GUJARAT TECHNOLOGICAL UNIVERSITY
CHEMICAL ENGINEERING (05)
PETROLEUM REFINING AND PETROCHEMICALS
SUBJECT CODE: 2180502
B.E. 8thSEMESTER

Type of course: Chemical Engineering

Prerequisite: Basics of Chemical Process Industries

Rationale: The development of refining and petro-chemical industries in the country has made it compulsory for the chemical engineers to understand important aspects of petroleum refining and petrochemical technology. 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 smooth and 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.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
	PETROLEUM REFINING		
1	**Basic of Petroleum**: Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as TBP,ASTM&EFV, etc.	**06**	**08**
2	**Properties of Crude and Petroleum Products:** Various types of Average Boiling Points of Crude Oil & Petroleum Fractions. ➢ Types of Gases & 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 & Applications. ➢ Important Tests & Properties of Kerosene such as Flash& Fire Point,Smoke Point , Aniline Point etc., ➢ Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc. ➢ Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important	**10**	**14**

	Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.		
3	**Processing of Petroleum**: Pretreatment of Crude (Dehydration & Desalting),Pumping of Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux,ADU & VDU, Topping Operations etc.	**08**	**11**
4	**Treatment Techniques**: Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene, Various Methods of Treatment of Lubes such as Clay Treatment, Phenol Extraction, Furfural Extraction, Dewaxing etc.	**09**	**13**
5	**Thermal & Catalytic Cracking :** Necessity and Types of Cracking **Thermal Cracking:** Mechanism of Thermal Cracking, Properties of Cracked Materials, Vis Breaking, Dubb's Two Coil Process, Delayed Coking, Naphtha Cracking, etc. **Catalytic Cracking:** Advantage & 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.	**09**	**13**
PETROCHEMICALS Physical & Chemical Properties, Various Routes of Production, Manufacturing Processes, Flow Sheets, Thermodynamics & Kinetics Consideration & Major Engineering Problems for following Petrochemicals			
6	**C1 Petrochemicals:** PetrochemicalsObtained from Methanol, Formaldehyde, Chloromethane etc.	**05**	**06**
7	**C2 Petrochemicals :** Petrochemicals obtained from Ethylene, Ethanolamine, Ethylene Dichloride,Vinyl Chloride, Ethylene Oxide, etc.	**08**	**11**
8	**C3 &Aromatic Petrochemicals :** Petrochemicals Obtained from Propylene, ACN, Isopropanol,Cunene, BTX Separation, Phenol, Styrene, Phthalic Anhydride etc.	**08**	**11**
9	**Polymers:** PVC, LDPE, LLDPE, HDPE,Polypropylene, Polypropylene Co-polymers, Polystyrene, SBR, Polyesters, etc.	**09**	**13**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**28**	**7**	**7**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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,3rdEdition East-West press pvt. Ltd, Delhi
3. B.K.Bhaskar Rao, A Text on Petrochemicals, 2ndEdition, Khanna Publishers, Delhi, 1998
4. George Austin, Shreve's Chemical Process Industries,5thEditionMcGraw Hill publication –New Delhi.
5. W.L.Nelson, Petroleum Refinery Engineering, McGraw Hill, Newyork, 1958.
6. James H, Gary & Glenn E. Handwerk, Petroleum Refining, Technology & Economics,
7. 4thEdition, Marcel Dekker, Inc, 2001.
8. Speight, J. G., The Chemistry and technology of Petroleum, 5th Edition, M. Dekker, 1991.
9. Watkins, R. N., Petroleum Refinery Distillation, 2nd Edition Gulf Pub. Co., Houston, Tex, 1979.

Course Outcome:

After learning the course the students should be able to:

- Understandfundamentals of petroleum refinery & various petrochemical plants.
- Characterize & Test various properties of different petroleum fractions.
- Understand scenario of refinery & petrochemical industries.
- Understand manufacturing processes & applications of widely used petrochemicals.

List of Experiments:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects/study reports/latest outcomes in technology study**:-**

PRACTICALS (ANYFIVE):

Sr. No	Name of experiment
1.	To determine the carbon residue of given sample by rams bottom apparatus.
2.	To determine the carbon residue of given sample by conradson apparatus.
3.	To determine the calorific value of given sample by bomb calorimeter.
4.	To determine the viscosity of given sample using engler viscometer at different temperature ranges.
5.	To determine the viscosity of given sample using say bolt viscometer at different temperature ranges.
6.	To determine the flash & Fire point of given oil sample using Cleveland open cup apparatus.
7.	To determine the smoke point of given kerosene (with and without treatment) sample using smoke point apparatus.
8.	To determine the percentage of corrosive sulfur in a given petroleum product using constant temperature bath.
9.	To characterize the given petroleum product (Diesel & Gasoline) by A.S.T.M distillation (To plot A.S.T.M curve).
10.	To find out the flash point of given oil sample using Able's apparatus
11.	To determine the flash and fire point of given sample of oil using Pensky-Martin apparatus.
12.	To determine the softening point & penetration index of Bitumen.
13.	To determine the cloud & pour point of given oil sample.
14.	To determine the aniline point of given sample.

Design based Problems (DP)/Open Ended Problem:

Open ended problems based on following topics can be selected:

- Design of Refinery equipments and its auxiliaries
- Prepare a 3D layout of the entire Refinery starting from the Jetty to Retail market & petrochemical complexes.
- Compare the properties of different grades of Petrol like Regular, Speed, Super petrol etc.
- Determination of physical properties of Petrol-Kerosene and Diesel-blend etc.

Major Equipments:

1. Penskey Martin apparatus:
2. Cleveland Flash and Fire Point apparatus:
3. Ram's bottom apparatus:
4. Conradsonapparatus
5. Cloud and pour point apparatus:
6. ASTM Distillation apparatus:
7. Saybolt Viscometer
8. Engler Viscometer
9. Smoke point apparatus
10. Ring & Ball apparatus
11. Bomb calorimeter
12. Able's apparatus
13. Constant Temperature Bath
14. Aniline Point apparatus

List of Open Source Software/learning website:

- NPTEL lecture series
- Literature available for Petroleum Refining
- MIT Open course lecture on Petroleum Refining

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.