	2	
CO5	Evaluation of life time of machine based on time value money and demand, economic analysis with respect to demand side management.	3	2	2	1	3							2	2	2	
OVERALL CO		3	2	2	1	3	-	-	-	-	-	-	2	2	2	-

1,2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23043	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The course is designed to describe the theory and applications of different energy storage devices and to identify the optimal (appropriateness, cost and sustainability) solutions to any potential energy storage application.

UNIT I **9**

Energy availability, Demand and storage, Need for energy storage, Different types of energy storage; Mechanical, Chemical, Electrical, Electrochemical, Biological, Magnetic, Electromagnetic, Thermal; Comparison of energy storage technologies.

UNIT II **9**

Thermal energy storage: principles and applications, Sensible and Latent heat, Phase change materials; Energy and energy analysis of thermal energy storage, solar energy and thermal energy storage, case studies. Flywheel and compressed air storage; Pumped hydro storage; Hydrogen energy storage.

UNIT III **9**

Capacitor and super capacitor, Electrochemical Double Layer Capacitor: Principles, performance and applications. Electrochemical energy storage: Battery – fundamentals and technologies, characteristics and performance comparison: Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries.

UNIT IV **9**

Hydrogen as energy carrier and storage; Hydrogen resources and production; Basic principle of direct energy conversion using fuel cells; Thermodynamics of fuel cells; Fuel cell types: AFC, PEMFC, MCFC, SOFC, Microbial Fuel cell; Fuel cell performance, characterization and modeling; Fuel cell system design and technology, applications for power and transportation.

UNIT V **9**

Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

CO1: Gain the knowledge on the various types of fuel cell.
CO2: Apply the concepts involved hydrogen and production techniques.
CO3: Understanding the skill in hydrogen storage and applications.
CO4: Understand the principal mechanism and working of microbial fuel cells.
CO5: Evaluating the materials used for different types of fuel cell design for various applications.

TEXT BOOKS:

1. Dincer I., and Rosen M. A. (2011); Thermal Energy Storage: Systems and Applications, Wiley
2. Huggins R. A. (2015); Energy Storage: Fundamentals, Materials and Applications. Springer

REFERENCE BOOKS:

1. O'Hayre R., Cha S., Colella W., and Prinz F. B. (2009); Fuel Cell Fundamentals, Second Edition, Wiley
2. Narayan R. and Viswanathan B. (1998); Chemical and Electrochemical Energy System, Universities Press
3. Rahn C. D. and Wang C. (2013); Battery Systems Engineering, First Edition, Wiley
4. Moseley P. T., and Garche J. (2014); Electrochemical Energy Storage for Renewable Sources
5. Miller F. P., Vandome A. F., and John M. B. (2010); Compressed Air Energy Storage, VDM Publishing.

COURSE ARTICULATION MATRIX:

Course Outcome	STATEMENT	PROGRAMME OUTCOME													
		PO1	PO 2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Gain the knowledge on the various types of fuel cell.	3	2	2	1	3							2	2	2	
CO2	Apply the concepts involved hydrogen and production techniques	3	2	2	1	3							2	2	2	
CO3	Understanding the skill in hydrogen storage and applications.	3	2	2	1	3							2	2	2	
CO4	Understand the principle mechanism and working of microbial fuel cells	3	2	2	1	3							2	2	2	
CO5	Evaluating the materials used for microbial fuel cells design	3	2	2	1	3							2	2	2	
OVERALL CO		**3**	**2**	**2**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23044	BIOFUELS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The course is planned to explore the various types of bio-fuel and environmental impacts of bio fuels and co-products.

UNIT I OVERVIEW OF BIOFUELS 9

Generation of biofuels − Development of biological conversion technologies − Integration of biofuels into bio refineries − Energy security and supply − Environmental sustainability of biofuels − Economic sustainability of biofuels.

UNIT II BIODIESEL 9

Biodiesel − Microorganisms and raw materials used for microbial Oil production − Treatment of the feed stocks prior to production of the Biodiesel − Current technologies of biodiesel production − Purification of biodiesel; Industrial production of biodiesel − Biodiesel production from single cell oil.

UNIT III BIOETHANOL 9

Bioethanol – Properties – Feed stocks − Process technology − Pilot plant for ethanol production from lingo cellulosic feedstock − Environmental aspects of ethanol as a biofuel.

UNIT IV BIOMETHANE AND BIOHYDROGEN 9

Bio methanol − Principles, materials and feed stocks − Process technologies and techniques − Advantages and limitations − Biological hydrogen production methods − Fermentative hydrogen production − Hydrogen economy − Advantages and limitations.

UNIT V OTHER BIOFUELS 9

Biobutanol production − Principles, materials and feed stocks − Process technologies – Bio propanol – Bio glycerol − Production of bio-oils via catalytic pyrolysis − Life-Cycle environmental impacts of biofuels and Co-products.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Gain the knowledge on the various types of bio-fuel and its overview.
CO2: Apply the concepts involved in production techniques of biodiesel.
CO3: Review the unit process in the manufacturing of bioethanol and life cycle analysis of the plant.
CO4: Understand the mechanism and production of biomethane and biohydrogen.
CO5: Assess the production units for various fuels like bio propanol, bio glycerol and pyrolysis oil

TEXT BOOKS:

1. Luque, R., Campelo, J.and Clark, J. Handbook of biofuels production, Woodhead Publishing Limited 2011
2. Gupta, V, K. and Tuohy, M, G. Biofuel Technologies, Springer, 2013
3. Moheimani, N. R., Boer, M, P, M, K, Parisa A. and Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015

REFERENCE BOOKS:

1. Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016.
2. Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, In Tech, 2011.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome													
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Gain the knowledge on the various types of bio-fuel and its overview.	3	3	3	2	1			-	-	-		1	2	2	1
CO2	Apply the concepts involved in production techniques of biodiesel	3	3	3	2	1			-	-	-		1	2	2	2
CO3	Review the unit process in the manufacturing of bioethanol and life cycle analysis of the plant	3	3	3	2	1			-	-	-		1	2	2	1
CO4	Understand the mechanism and production of biomethane and biohydrogen	3	3	3	2	1			-	-	-		1	2	2	1
CO5	Assess the production units for various fuels like bio propanol, bio glycerol and pyrolysis of bio oil	3	3	3	2	1			-	-	-		1	2	2	-
Overall CO		**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**1.3**

1,2 and 3 are correlation levels with weightings as Slight (Low), Moderate(Medium)and Substantial (High) respectively.

PE23045	UNCONVENTIONAL HYDROCARBON SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To teach geographic distribution of unconventional hydrocarbon resources, characterization of source and reservoir rocks and the methodology to produce these reserves and their environmental issues and consequences

UNIT I NON-CONVENTIONAL OIL 9

Continuous Accumulation System

Introduction, geology of Heavy oil, extra heavy oil, Tar Sand and bituminous, oil shales, their origin and occurrence worldwide, resources, reservoir characteristics, new production technologies. Challenges in petroleum industry.

