

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM COURSE TITLE: PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY (COURSE CODE: 3350503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5 th semester

1. RATIONALE

The development of refining and petro-chemical industries in the country has made it compulsory for the chemical engineers to get acquainted with important aspects of petroleum refining and petrochemical technology. Every diploma chemical engineer has to invariably handle the vast consumption of petroleum products, their diversity and increasing applications. Diploma holders have to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a smooth and safe manner. These may also helpful in marketing and quality check of petro products. Hence, this course has been designed to develop such competency and skills.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Operate petroleum refinery and petro-chemical plant**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- i. Characterize crude petroleum and petroleum refinery
- ii. Fractionate crude petroleum into useful fractions
- iii. Measure important physical properties of petroleum products
- iv. Apply refinery processes to maximize desired petro products
- v. Use treatment techniques to purify petro products
- vi. Manufacture widely used petrochemicals

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit; ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Petroleum and Refinery	1a. Describe the reserves of Crude Petroleum oil in India 1a.1 State basics occurrence of Petroleum 1a.2 Classify Petroleum 1a.3 Describe history of Petroleum	1.1 Occurrence and history of Petroleum
		1.2 Crude Petroleum oil reserves in India
		1.3 Composition of Petroleum
		1.4 Classification of Petroleum
	1b. Explain basics of refineries and-products 1b.1 State types of Refineries 1b.2 Describe Refinery processes- Physical and Chemical changes	1.5 Refineries development in Gujarat and India
		1.6 Types of Refineries
		1.7 Refinery processes 1.7.1 Physical changes 1.7.2 Chemical changes
		1.8 Refinery products
Unit – II Fractionation of Petroleum	2a. Describe primary treatment of crude	Primary treatment of crude : 2.1 Dehydration and Desalting of crude oil 2.2 Pipe still heater
	2b. Describe distillation of crude and crude residue	2.3 Atmospheric distillation of crude 2.4 Vacuum distillation of crude residue
	2c. Identify Physical properties of petroleum products fractions and measure- (Units of measure)	2.5 Physical properties of petroleum products and its measurements : 2.5.1 Petrol 2.5.2 Diesel 2.5.3 Kerosene 2.5.4 Lubricant oil 2.5.5 CNG and LPG 2.5.6 Grease
Unit – III Refinery Processes	3a. Compare Cracking methods 3a.1 Describe the Purpose of cracking & Effect of temperature and pressure on Cracking	3.1 Cracking 3.1.1 Purpose of cracking 3.1.2 Effect of temperature and pressure on Cracking Cracking methods 3.1.3 Thermal cracking 3.1.4 catalytic cracking 3.1.5 Fluidised bed catalytic cracking
		3.2 Reforming 3.2.1 Purpose of Reforming 3.2.2 Differentiate thermal and catalytic reforming 3.2.3 Platforming(Pt catalyst-Reforming)
	3b. Explain need of Reforming 3b.1 Differentiate thermal and catalytic reforming 3b.2 Identify effect of important parameters on reforming 3b.3 Explain Pt catalyst-Reforming	
		3.3 Other important refinery processes 3.3.1 Hydrotreating 3.3.2 Hydrocracking 3.3.3 Delayed coking 3.3.4 Visbreaking
Unit – IV Treatment Techniques	4a. State the purposes of sulphur removal 4a.1 Explain methods of sulphur removal - Doctor's sweetening, Catalytic desulfurization ,	4.1 Purposes and methods of sulphur removal 4.2 Doctor's sweetening 4.3 Catalytic desulfurization 4.4 MEROX treatment

