GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Chemical Engineering
Subject Code: BE05005031
Subject Name: Petroleum Refining and Petro Chemicals

w.e.f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Basics of Chemical Technologies
Rationale:	Petroleum refining as well as petrochemical industries constitute a major part of chemical sector. Every chemical engineer has to invariably handle the enormous consumption of petroleum products, their diversity and increasing applications. Chemical engineer has to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a safe manner. Beside this, a chemical engineer must be aware about the various properties of petroleum fractions as well as petrochemicals. Hence, this course has been designed to develop such expertise and skills.

Course Outcome:

After Completion of the Course, Students will be able to:

No	Course Outcomes	% of Weightage
01	Define various test properties of crude oil and petroleum products and also explain their physical significance.	20
02	Explain crude oil processing, treatment techniques and cracking reactions taking place in a petroleum refinery.	40
03	Apply acquired knowledge of refinery processing and manufacturing technologies of producing petrochemicals for problem solving.	20
04	Compare various routes of production of widely used petrochemicals.	20

Teaching and Examination Scheme:

Teaching/Learning Scheme in hrs/semester					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Practical			
L	T	P	PBL*	TH	TH/30	ESE (E)	PA (M)	PA (I)	PBL(I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Basics of Petroleum** Role of Crude Oil in Global Economy, Present Scenario of Crude Oil Refinery, Origin(Formation), Composition, Classification and Evaluation of Crude Oil, Crude Assay Analysis, Distillation Characteristics such as TBP, ASTM & EFV etc.	4	9
2	**Properties of Petroleum Products** Types of Gases and their Composition, Types of Gasoline & it's Important Properties and Tests such as ASTM Distillation, RVP, Octane number, Oxidation stability, Sulphur Content etc., Various types of Naphtha and their Important Properties and Application, Important tests and Properties of Kerosene such as Flash & Fire Point, Smoke Point, Aniline Point etc., Types of Diesel & its Important Properties and Tests such as Pour Point, Diesel Index, Cetane Number etc., Heavy Fractions Like Lube Oil, Bitumen, Asphalt etc. and their Important Properties Such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.	6	13
3	**Processing of Petroleum:** Pretreatment of Crude (Dehydration & Desalting), Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU etc	5	11
4	**Treatment Techniques:** Physical Impurities Found in Crude & their Removal, Sweetening Techniques, Production and Treatment of LPG, Gasoline Treatment Such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Various Methods of Treatment of Lubes Such as Phenol Extraction, Furfural Extraction, etc.	6	13

5	**Thermal & Catalytic Cracking:** Necessity and types of cracking. Thermal cracking: Mechanism of Thermal Cracking, Properties of Cracked Materials, Visbreaking, Dubb's Two Coil Process, Delayed Coking, Naphtha Cracking etc. Catalytic cracking: Advantages & Theory of Catalytic Cracking, Fixed Bed, Moving Bed & Fluidized Bed Technology, FCC, Hydrocracking, Catalytic Reforming, Platforming, Continuous Catalyst Regeneration Reforming, Catalytic Polymerization, Catalytic Alkylation, Catalytic Isomerization etc.	9	20
6	**C1 and C2 Petrochemicals:** Methanol, Formaldehyde, Chloromethane etc. Ethylene, Ethylene Dichloride, Vinyl Chloride, Ethylene Oxide, Ethylene Glycol, Ethanol amines etc.	5	11
7	**C3, C4, Aromatics and Polymers:** Propylene, Butadiene, etc. BTX Separation, p-xylene, Styrene, p-terephthalic acid, etc. PVC, LDPE, LLDPE, HDPE, Polypropylene, Polypropylene Co-polymers, Polystyrene, SBR, PBR, Polyesters etc.	10	22

Sustainability alignment: This course addresses with different weightage of SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) by applications of Petroleum Refining and Petrochemicals subject knowledge essential for industrial operations.

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	30	40	20	---	---

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze; E: Evaluate and C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. B. K. Bhaskar Rao, Modern Petroleum Refining Processes, Oxford and IBH 2007.
2. M Gopal Rao, Dryden's Outlines of chemical technology, 3rd Edition East-West press pvt. Ltd, Delhi
3. B.K. Bhaskar Rao, A Text on Petrochemicals, 2nd Edition, Khanna Publishers, Delhi, 1998
4. George Austin, Shreve's Chemical Process Industries, 5th edition McGraw Hill publication – New Delhi.
5. W.L. Nelson, Petroleum Refinery Engineering, McGraw Hill, New York, 1958.
6. James H, Gary & Glenn E. Handwerk, 'Petroleum Refining, Technology & Economics', 4th Edition, Marcel Dekker, Inc, 2001.
7. Speight, J. G., The Chemistry and technology of Petroleum, 5th Edition, M. Dekker, 1991.
8. Watkins, R. N., Petroleum Refinery Distillation, 2nd Edition Gulf Pub. Co., Houston, Tex, 1979.

List of Experiments:

1. To determine the smoke point of a given sample of kerosene by using smoke point apparatus.
2. To determine the flash and fire point of a given sample of oil by using Cleveland Open Cup Tester and Pensky Marten Closed Cup Tester.
3. To determine the softening point of lubricant grease by using softening point apparatus (Ring and ball arrangement).
4. To determine aniline point and diesel index for a given diesel oil sample.
5. To determine Penetration Index of a given grease sample by using an apparatus for Penetration Index (Hollow cone type)
6. To determine the cloud and pour point of the given diesel oil sample by pour point apparatus.
7. To determine quantitatively the boiling range characteristics of petroleum products by ASTM Distillation.
8. To determine the kinematic viscosity and absolute viscosity of the given lubricating oil at different temperatures using Redwood viscometer.
9. To determine the carbon residue of a given sample of petroleum product by the Conradson test method.
10. To determine the carbon residue of a given sample of petroleum product by Ramsbottom test method.
11. To study modern refinery operations.
12. To study petrochemical products.

Major Equipment:

Smoke point apparatus, ASTM Distillation, Redwood viscometer, Cleveland Open Cup, Marten Closed Cup, Softening point Apparatus, Cloud and pour point Apparatus, Ram's bottom Apparatus, Penetration test apparatus

List of Open Source Software/learning website:

1. Video lectures available on the websites including NPTEL lecture series
2. Open access Literature available for Petroleum Refining
3. MIT Open course lecture on Petroleum Refining

List of suggested activities for Problem Based Learning:

Sr. No.	Description	No. of hours	Total Hrs.
1	Assignment writing. Numerical based assignment is preferable.	5 assignments of 1h each.	5
2	Discussion on research paper based on relevant subject. Summarize research paper and evaluation critical parameters	2 research papers can be included. Each one has 5h	10
3	Complex problem solving of real world problem	Study of the problem and solution finding using PRPC knowledge	5
4	Industrial exposure to observe and provide tentative solutions on environment/ health/ any other issue	Duration (5h) for industrial exposure Problem identification and tentative solution (5h)	10
Max. Hours to be allotted			15

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