UNIT II SHALE GAS/ OIL RESERVOIR 9

Introduction to shale gas & basin centered gas, tight reservoirs. Shale gas geology, important occurrences in India, petro physical properties, Development of shale gas, design of hydro fracturing job, horizontal wells, production profiles.

UNIT III COAL BED METHANE 9

Formation and properties of coal bed methane. Thermodynamics of coal bed methane. Exploration and Evaluation of CBM. Hydro-fracturing of coal seam. Production installation and surface facilities. Well operations and production equipment.

UNIT IV GAS HYDRATES 9

Introduction & present status of gas hydrates. Formation and properties of gas hydrates, Thermodynamics of gas hydrates. Recovery methods. Prevention& control of gas hydrates, Gas hydrates accumulation in porous medium. Gas extraction from gas hydrates.

UNIT V COAL AND GAS CONVERSION TO OIL 9

Introduction, classification and principles, pyrolysis, theoretical aspect of processes involved in conversion. Technological development of direct conversion and indirect processes and sustainability of conversions.

TOTAL:45 PERIODS

COURSE OUTCOME:

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

CO1: Apply the concept of continuous accumulation system.
CO2: Implement the concepts related to exploration and development of Shale Gas Reservoirs.
CO3: Implement the concepts related to exploration and development of Coal Bed Methane.
CO4: Assess and apply the concepts related to formation of gas hydrates.
CO5: Classify and apply different conversion processes for the production of Hydrocarbons.

TEXT BOOKS:

1. Carrol John, 2003, Natural Gas Hydrates: A guide for engineers, Gulf Publications.
2. Farooqi Ali, S M, Jones S A and Meldau R F, Practical Heavy Oil Recovery, SPE, 1997.

REFERENCE BOOKS:

1. James T. Bartis, Frank Camm, David S. Ortiz, Producing Liquid Fuels from Coal, Prospects and Policy Issues. NETL, DOE, USA, 2008.
2. Warner, H.R., 2009, Emerging and Peripheral Technologies, Society of Petroleum Engineers, Handbook, Volume VI.
3. Pramod Thakur, Steve Schatzel and Kashy Aminian, (Editors), 2014, Coal Bed Methane: From Prospects to Pipeline, Elsevier.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Apply the concept of continuous accumulation system.	3	1	1	-	-	-	-	-	-	-	-	-	2	2	-
CO2	Implement the concepts related to exploration and development of Shale Gas Reservoirs.	3	3	3	2	2	2	-	-	-	-	-	2	2	-	2
CO3	Implement the concepts related to exploration and development of Coal Bed Methane.	3	3	3	2	2	2	-	-	-	-	-	2	2	2	-
CO4	Assess and apply the concepts related to formation of gas hydrates.	3	3	3	2	2	2	-	-	-	-	-	2	-	2	2
CO5	Classify and apply different conversion processes for the production of Hydrocarbons.	3	3	3	2	2	3	-	-	-	-	-	2	-	2	2
Overall CO		**3**	**2.6**	**2.6**	**2**	**2**	**2.3**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**

1,2 and 3 are correlation levels with weightings as Slight (Low), Moderate(Medium)and Substantial (High) respectively.

PE23046	CIRCULAR ECONOMY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To make learners to understand about zero waste management and give them knowledge about policy goals and role of government in it.

UNIT I INTRODUCTION TO CIRCULAR ECONOMY 9

Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy.

UNIT II CHARACTERISTICS OF CIRCULAR ECONOMY 9

Material recovery, Waste Reduction, reducing negative externalities, Explaining Butterfly diagram, Concept of Loops

UNIT III CIRCULAR DESIGN, INNOVATION AND ASSESSMENT 9

Zero waste: Waste Management in context of Circular Economy, Circular design, Research and innovation, LCA, Circular Business Models

UNIT IV CASE STUDIES 9

Business models, Solid Waste Management / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks

UNIT V LEGAL AND POLICY FRAMEWORK 9

Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1. Apply the concept of circular economy to environmental engineering problems
CO 2. Understand the concept of circularity and conduct relevant research
CO 3. Use the principles of circularity for application to sustainable development
CO 4. Understand the concept of Industrial symbiosis/ Eco-parks
CO 5. Apply complexity aspects of circular economy for creating circular business models

TEXT BOOKS:

1. The Circular Economy A User's Guide Walter R Stahel Routledge; 1st Edition (24 June 2019)
2. Circular Economy: (Re) Emerging Movement Shalini Goyal Bhalla Invincible Publisher
3. The Circular Economy Handbook: Realizing The Circular Advantage Peter Lacy, Jessica Long, Wesley Spindler Palgrave Macmillan UK
4. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist Palgrave Macmillan

REFERENCE BOOKS:

1. Towards Zero Waste: Circular Economy Boost, Waste to Resources María-Laura Franco-García, Jorge Carlos Carpio-Aguilar, Hans Bressers. Springer International Publishing 2019
2. Strategic Management and the Circular Economy Marcello Tonelli, Nicolo Cristoni, Routledge 2018.
3. Circular Economy: Global Perspective Sadhan Kumar Ghosh, Springer, 2020 4. The Circular Economy: A User's Guide Stahel, Walter R. Routledge 2019
4. An Introduction to Circular Economy Lerwen Liu, Seeram Ramakrishna, Springer Singapore 2021.

Course Articulation Matrix:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Apply the concept of circular economy to environmental engineering problems	3	3	3	2	1	3	3	-	-	-	1	1	2	2	1
CO2	Understand the concept of circularity and conduct relevant research	3	3	3	2	1	3	3	-	-	-	1	1	2	2	2
CO3	Use the principles of circularity for application to sustainable development	3	3	3	2	1	3	3	-	-	-	1	1	2	2	1
CO4	Understand the concept of Industrial symbiosis/ Eco-parks	3	3	3	2	1	3	3	-	-	-	1	1	2	2	-
CO5	Apply complexity aspects of circular economy for creating circular business	3	3	3	2	1	3	3	-	-	-	1	1	2	2	-
Overall CO		**3**	**3**	**3**	**2**	**1**	**3**	**3**	**-**	**-**	**-**	**1**	**1**	**2**	**2**	**1.3**

1,2 and 3 are correlation levels with weightings as Slight (Low),Moderate(Medium)and Substantial (High) respectively

PE23047	OPTIMUM UTILIZATION OF HEAT AND POWER	L	T	P	C
		3	0	0	3

OBJECTIVES

To learn basic principles underlying pumping, heat exchangers; modeling and optimization in design of thermal systems.

UNIT I **9**

Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation

UNIT II **9**

Basic concepts of CHP- The benefits and problems with CHP –Balance of energy demand– Types of prime movers - Economics– CHP in various sectors. Application & techno economics of Cogeneration- Cogeneration -Performance calculations, Part load characteristics- financial considerations - Operating and Investments

UNIT III **9**

Pinch Technology–significance– Selection of pinch temperature difference – Stream splitting – Process retrofit – Installation of heat pumps, heat engines - Grand composite curve.

UNIT IV **9**

Insulation – Recuperative heat exchanger – Run –around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes –. Waste Heat Recovery -Cogeneration Technology

UNIT V **9**

Sources of waste heat, Cogeneration - Principles of Thermodynamics - Combined Cycles Topping - Bottoming - Organic Rankine Cycles- Advantages Of Cogeneration Technology

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course students are expected to
CO1: Understand the energy economics and energy generation and conservation.
CO2: Learn basic concepts of CHP.
CO3: Apply pinch technology.
CO4: Analyze waste heat recovery.
CO5: Evaluate the thermodynamic energy cycles.

TEXT BOOKS:

1. Eastop, T.D. & Croft D.R, “Energy efficiency for engineers and Technologists”, 2ndedition, Longman Harlow, 1990.
2. O”Callaghan, Paul W, “Design and Management for energy conservation”, Pergamon,1993.

REFERENCE BOOKS:

1. Osborn, peter D, “Handbook of energy data and calculations including directory of products and services”, Butterworths, 1980.
2. Charles H.Butler, Cogeneration, McGraw Hill Book Co., 1984.
3. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the energy economics and energy generation and conservation	3	2	3	3	2	-	3	-	-	-	-	3	-	-	3
CO2	Learn basic concepts of CHP	3	2	3	3	2	-	3	-	-	-	-	3	-	-	3
CO3	Apply pinch technology	3	2	3	3	2	-	3	-	-	-	-	3	-	-	3
CO4	Analyze waste heat recovery	3	2	3	3	2	-	3	-	-	-	-	3	-	-	3
CO5	Evaluate the thermodynamic energy cycles	3	2	3	3	2	-	3	-	-	-	-	3	-	-	3
Overall CO		**3**	**2**	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**3**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

EMERGING TECHNOLOGY COURSES

PE23E01	RESERVOIR AND REFINING SIMULATION	L	T	P	C
		0	0	6	3

OBJECTIVES

To provide an overview of software tools used in the oil and gas industry, modelling and simulations for different petroleum engineering problems.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

Minimum1 0 experiments to be offered

Stand alone desktops/server with respective simulation software's 30 users.
Software's

1. MATLAB Single user license
2. Chemical engineering simulation software
3. Prosimulator software package – Petrochemical Engineering Suite
4. Open source office

LIST OF SUGGESTED EXERCISES

Practice the following using process simulator. The simulator can be used from Virtual Lab simulators:

1. Solve momentum, heat and mass balance using EXCEL and MATLAB
2. Seismic and Geological Interpretation Software Optimize Interpretations, Drilling decisions and field development
3. Geophysics, Geology and Modelling Prestack processing, Microseismic, Reservoir Elastic Modelling, 1D Petroleum System Modelling
4. Production Forecasting, Reservoir and Dual Scale Modelling
5. Reserve Estimation
6. Petro physical and Multi-well interpretation
7. Pressure Transient Analysis and Production Behaviour
8. Casing Design, Drill string design, Production Design, Tube Design, Production Optimization, Nodal Analysis
9. Geomechanics Fracture Simulator, Hydraulic Fracturing: Design, Analysis and Optimization
10. Heat Exchanger Design and Simulation, Design of industrial-scale heat transfer equipment
11. Refinery Process Simulation, Project/Process Design and Optimization Types of reactor and Reaction kinetics, Centrifugal pump, Centrifugal compressor, Fluidized bed column, Packed bed column, Cyclone separator, Evaporator, Crude Distillation unit, etc.

TOTAL: 90 PERIODS

COURSE OUTCOME:

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

CO1 : Gain industrial exposure in computational pro-simulation.
CO2 : Understand in-depth Processes of chemical and refinery operation.
CO3: Apply project knowledge and Carry out In-house projects
CO4: Analyze sound fundamental concepts of process control and safety with DCS operations.
CO5: Evaluate the intricacy & complexity of process dynamics.

TEXT BOOKS:

1. Bequette.B.W, —ProcessDynamics‖: Modeling, Analysis and Simulation,‖ PrenticeHall(1998)
2. Himmelblau.D.M. and Bischoff.K.B, —Process Analysis and Simulation ‖, Wiley, 1988.
3. Strang.G.,‖ Introduction to Linear Algebra‖, Cambridge Press, 4th edition, 2009.

REFERENCE BOOKS:

1. William. Luyben, Process Modeling, simulation and control for Chemical Engineers, 2nd Edn.,McGraw Hill International Editions, New York, 1990.
2. Chapra.S.C. and Canale.R.P. —Numerical Methods for Engineers ‖, McGraw Hill, 2001.

Course Articulation Matrix:

Course Outcomes	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Gain industrial exposure in computational pro-simulation.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Understand in-depth Processes of chemical and refinery operation.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Apply project knowledge and Carry out In-house projects	3	2	3	2	3	-	-	-	-	-	-	2	2	3	-
CO4	Analyze sound fundamental concepts of process control and safety with DCS operations.	3	2	2	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Evaluate the intricacy & complexity of process dynamics.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
Overall CO		**3**	**2**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23E02	DIGITALIZATION FOR OIL AND GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To gain practical knowledge on implementing digital tools to optimize production, enhance asset management, and improve decision-making processes.

UNIT I OVERVIEW OF THE DIGITAL INDUSTRY 9

Introduction: Digital Oil field components-Monitor and control networks-Automation systems. Digitalization ventures-Value of legacy-based data-Informed decisions for intelligent operations

UNIT II DIGITALIZATION IN ACTION 9

Oil and gas industry as a system-Digitalization value. Digitalization for HSSE-Organization and behavioral aspects. Machine learning techniques-Artificial intelligence.

UNIT III INTEGRATED CYBER SECURITY 9

Understanding the threat and its implications-Oilfields as a critical infrastructure. Cybersecurity vs. Physical Security-Integrated solutions. Digital policies. Cybersecurity for contractors and subcontractors

UNIT IV APPLIED PETROLEUM INFORMATICS 9

Secure network architecture-Function-specific design. Digital twin concept-Digital Twin VS Traditional Simulation. Virtual reality-Collaborative online environments.

UNIT V MODERN INFORMATION AND DATA FLOW 9

Big data for big opportunities-Data and information flow Control network deployment patterns. Logical operations control centers. Project assignment-Project design and optimization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the overview of the digital Industry.
CO2: Assess digitalization in action.
CO3: Learn integrated cyber security.
CO4: Understand the importance of applied petroleum informatics.
CO5: Analyze modern information and data flow.

TEXT BOOKS:

1. Unconventional Methods for Geoscience, Shale Gas and Petroleum in the 21st Century J. Watada et al. (Eds.), doi:10.3233/AERD230002
2. Digital Transformation: Building Resilience in the Oil & Gas Sector

REFERENCE BOOKS:

1. Bits, Bytes, and Barrels : The digital transformation of oil and gas Geoffrey Cann and Rachael Ooydan.
2. Oil and Gas definitive path towards digitalization Feb 2019

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the overview of the digital Industry.	3	2	2	3	3	1	1	2	-	-	-	-	1	2	-
CO2	Assess digitalization in action.	2	2	-	2	2	-	-	1	2	1	2	2	1	-	2
CO3	Learn integrated cyber security.	2	2	3	2	1	-	-	2	3	2	2	2	1	2	2
CO4	Understand the importance of applied petroleum informatics.	2	2	1	1	1	-	-	1	2	1	2	2	1	-	1
CO5	Analyze modern information and data flow.	2	2	1	-	1	-	-	1	2	1	-	3	1	-	2
Overall CO		**2.2**	**2**	**1.8**	**2**	**1.6**	**1**	**1**	**1.4**	**2.3**	**1.3**	**2**	**2.3**	**1**	**2**	**1.8**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23E03	DATA ANALYTICS AND AI FOR OIL AND GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To introduce students to basic applications, techniques of data mining and machine learning approaches.

UNIT I **9**

Introduction: Introduction to Data Analytics and Artificial Intelligence- Some illustrations of AI problems- Data-Information-Knowledge-Applications of Data Analytics-Introduction to the Languages of Data Science: R, SQL, and Python.

UNIT II **9**

Data warehousing: Introduction to Data warehousing, Concepts of Data warehousing-OLAP-Data Preparation and Visualization. IoT in Upstream Oil and Gas Industry; 3D virtual modelling with Drone Technology, Video Surveillance technology.

UNIT III **9**

Descriptive Statistics: Central Tendency and Variability, Inferential Statistics-Probability-Central Limit Theorem-Exploratory Data Analysis-Hypothesis Testing-Linear Regression.

UNIT IV **9**

Classification: KNN, Naïve Bayes and Logistic Regression-K-means and Hierarchical Clustering-Decision Trees-Support Vector Machines-Neural Networks-Association Rule Mining.

UNIT V **9**

Introduction to Big Data and Hadoop: Managing Big Data-Hadoop Ecosystem Tools (Sqoop and Hive). Introduction to Spark: Big Data Analysis using Spark R-Spark SQL-Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the need for data analysis, basic techniques used in data mining and machine learning.
CO2: Design a data mart for any organization using data mining techniques.
CO3: Design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate the various machine learning algorithms.
CO4: Understand the importance of big data analytics and its uses.
CO5: Implement the concept of had loop and spark SQL.

TEXT BOOKS:

1. Thomas A. Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis, Springer, 2012.
2. Data Mining: Concepts and Techniques (The Data Mining: Concepts and Techniques (The Morgan Kaufmann Series in Data Management Systems) by Jiawei Han (Author), Micheline Kamber (Author), Jian Pei.

REFERENCE BOOKS:

1. Big Data and Hadoop by V. K. Jain.
2. Wes McKinney, Python for Data Analysis, O' Relley, 2013.
3. Keith R. Holdaway, Harness Oil and Gas Big Data with Analytics: Optimize exploration and Production with Data Driven Models, Weily, 2014.
4. Robert Haining, Spatial Data Analysis, Theory and Practice, Cambridge University Press, 2003.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the need for data analysis, basic techniques used in data mining and machine learning.	3	2	2	3	3	1	1	2	-	-	-	-	1	2	-
CO2	Design a data mart for any organization using data mining techniques.	2	2	-	2	2	-	-	1	2	1	2	2	1	-	2
CO3	Design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate the various machine learning algorithms.	2	2	3	2	1	-	-	2	3	2	2	2	1	2	2
CO4	Understand the importance of big data analytics and its uses.	2	2	1	1	1	-	-	1	2	1	2	2	1	-	1
CO5	Implement the concept of had loop and spark SQL.	2	2	1	-	1	-	-	1	2	1	-	3	1	-	2
Overall CO		**2.2**	**2**	**1.8**	**2**	**1.6**	**1**	**1**	**1.4**	**2.3**	**1.3**	**2**	**2.3**	**1**	**2**	**1.8**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23E04	HYDROGEN ENERGY: PRODUCTION, STORAGE, TRANSPORTATION AND SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVE:

To provide the students with knowledge in hydrogen energy value chain including production methods from hydrocarbons & renewables, separation & purification, storage, transportation & distribution, refueling, utilization in various sectors, associated energy conversion devices, sensing and safety.

UNIT I **9**

Properties of hydrogen, global status of supply and demand.

UNIT II **9**

Methods of hydrogen production, steam reforming, advanced methods of steam reforming, partial oxidation, auto-thermal reforming, combined reforming, reforming using alternate energy sources. Hydrogen production from methane decomposition, from coal and biomass. Hydrogen separation and purification, thermochemical cycles for hydrogen production, technical and economic comparison of different production methods and global status, cost analysis.

UNIT III **9**

Fundamentals for electrolysis of water-Components of electrolytic cell, configuration of electrolyzer stack, different electrolyzer technologies, photoelectrochemical hydrogen production. Fundamentals and thermodynamics of absorption based hydrogen storage, metal hydrides, types of metal hydrides, metal hydride based systems design.

UNIT IV **9**

Introduction to hydrogen storage, underground hydrogen storage, fundamentals of hydrogen compression and expansion Mechanical and non-mechanical hydrogen compressors; compressed hydrogen tank types and design considerations Hydrogen liquefaction, liquid state hydrogen storage tanks, fundamentals of hydrogen storage in adsorption based materials.

UNIT V **9**

Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status and future directions

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the demand of hydrogen globally.
CO2: Learn the methods of hydrogen production.
CO3: Analyse the electrolysis technologies.
CO4: Understand the importance of hydrogen storage.
CO5: Assess the hazards associated with hydrogen.

TEXT BOOKS:

1. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009.
2. Global Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-2021

REFERENCE BOOKS:

1. AgataGodula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015.
2. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. “Hydrogen storage: state-of-the-art and future perspective. Netherlands”: European Communities, 2003.
3. Michael Hirscher, “Handbook of Hydrogen Storage”, Wiley-VCH, 2010.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome													
		PO1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the demand of hydrogen globally.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Learn the methods of hydrogen production.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Analyze the electrolysis technologies.	3	2	3	2	3	-	-	-	-	-	-	2	2	3	-
CO4	Understand the importance of hydrogen storage.	3	2	2	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Assess the hazards associated with hydrogen.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	3
Overall CO		3	2	3	2	3	-	-	-	-	-	-	-	3	3	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

SKILL DEVELOPMENT COURSE

PE23S01	INDUSTRIAL INSTRUMENTATION	L	T	P	C
		2	0	0	2

OBJECTIVE:

To help the students to be aware of various measurement system used in chemical & petrochemical industries to measure process variables.

UNIT I PRINCIPLES OF INSTRUMENTATION MEASUREMENT OF VIBRATION AND DENSITY: 6

Measuring Instrument: Introduction and its types- Elements and its function. Transducer: Importance and its classification - Measuring errors: Sources - reduction - quantification of systematic and Random errors. Performance characteristics: Static and Dynamic characteristics

Mechanical type vibration instruments – Seismic instruments as accelerometer – Vibration sensor – Calibration of vibration pickups – Units of density and specific gravity – Baume scale and API scale – Densitometers: Pressure type densitometers, Float type densitometers, Ultrasonic densitometer and gas densitometer.

UNIT II TEMPERATURE MEASUREMENT: 6

Principles of temperature measurement: Thermoelectric effect sensors - Varying resistance devices - Bimetallic thermometers – IC sensors –Thermocouples:Special techniques for measuring high temperature using thermocouple – Radiation thermometers - Thermography - Thermal expansion methods - Fibre-optic temperature sensors - Selection of temperature transducers.

UNIT III PRESSURE MEASUREMENT: 6

Principles of Pressure Measurement: Manometers - Bourdon tube - Bellows - Diaphragms - Capacitive pressure sensor - Fibre-optic pressure sensors - Resonant-wire devices - Dead-weight gauge - Special measurement devices for low pressures measurement -Selection of pressure sensors.

UNIT IV FLOW AND VISCOSITY MEASUREMENT: 6

Principles of Flow Measurement: Mass flow rate measurement and Volume flow rate measurement - Choice between flow meters for particular applications. Viscosity measurement: Capillary and tube viscometers - Falling body viscometer - Rotational viscometers-Saybolt viscometer.

UNIT V LEVEL MEASUREMENT: 6

Principles of Level Measurement: Float systems - Pressure measuring devices - Capacitive devices - Ultrasonic level gauge - Radar (microwave) methods - Radiation methods - Vibrating level sensor and Laser methods - Choice between different level sensors.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the type, performance characteristics and error generation of measurement

CO2: Explain temperature measurement device applied in chemical industries

CO3: Assess various range of pressure measuring system used in process industries

CO4: Illustrate flow and viscosity measurement techniques in process industries

CO5: To estimate the level measurement tool adopted in industries

TEXT BOOKS

1. Alan S Morris, Reza Langari, "Measurement and Instrumentation: Theory and Application", 3rd Edition, Academic Press, United States of America, 2001.

REFERENCE BOOKS:

1. William C Dunn, "Fundamentals of Industrial Instrumentation and Process Control", 1st Edition, McGraw Hill International Edition, New Delhi, 2005.
2. Singh S.K, "Industrial Instrumentation and Control", 2nd Edition, McGraw Hill International Edition, New Delhi, 2006.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	INDUSTRIAL INSTRUMENTATION														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand the type, performance characteristics and error generation of measurement.	3	2	2	2	2	1	-	-	-	-	-	1	-	2	-
CO2	Explain temperature measurement device applied in chemical industries	3	2	2	2	2	1	-	-	-	-	-	1	-	2	-
CO3	Assess various range of pressure measuring system used in process industries	3	2	2	2	2	1	-	-	-	-	-	1	-	2	-
CO4	Illustrate flow and viscosity measurement techniques in process industries	3	2	2	2	2	1	-	-	-	-	-	1	-	2	-
CO5	To estimate the level measurement tool adopted in industries	3	2	2	2	2	1	-	-	-	-	-	1	-	2	-
	Overall CO	**3**	**2**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**-**

1,2 and 3 are correlation levels with weightings as Slight (Low), Moderate(Medium)and Substantial (High) respectively.

PE23S02	SIMULATION TOOLS FOR PETROLEUM ENGINEERS	L	T	P	C
		0	0	4	2

OBJECTIVE:

This course is intended to provide basics of chemical process design.

UNIT I **12**

Steady state simulation of Heat Exchanger using ASPEN PLUS/ HYSYS; Dynamic simulation of Heat Exchanger using ASPEN PLUS/ HYSYS.

UNIT II **12**

Steady state simulation of a CSTR using ASPEN PLUS/ HYSYS; Dynamic simulation of a CSTR using ASPEN PLUS/ HYSYS.

UNIT III **12**

Steady state simulation of Flash vessel using ASPEN PLUS/ HYSYS; Dynamic simulation of Flash vessel using ASPEN PLUS/ HYSYS.

UNIT IV **12**

Steady state simulation of Distillation Column using ASPEN PLUS/ HYSYS; Dynamic simulation of Distillation Column using ASPEN PLUS/ HYSYS.

UNIT V **12**

Steady state simulation of an Absorption column using ASPEN PLUS/ HYSYS; Dynamic simulation of an Absorption column using ASPEN PLUS/ HYSYS.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the simulation of Heat Exchanger.
CO2: Learn the simulation of a CSTR.
CO3: Analyse the simulation of Flash vessel.
CO4: Apply the simulation of Distillation Column.
CO5: Assess the simulation of an Absorption column.

TEXT BOOKS:

1. W. L. Luyben, Process Modelling, Simulation and Control for Chemical Engineers, 2 Sub Edition, McGraw Hill, 1989

REFERENCE BOOKS:

1. B. V. Babu, Process Plant Simulation, Oxford University Press, 2004
2. K. Najim, Process Modeling and Control in Chemical Engineering, 1st Ed., CRC, 1989

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the simulation of Heat Exchanger.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Learn the simulation of a CSTR.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Analyse the simulation of Flash vessel.	3	2	3	2	3	-	-	-	-	-	-	2	2	3	-
CO4	Apply the simulation of Distillation Column.	3	2	2	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Assess the simulation of an Absorption column.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
Overall CO		3	3	2	3	2	-	-	-	-	-	-	2	3	3	-

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23S03 COMPUTER AIDED DESIGN AND COMPUTER AIDED ENGINEERING

L	T	P	C
0	0	4	2

OBJECTIVE:

Student will be able to understand the fundamental of CAD/CAE Graphic standards, their modes, geometric modelling, surface modelling and their engineering application.

UNIT I **12**

Review of basic fundamentals of CAD, CAD data exchange, Graphics standards, modes of graphics operation. Geometric Modelling: Types of mathematical representation of curves, parametric representation of analytic and synthetic curves, wire frame modeling. Introduction of transformation of geometric models, visual realism.

UNIT II **12**

Surface Modelling: Parametric representation of analytic and synthetic curves, surface manipulation, Design and engineering applications. Solid Modelling: Boundary representation, constructive solid geometry, sweep representation, analytical solid modelling, Design and engineering applications.

UNIT III
12

Engineering analysis of solid model; Strategic plan of CAD system design & development, Graphic exchange, features recovery etc.

UNIT IV **12**

Numerically Calculation and MATLAB Simulation- Part A: Invariants, Principal stresses and strains with directions Part B: Maximum shear stresses and strains and planes, Von-Mises stress Part C: Calculate and Plot Stresses in Thick-Walled Cylinder.

UNIT V **12**

Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. Shear Part A: Mat lab simulation for Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate Part B: Modeling of plate geometry under chosen load conditions and study the effect of plate geometry. Part C: Numerical Analysis using FEA package.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basic fundamentals of CAD and Geometric Modelling.
CO2: Learn the Surface Modell and Solid Modelling.
CO3: Analyse the solid model.
CO4: Apply the Numerically Calculation and MATLAB Simulation.
CO5: Assess the Stress analysis.

TEXT BOOKS:

1. Chris McMohan and Jimmi Browne ,"CAD/CAM Principles, practice and manufacturing management ", Pearson Education Asia , Ltd, 2000
2. Donald Hearn and M.Pauline Baker"Computer Graphics",Prentice Hall, Inc. 1992

REFERENCE BOOK:

1. Ibrahim Zeid"CAD/CAM- Theory and practice"-Mcgraw Hill, International edition,1998

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the basic fundamental of CAD and Geometric Modelling.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Learn the Surface Modell and Solid Modelling.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Analyse the solid model.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO4	Apply the Numerically Calculation and MATLAB Simulation.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Assess the Stress analysis.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
Overall CO		**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

OPEN ELECTIVES (OE)

PE23901	INTRODUCTION TO PETROLEUM ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE:

To provide students an overview of petroleum industry. Petroleum exploration and exploitation techniques, oil and gas reserve identification and evaluation; Drilling and production of oil and gas and Disposal of effluents.

UNIT I **9**

Earth science - occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism.

UNIT II **9**

Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipments. Drilling fluids and cementing.

UNIT III **9**

Logging techniques. Various types of logs. Formation parameters. Log applications. Formation evaluation. Well completion.

UNIT IV **9**

Petroleum exploitation – well testing, production potential and well performances. Material balance, Artificial lift, Improved recovery methods.

UNIT V **9**

Surface equipments, processing of oil and gas. Transportation of oil and gas. Effluent treatment.
Petroleum economics. Supply and demand trends.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the students will be able to
CO1: Understand the Earth science and Reservoir.
CO2: Learn the drilling of oil and gas wells.
CO3: Analyse various types of logs.
CO4: Apply the Material balance.
CO5: Assess the Petroleum economics.

TEXT BOOKS:

1. Geology of Petroleum by Leverson A.L.- 2nd edition The AAPG foundation, 2006.
2. Principles of oil production by T.E.W Nind- 2nd edition Mc Graw-Hill, 1981.

REFERENCE BOOKS:

1. Introduction to Petroleum Engineering by Geltin
2. Wellsite Geological Techniques for petroleum exploration, Oxford and IBH publishing company, 1988

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome													
		PO1	**PO 2**	**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Understand the Earth science and Reservoir.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO2	Learn the drilling of oil and gas wells.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
CO3	Analyse various types of logs.	3	2	3	2	3	-	-	-	-	-	-	2	2	3	-
CO4	Apply the Material balance.	3	2	2	2	3	-	-	-	-	-	-	2	3	3	-
CO5	Assess the Petroleum economics.	3	2	3	2	3	-	-	-	-	-	-	2	3	3	-
Overall CO		**3**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23902	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about importance of safety and its regulations
- To know about types of hazards and safety management to mitigate it
- To provide necessary assists to safety audits and techniques
- To realize about the requisite of safety education and training
- To know about the waste management system and its significance

UNIT I NEED FOR SAFETY IN INDUSTRIES AND REGULATION 9

General definitions- Importance & objectives of safety- Safety Programmes & its key elements –- safety policy – safety organization, Implementation of Health and safety culture & factors influencing it- Factories Act and Safety Regulations.

UNIT II OCCUPATION HEALTH AND SAFETY MANAGEMENT 9

Physical hazard- chemical hazards- biological hazards- ergonomical hazards-Fire hazards-, Electrical hazards-safety management structure & its importance-safety philosophy & psychology- - emergency planning-on site & off site emergency planning- work permit systems

UNIT III SAFETY AUDIT AND SAFETY DOCUMENTS 9

Objective of safety audit- elements of audits-, checklist, third party certifications- what if analysis, HIRA (Hazard Identification & risk Assessment) - Job Safety Analysis (JSA), safety – survey, Tool box talks, safety committee meeting -inspection, sampling- EMS models case studies

UNIT IV SAFETY EDUCATION AND TRAINING 9

Importance of training-identification of training needs-training methods – programme, seminars ,Conferences, competitions – method of promoting safe practice - motivation – communication -role of government agencies and private consulting agencies in safety training – creating Awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive Scheme, safety campaign – Domestic Safety and Training.

UNIT V WASTE MANGEMENT SYSTEM 9

Waste classification and regulatory requirements- waste identification, characterization and classification -Methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification -source reduction and recycling- collection-transport and material recovery- biological and thermal processing of wastes- waste disposal

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Recognize the value of safety role in industry and its regulations
CO2: Aware of the types of hazards dealt in industry and system to manage it
CO3: Understand about safety audit and safety techniques
CO4: Significance of safety education and training to employees
CO5: Importance of waste management system in industries and its procedure

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
2. John Ridley, “Safety at Work”, Butterworth & Co., London, 1983.
3. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973.
4. McCornick, E.J., Human Factors in Engineering and Design, Tata McGraw-Hill, 1982.

Course Articulation Matrix:

Course Outcome	Statement	Program Outcomes														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Recognize the value of safety role in industry and its regulations	3	2	3	2	3	-	-	-	-	-	-	3			3
CO2	Aware of the types of hazards dealt in industry and system to manage it	3	2	3	2	3	-	-	-	-	-	-	3			3
CO3	Understand about safety audit and safety techniques	3	2	3	2	3	-	-	-	-	-	-	3			3
CO4	Significance of safety education and training to employees	3	2	2	2	3	-	-	-	-	-	-	3			3
CO5	Importance of waste management system in industries and its procedure	3	2	3	2	3	-	-	-	-	-	-	3			3
Overall CO		**3**	**2**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**			**3**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23903	LIFESTYLE MODIFICATIONS AND HEALTH IN UNISON	L	T	P	C
		3	0	0	3

OBJECTIVES

The course is aimed to make the students understand Glycemic index value, importance of millet foods, immunization scheduling, avoiding cervical cancer; ORS, HDL and LDL cholesterol, Thyroid stimulating hormone. To create an awareness about pollution and hazards among students

UNIT I: IMPORTANCE OF MICRONUTRIENTS AND ADHERING TO LOW GLYCEMIC INDEX FOODS **9**

Millets and fibre rich foods –Their high nutritive value –Dangers of consumption of refined foods – Iron protein combination –Micronutrients–Their importance in upkeep of good health –Overcoming their deficiency – Foods rich in micronutrients –Glycemicindex -Its importance –Comparative glycemic index of various foods.

UNIT II: IMMUNIZATION SCHEDULING – NEED FOR ADHERENCE **9**

Protein calorie malnutrition –Importance of intake of folic acid supplements to prevent genital abnormalities –Necessity to avoid early marriage –Need for various immunizations their dosage schedules-Need to immunize adolescent girl children to prevent cervical cancer.

UNIT III: LIFE SAVING CHILD SURVIVAL STRATEGIES **9**

Drastically cutting down mortality and morbidity –Causative factors of dehydration –Warning symptoms - Need to administer lifesaving Oral Rehydration Salt solution (ORS) Methodology of preparing ORS solution- Importance of zinc as an additive.

UNIT IV: STRATEGIES FOR INCREASING HDL AND LOWERING LDL CHOLESTEROL **9**

Healthy fats –Need to avoid saturated and trans fats - Optimum value of HDL and LDL cholesterols –Need to lower triglycerides - Ways of reducing bad LDL cholesterol –Role of Thyroid Simulating Hormone (TSH) - Importance of mental health –Positive and optimistic outlook on life – Pranic breathing as a stress relief mechanism.