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	MEROX treatment	
	4b. Explain Treatment of Kerosene by liquid SO ₂ extraction	4.5 Treatment of Kerosene by liquid SO ₂ extraction
	4c. Distinguish solvent extraction processes – Furtural, Phenol, Duo sol	4.6 Solvent extraction processes 4.6.1 Furtural extraction method 4.6.2 Phenol extraction method 4.6.3 Duo sol extraction process
	4d. Describe Purpose of dewaxing 4e. Compare dewaxing Techniques	4.7 Purpose of dewaxing Dewaxing Techniques 4.8 Dewaxing without solvent 4.9 Dewaxing with solvent 4.9.1 Ketone dewaxing and propane dewaxing
Unit – V Petrochemicals	5a. Describe in brief development of petrochemical industry in Gujarat and in India	5.1 Development of petrochemical industry in Gujarat and in India
	5b. Draw flow chart for manufacturing of - C1 compounds- Methanol and Formaldehyde -C2 compounds - Ethylene dichloride ,Vinyl chloride and Ethylene Oxide - C3 compounds- Polypropylene.Propyene oxide -Chemicals from aromatics- Linear Alkyl Benzene Phenol by benzene sulfonate process	5.2 Manufacturing of important C1 compounds 5.2.1 Methanol 5.2.2 Formaldehyde
		5.3 Manufacturing of important C2 compounds 5.3.1 Ethylene dichloride 5.3.2 Vinyl chloride 5.3.3 Ethylene Oxide
		5.4 Manufacturing of important C3 compounds 5.4.1 Polypropylene. 5.4.2 Propylene oxide
		5.5 Chemicals from aromatics 5.6 Manufacture of Linear Alkyl Benzene 5.7 Manufacture of Phenol by benzene sulfonate process

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Petroleum and Refinery	6	4	2	2	8
II	Fractionation of Petroleum	8	4	4	2	10
III	Refinery Processes	10	5	5	3	13
IV	Treatment Techniques	14	6	6	5	17
V	Petrochemicals	18	8	7	7	22
Total		56	27	24	19	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (*outcomes in psychomotor and affective domain*) so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of Course Outcomes related to affective domain. Thus over all development of Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Prepare a detail chart of modern refinery	2
2	I	Prepare a detail chart of petrochemical products	2
3	II	Determine flash point by Penskey Martin method	2
4	II	Determine fire point by Penskey Martin method	2
5	II	Measure softening point and drop point of Grease	2
6	II	Measure Aniline point of lubricating oil	2
7	II	Determine penetration number of Grease	2
8	II	Determine Carbon residue by Ram's bottom method	2
9	II	Determine Carbon residue by conradson method	2
10	II	Measure smoke point of kerosene	2
11	II	Measure cloud point lubricating oil	2
12	II	Measure pour point lubricating oil	2
13	II	Measure initial & final boiling point of any petroleum product	2
14	II	Measure Viscosity of lube oil by Redwood /Saybolt/Engler viscometer	2
Total			28

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

- i. Course/topic based presentation
- ii. Market survey of various petrochemical products of different manufacturers and their comparison based on their specification, composition and cost
- iii. MCQ/Quiz

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

- i. Lecture and demonstration of Animated videos of refinery and petrochemical plant
- ii. Arrange an industrial visit to nearby petrochemical industry
- iii. Mini project

10 SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Modern Petroleum Refining Processes	B. K. Bhaskar Rao	Oxford and IBH, 2007
2	Outlines of chemical Technology	M. Gopala Rao, Marshall Sittig	3 rd Edition East-West press pvt. Ltd, Delhi
3	Shreve's Chemical Process Industries	Austin G.T.	McGraw Hill publication – New Delhi, 5 th edition
4	A Text on Petrochemicals	B.K. Bhaskar Rao	2 nd Edition, Khanna Publishers, Delhi, 1998
5	Petroleum Refinery Engineering	W.L. Nelson	McGraw Hill, Newyork, 1958