UNIT V: DRINKING WATER STANDARDS **9**

WHO Standards of drinking water – Importance of dissolved oxygen – Effect of biodegradable organic particulate matter on dissolved oxygen – Estimation of sulphate in water – air pollution hazards – Domestic air pollutants.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course students are expected to

CO1: Gain the knowledge about Glycemic index value and regular usage of millet foods in our daily life.
CO2: Know the necessity of regular immunization from birth and to avoid cervical cancer in girls
CO3: Learn the preparative methodology and advantages of lifesaving OR solution.
CO4: Understand about the bad cholesterol and ways of reducing it and about TSH.
CO5: Apply their Knowledge in day today life to avoid pollution.

TEXT BOOKS:

1. Thomas L. Lenz, ‘Lifestyle Modifications in Pharmacotherapy’, Lippincott Williams and Wilkins; 1st edition (1 June 2007).

REFERENCE BOOK:

1. KedarN.Prasad, Micronutrients in Health and Disease, CRC Press, 1st Edition, 2010

Course Articulation Matrix:

Course Outcome	Statement	Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Gain the knowledge about Glycemic index value and regular usage of millet foods in our daily life	-	-	-	-	-	3	3	2	-	-	-	2	-	-	1
CO2	Know the necessity of regular immunization from birth and to avoid cervical cancer in girls	-	-	-	-	-	3	3	2	-	-	-	2	-	-	1
CO3	Learn the preparative methodology and advantages of lifesaving OR solution	-	-	-	-	-	3	3	2	-	-	-	2	-	-	1
CO4	Understand about the bad cholesterol and ways of reducing it and about TSH	-	-	-	-	-	3	3	2	-	-	-	2	-	-	1
CO5	Apply their Knowledge in day today life to avoid pollution	-	-	-	-	-	3	3	2	-	-	-	2	-	-	1
Overall CO		**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**1**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23904	BIO MASS CONVERSION AND TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

This course will enable students to learn types of biomass, assessment techniques, biomass properties, thermo chemical, biological and chemical conversion, and power generation using bio mass.

UNIT-I INTRODUCTION **9**

Introduction: Types of biomass, advantages and dis advantages in use of biomass as energy, sources of biomass, current biomass applications and trends, physical and thermal properties of biomass, techniques for biomass assessment.

UNIT-II THERMO CHEMICAL CONVERSION **9**

Thermo chemical conversion: Combustion, gasification, pyrolysis, hydrothermal liquefaction, hydro pyrolysis, torrefaction, choice of thermal process based on biomass type and product requirement. Economics of thermo chemical conversion.

UNIT-III BIOLOGICAL CONVERSION **9**

Biodegradation and biodegradability of substrate - Biochemistry and process parameters of Biomethanation - Biogas digester types - Digester design and biogas utilization. Biomethanation Process - Economics of biogas plant with their environmental and social impacts - Bioconversion of substrates into alcohol - Methanol & ethanol Production - Organic acids – Solvents - Amino acids - Antibiotics.

UNIT-IV CHEMICAL CONVERSION **9**

Chemical Conversion: Hydrolysis & hydrogenation - Solvent extraction of hydrocarbons - Solvolysis of wood - Bio crude and biodiesel - Chemicals from biomass.

UNIT-V POWER GENERATION **9**

Utilisation of gasifier for electricity generation - Operation of spark ignition and compression ignition engine with wood gas – Methanol - ethanol & biogas - Biomass integrated gasification/combined cycles systems - Sustainable cofiring of biomass with coal - Biomass productivity - Energy plantation and power programme.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course students are able to

CO1: Demonstrate different types of biomass, advantages and limitations of bio mass, sources of bio mass, properties of bio mass and biomass assessment techniques.

CO2: Explain thermo chemical conversion processes of biomass.

CO3: Describe various biological conversion processes of biomass.

CO4: Discuss about chemical conversion processes of biomass.

CO5: Explain concepts of power generation using biomass.

TEXT BOOKS:

1. Sergio C. Caperda, Introduction to Biomass energy conversions, CRC Press, Taylor & Francis Group.
2. Erik Dahlquist, Technologies for converting Boimass to Useful energy, CRC Press, Taylor & Francis Group.

REFERENCE BOOKS:

1.Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

2. Biogas Systems: Principles and Applications, Mital K.M

3. Biomass Energy Systems, Venkata Ramana P and Srinivas S.N

4. Thermochemical Characterization of Biomass, Iyer PVR , M N E S

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Demonstrate different types of biomass, advantages and limitations of bio mass, sources of bio mass, properties of bio mass and biomass assessment techniques	3	2	3	3	2	-	-	-	-	-	-	3	-	-	2
CO2	Explain thermo chemical conversion processes of biomass	3	2	3	3	2	-	-	-	-	-	-	3	-	-	2
CO3	Describe various biological conversion processes of biomass	3	2	3	3	2	-	-	-	-	-	-	3	-	-	2
CO4	Discuss about chemical conversion processes of biomass	3	2	3	3	2	-	-	-	-	-	-	3	-	-	2
CO5	Explain concepts of power generation using biomass	3	2	3	3	2	-	-	-	-	-	-	3	-	-	2
Overall CO		**3**	**2**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

PE23U01	STANDARDS - PETROLEUM ENGINEERING AND TECHNOLOGY	L	T	P	C
		1	0	0	1

MODULE I OVERVIEW OF STANDARDS 6

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II BUREAU OF INDIAN STANDARDS (BIS) SPECIFICATION FOR PETROLEUM PRODUCTS 2

IS 4576: Liquefied Petroleum Gases (LPG) - IS 2796: Motor Gasoline - IS 1571: Aviation Turbine Fuels, (ATF) Kerosene Type, JET A1 - IS 1459: Kerosene Grade A: Low Sulphur Kerosene Grade B: Kerosene - IS 1460: Automotive Diesel Fuel - IS 16861: High Flash High Speed Diesel (HFHSD) - IS 1593: Fuel Oil - IS 73: Paving Bitumen. BIS III **-** BIS IV **-** BIS V **-** BIS VI.

MODULE III INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) 2

ISO 9001 Standard: Quality Management System - ISO 14001 Standard: Environmental Management System - ISO 27001 Standard: Information Security Management Systems. ISO/IEC 17025 Testing And Calibration Laboratories - ISO 45001 Hazardous Chemicals and Dangerous Goods Procedures

MODULE IV ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS) 2

ASME Sec VIII Div 1 and 2: Guidelines for designing and constructing pressure vessels - ASME B 31.8: gas transmission and distribution piping systems - ASME section V: boiler and pressure vessel -code non-destructive examination - ASME B31.3: Process Piping Code that covers design, fabrication, and inspection of process piping systems

MODULE V API (AMERICAN PETROLEUM INSTITUTE) STANDARDS 3

API RP 14C: Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms - API RP 14E: Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems - API RP 14J: Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities - API STD 53: Drilling side blowout preventers - API RP 75: Safety and Environmental Management System (SEMS).

API RP 96: Deepwater well design & construction API RP 520: Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries - API RP 521: Guide for Pressure-Relieving and Depressuring Systems - API STD 610: Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries - API RP 2000: Venting Atmospheric and Low-Pressure Storage Tanks.

TOTAL: 15 PERIODS

COURSE OUTCOMES:

At the end of the course students are able to

CO1: Demonstrate overview of standards.

CO2: Explain Bureau of Indian Standards specification for petroleum products.

CO3: Describe International Organization for Standardization.

CO4: Discuss about American Society of Mechanical Engineers.

CO5: Evaluate concepts of American Petroleum Institute Standards.

TEXT BOOKS:

1. James G. Skakoon, The Unwritten Laws of Engineering, ASME Press, 2019.
2. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai. ISO 9001, ISO 14001, ISO 45001 standards.

REFERENCE BOOKS:

1. International Space Olympiad, 2024.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	Demonstrate overview of standards	3	2	-	2	-	3	3	2	2	2	1	3	-	-	2
CO2	Explain Bureau of Indian Standards specification for petroleum products	3	2	-	2	-	3	3	2	2	2	1	3	-	-	2
CO3	Describe International Organization for Standardization	3	2	-	2	-	3	3	2	2	2	1	3	-	-	2
CO4	Discuss about American Society of Mechanical Engineers	3	2	-	2	-	3	3	2	2	2	1	3	-	-	2
CO5	Evaluate concepts of American Petroleum Institute Standards	3	2	-	2	-	3	3	2	2	2	1	3	-	-	2
Overall CO		**3**	**2**	**-**	**2**	**-**	**3**	**3**	**2**	**2**	**2**	**1**	**3**	**-**	**-**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

PE23U02	PERSPECTIVES OF SUSTAINABLE DEVELOPMENT	L	T	P	C
		2	0	2	3

OBJECTIVE:

To develop the theoretical and knowledge foundation on the concept of sustainable development and to gain an empirical understanding of the emerging global challenges for sustainable environmental and societal governance systems.

MODULE I INTRODUCTION 6

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II ENVIRONMENTAL SUSTAINABILITY 6

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III SOCIAL & ECONOMIC SUSTAINABILITY 9

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV DISASTER MANAGEMENT 9

Disasters: Definition, Components of disasters - Types of disasters: Natural disasters and Man-made disasters. Natural disasters: Definitions and introduction to Earthquakes, Tropical cyclones, Cloud bursts, Floods, Drought, Land subsidence, Landslides, Mudslides, Volcanoes, Tsunami, Avalanches, Heat waves, Cold waves, Dust storms, and Locust attacks. Man-made disasters: Definitions and introduction to Gas leaks, Toxic and Hazardous wastes, Nuclear and radiation accidents, Oil spills, Forest fires, Pandemics, Weather Extremes & Climate Change and Wars. Disaster Management Authority at National, State and District levels; Roles and responsibilities of Government Authorities including Local Self-Government at various levels.

MODULE V SUSTAINABILITY PRACTICES 30

Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours) - Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans. Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA) - Ecological footprint assessment using the Global Footprint Network spreadsheet calculator - National/Sub national Status of Sustainable Development Goals.

TOTAL: 60 PERIODS

COURSE OUTCOME:

At the end of the course students are able to

CO1: Understand the basic concept of Sustainable Development, the environmental, social and economic dimensions.

CO2: Demonstrate knowledge and understanding of the current sustainable development policies followed by selected countries.

CO3: Develop an encompassing understanding of sustainability issues.

CO4: Depth learning and analysis of factors that support to achieve sustainability and resilience in an individual level and in a community.

CO5: Assess the sustainable practices of any community; become critical and proactive thinkers and, with this, successful leaders in the field.

TEXT BOOKS:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.

REFERENCE BOOKS:

1. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
2. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
3. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
4. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

COURSE ARTICULATION MATRIX:

Course Outcome	Statement	Programme Outcome														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	Understand the basic concept of Sustainable Development, the environmental, social and economic dimensions	3	2	2	2	2	2	3	2	2	2	-	3	-	-	2
CO2	Demonstrate knowledge and understanding of the current sustainable development policies followed by selected countries	3	2	2	2	2	2	3	2	2	2	-	3	-	-	2
CO3	Develop an encompassing understanding of sustainability issues	3	2	2	2	2	2	3	2	2	2	-	3	-	-	2
CO4	Depth learning and analysis of factors that support to achieve sustainability and resilience in an individual level and in a community	3	2	2	2	2	2	3	2	2	2	-	3	-	-	2
CO5	Assess the sustainable practices of any community; become critical and proactive thinkers and, with this, successful leaders in the field	3	2	2	2	2	2	3	2	2	2	-	3	-	-	2
Overall CO		**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**-**	**3**	**-**	**-**	**2**

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EN23C03 **EMPLOYABILITY SKILLS LAB** **L T P C**

0 0 4 2

OBJECTIVES

- To equip learners with effective communication skills essential for professional success.
- To foster creativity, critical thinking, problem-solving, leadership skills, and team-building abilities for holistic development.
- To train learners to present logical arguments with supporting evidence in group discussions
- To enable learners to present their ideas on various topics using appropriate audio visual tools before an audience.
- To teach learners effective strategies and professional behaviour to excel in job interviews.

UNIT I COMMUNICATION SKILLS **12**

Official letter writing / Email writing – Email etiquette – Reading and comprehending Job advertisements – Research on company - Job Application – Writing cover letters – Resume writing – Video resume – Using AI tools for resume writing – Advantages and disadvantages in using AI tools.

UNIT II SOFTSKILLS **12**

Introduction to soft skills – Types of soft skills – Importance of soft skills – Strategies for inculcating soft skills - Team building, Problem solving, Critical thinking, Creativity, Decision making, Negotiation, Adaptability, and other soft skills – Social skills

UNIT III PRESENTATION SKILLS **12**

Structure of a presentation – Use of ice breakers – Data collection – Plagiarism, citation, acknowledging the sources – Making PowerPoint slides – Introducing the topic – Data interpretation – Conclusion – Answering questions – Delivering presentations.

UNIT IV GROUP DISCUSSION SKILLS **12**

Watching a group discussion and brainstorming – GD etiquette – Preparation for a GD – Understanding group dynamics – Brainstorming – Politeness strategies – Soft skills used in a GD – GD activities – Mock GD

UNIT V INTERVIEW SKILLS **12**

Types of interviews – Watching sample interviews – Interview activities - Preparation for an interview – Interview etiquette – Body language – Attending job interviews – FAQs in an interview.

TOTAL:60PERIODS

Teaching Methods

Group discussions, lectures, seminar, role play activities, sample videos

Evaluation

Continuous Assessment (Assignment, Seminar)
EndSem Examination

COURSE OUTCOMES

- Demonstrate effective workplace communication by applying appropriate verbal and non-verbal techniques in various professional scenarios.

- Analyze and apply soft skills like critical thinking, creativity, problem-solving, leadership, and team-building skills to effectively address workplace challenges.
- Construct logical arguments with supporting evidence in group discussions and collaborate effectively within a team to achieve common goals.
- Design and deliver professional presentations on various topics, utilizing relevant audiovisual tools.
- Evaluate and practice appropriate interview strategies and behaviors to confidently navigate job interview processes.