B. List of Major Equipment/Materials (With major specifications):

- i. Penskey Martin Apparatus: Electrical heating with gas test jet and electric heater with energy regulator. Assembly is resting in air bath which is covered with dome shape metal top. The cup is fitted with insulated handle and locking arrangement. The round shaped heater with different temperature regulation system suitable for operation on 220 Volts AC mains.
- ii. Cleaveland Flash and Fire Point Apparatus: The apparatus consists of a cup, heating plate, thermometer clip and test flame attachment with swivel joint for passing over liquids.
- iii. Softening point and drop point Apparatus: Ring and Ball Apparatus with electric motorised stirrer and electric heater, concealed hot plate with temperature regulator.
- iv. Drop Point Apparatus - hand operated stirrer, consists of brass sleeve and case with metal cup and a glass boiling tube with cork fitted to a bath (Beaker) is provided.
- v. Penetrometer : A rack, pinion and pointer assembly, dial is graduated from 0-400 in on tenth millimeter sub division. Two samples containers made of Aluminium, round dial fitted on a Aluminium painted stand having adjustable penetration needle, holder sample container and transfer dish.
- vi. Ram's bottom Apparatus: It consists of a solid metal bath having 6 walls to accommodate cocking bulbs with heating elements around the bath, the temperature may be controlled by a Pyrometer depending upon the type supplied, 6 cocking bulbs are supplied with apparatus.
- vii. Conradson Apparatus: The Apparatus consists of Spun Sheet Iron Crucible 25cc capacity, sheet iron hood and sheet iron block on a stand with triangular wire bridge.

- viii. Cloud and pour point Apparatus: It consists of a main cooling bath made of stainless steel sheet and stand unit with drain plug and cover with provision for fitting thermometer and a filling aperture for adding freezing mixture. A glass jar for containing oils, jacket, disc and gasket.
- ix. Distillation Apparatus: The instrument consists of metal shield fitted with asbestos board to support distillation flask with height adjustable device. It has slide for vapour tube and lining having glass window for clear view of inside objects. The condenser bath is provided with Mild Steel black painted stand. Electrically operated on 220 volts AC mains.
- x. Red wood viscometer: Made of stainless steel bath big enough to accommodate 3 cups Redwood No.I and 2 cups of Redwood No.II. Oil cups fitted with Precision jets of Stainless Steel. Temperature is controlled by energy regulator.
- xi. Saybolt Viscometer: Stainless Steel bath with oil cup which is centrally placed in a water bath. The bath has a lid which contains a Water Cooling Tube, Two handle with Two Stirrer Blades, Thermometer socket, Straight heater, Stirring is done by turntable arrangement.
- xii. Engler Viscometer: It consists of Stainless steel water bath having oil cup with double walled lid. The water bath with stirring device mounted on stand. A thermometer clip to the water bath and the oil cup lid has a thermometer socket. The bath is fitted with 500 watts heater. It is supplied with wooden or ebonite valve to fit jet. It can operate on 220 Volts AC mains.
- xiii. Materials: Petrol, Diesel, Kerosene, Lube oil, Grease, Aniline

C List of Software/Learning Websites

- i. www.personal.psu.edu/jun3/blogs/assignments/Oil%20Refinery.pdf
- ii. <http://nptel.ac.in/courses/103103029/pdf/mod2.pdf>
- iii. www.processengr.com/ppt_presentations/oil_refinery_processes.pdf
- iv. http://www.exxonmobil.com/Europe-English/Files/Simple_Guide_to_oil_refining.pdf
- v. http://www.kau.edu.sa/Files/0001216/files/4354_Important%20Petrochemical%20Processes.pdf
- vi. <http://www.kau.edu.sa/Files/0053956/Subjects/Chapter%201%20petro.pdf>
- vii. <http://e-lib.dede.go.th/mm-data/Bib11162.pdf>
- viii. http://chemicalsbestpractices.sap.com/Files/2_SAP_In_The_Chemical_Industry/2_2_Chemical_Subindustries/SAP_Petrochemicals_Overview.pdf
- x. <http://nptel.ac.in/courses/103103029/pdf/mod3.pdf>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. D. H. Joshi**, I/C H. O. D. in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. P. D. Chaudhary**, Lecturer in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. Mrs K. J. Sareriya**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences