

Program Name : Diploma in Chemical Engineering
Program Code : CH
Semester : Sixth
Course Title : Petroleum and Petrochemical Technology (Elective-II)
Course Code : 22611

1. RATIONALE

To operate a plant efficiently, safely and economically every chemical engineering technologist gets acquainted with knowledge of petroleum refining and petrochemical technology. Proper selection of equipment and process improves efficiency of the plant. By learning this subject they can measure performance of various refinery products and select relevant process with safe handling of equipment to obtain desired petrochemical.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Use petroleum and petrochemical plant equipment efficiently.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Identify class of given petroleum sample.
- Use relevant distillation of crude oil to obtain required fraction.
- Apply relevant process to upgrade refinery product.
- Select proper process to manufacture petrochemicals.
- Use Udex process to manufacture aromatics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.



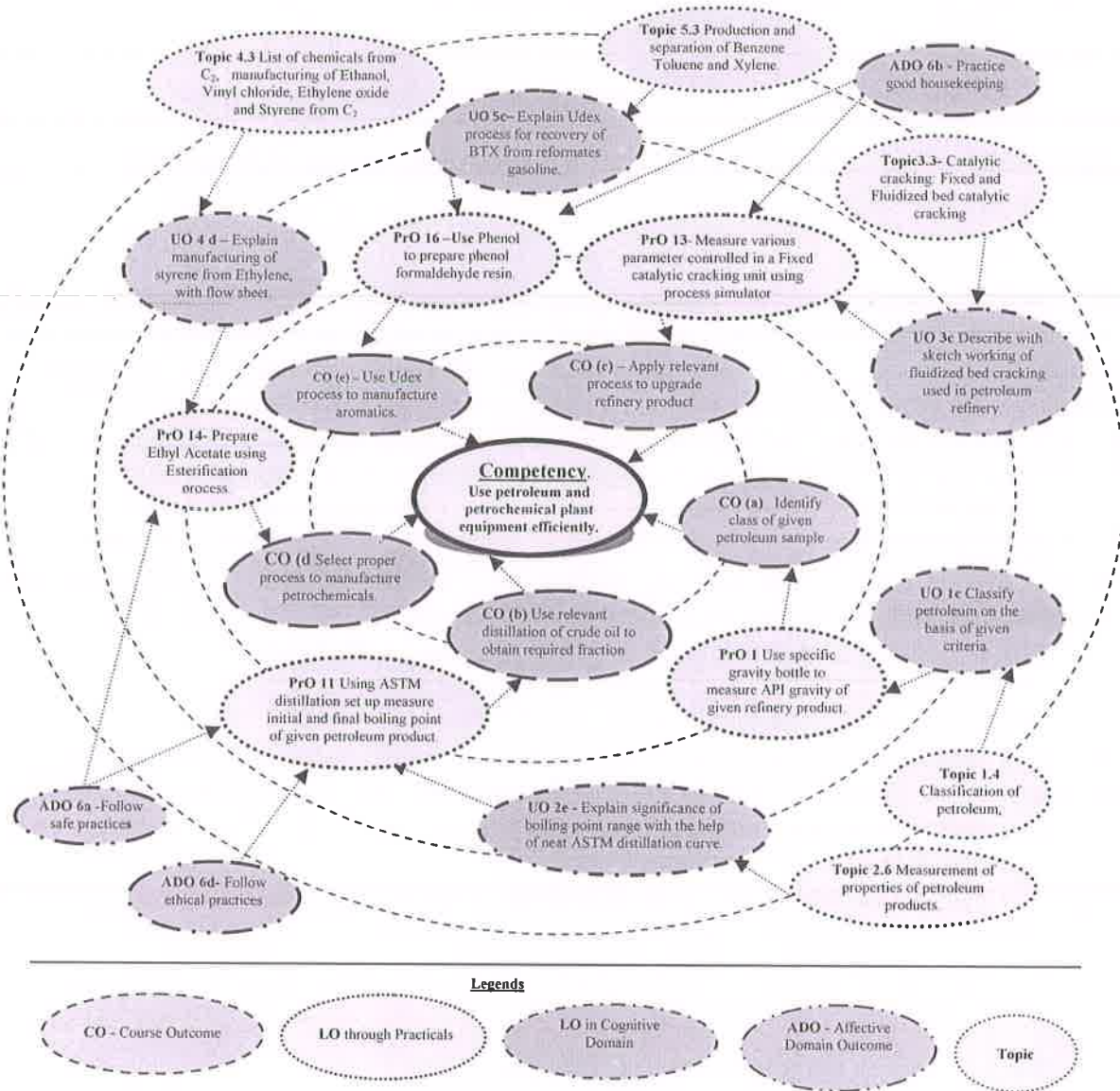


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use the specific gravity bottle to measure API gravity of given refinery product.	I	02*
2	Use the Pensky Marten’s apparatus to determine flash point of kerosene	II	02*
3	Use the Pensky Marten’s apparatus to measure fire point of kerosene.	II	02*
4	Use the Abel’s apparatus to measure flash and fire point of petrol.	II	02
5	Use the cloud and pour point apparatus to determine cloud and pour point of given oil.	II	02*
6	Use the drop point apparatus to measure drop point of given	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	sample.		
7	Use the smoke point apparatus to measure smoke point of kerosene.	II	02*
8	Use the aniline point apparatus to determine aniline point of given sample	II	02*
9	Use aniline point apparatus and gravity bottle to measure diesel index of given sample.	II	02*
10	Use the Conradson apparatus to determine carbon residue of given oil sample.	II	02
11	Use the ASTM distillation set up to measure initial and final boiling point of given petroleum product.	II	02*
12	Use the Draw distillation characteristic curve for given sample using ASTM distillation setup.	II	02
13	Use the process simulator to measure various parameters controlled in a Fixed or Fluidized bed catalytic cracking unit.	III	02*
14	Use the Esterification process to prepare Ethyl Acetate.	IV	02*
15	Use the transesterification process to prepare biodiesel from used oil.	IV	02
16	Prepare Phenol formaldehyde resin using Phenol.	V	02*
	Total		32

Note

- i. A suggestive list of practical Los are given in the above table, more such practical Los can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical/tutorials need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	100

The above PrOs also comprise of the following social skills/ attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/ field based experiences:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Practice energy conservation.



- d) Work as a leader/a team member.
- e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Specific gravity bottle , capacity =10ml/25ml.	1
2	Pensky Marten Flash Point Apparatus: electric heater with temp. regulator. Suitable for operation on 220 Volts 50 cycles AC Circuits.	2,3
3	Abels Flash Point Apparatus: It is supplied with oil cup, cover fitted with stirrer, thermometer socket S.S. Water Bath, Stand. An electric heater is fitted at bottom for range -18°C to +70°C with Refrigeration System	4
4	Cloud & Pour Point Apparatus: glass bath jar, polished brass cylinder mounted on metal tripod base, glass test cylinder, cork bottom disc and top rings, thermometer (H-2600.5F -36° to 120°F) fitted into cork for sealing test cylinder.	5
5	Drop point apparatus: Drop Point apparatus as per IP-132 and ASTM-D-566 20 to 120 Deg, C x 1 Deg, C Or 100 to 230 Deg., C x 1 Deg,	6
6	Smoke point apparatus: as per ASTM /IP standard.	7
7	Aniline Point Apparatus: Power: 10W, Supply Voltage: 220V/50Hz, 01 no. Transformer Unit Electrical heater with variable heat control, Multi-test Verification Material. Spares Kit, glassware. electrically heated with motorized stirrer	8,9
8	Conradson Carbon Residue Apparatus: The apparatus consists of spun sheet iron crucible 25cc Capacity, Sheet Iron hood and sheet iron block on a stand with triangular wire, and gas Burner. Elect heating with separate regulator control.	10
9	ASTM distillation set up as per ASTM standard.	11,12
10	PC with simulation software.	13

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I	1a. State the composition of the	1.1 Petroleum: occurrence and history

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Petroleum and Refinery	specified petroleum product. 1b. Classify petroleum on the basis of given criteria. 1c. Describe with sketches the function of the specified petroleum refinery equipment/ Component. 1d. State the properties of the specified refinery products.	Crude oil reserves in India 1.2 Composition of petroleum and petroleum products 1.3 Classification of petroleum. 1.4 Indian petroleum refinery and the different sections and equipment 1.5 Refinery products.
Unit– II Distillation of crude oil	2a Describe specified treatment of the specified type of crude. 2b Describe with sketches the procedure to measure the specified property (flash point, fire point, cloud and pour point, drop point, smoke point or aniline point) of the specified petroleum product. 2c Explain with sketches the specified type of distillation of crude oil. 2d State major properties of the specified petroleum product. 2e Explain significance of boiling point range for the specified material.	2.1 Primary treatment of crude: Dehydration and desalting of crude. 2.2 Atmospheric distillation of crude. 2.3 Vacuum distillation of crude 2.4 Fractions obtained from crude oil with their boiling range and uses. 2.5 Properties of petroleum products: octane number, cetane number, flash point, fire point, aniline point, pour point, cloud point, drop point, calorific value, carbon residue. 2.6 Pensky Marten's apparatus, Abel's apparatus, cloud and pour point apparatus, drop point apparatus, smoke point apparatus, aniline point apparatus, Conradson apparatus 2.7 Measurement of properties of petroleum products :Gasoline(ASTM distillation set up, specific gravity) Kerosene(flash and fire point , smoke point, aniline point) Diesel(cloud and pour point, aniline point, flash point, viscosity) wax(drop point) Lubricating oil.
Unit III- Processes in Refinery	3a. Explain with sketches the specified type of cracking process 3b. Compare the specified refinery processes based on the given criteria. 3c. Suggest up gradation process for the petroleum product with justification. 3d. Describe with sketches the specified treatment of the waste water from oil refinery.	3.1 Cracking: Definition, types of cracking (thermal and catalytic). 3.2 Thermal cracking: Visbreaking and delayed coking.(Flow sheet and reaction of following) 3.3 Catalytic cracking: Fixed and Fluidized bed catalytic cracking. 3.4 Reforming: catalytic reforming (platforming). 3.5 Hydrogenation, Hydrocracking and Isomerization. 3.6 Alkylation : sulfuric acid and (Hydro fluoric acid) HF alkylation process 3.7 Esterification and Hydration 3.8 Waste treatment: oil removal, organic



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		content removal, solid and hazardous waste treatment.
Unit-IV Petrochemicals (from C₁ to C₃)	4a. Explain the manufacturing of the specified petrochemical of C ₁ /C ₂ or C ₃ with process flow diagram. 4b. State the reaction of the specified petrochemical of C ₁ / C ₂ or C ₃ for its production.. 4c. Draw the flow sheet for manufacturing of specified of C ₁ /C ₂ or C ₃ petrochemical.	4.1 Petrochemical industries in India, List of chemicals from C ₁ , manufacturing of Methanol and Formaldehyde. 4.2 Esterification process 4.3 List of chemicals from C ₂ , manufacturing of Ethanol, Vinyl chloride, Ethylene oxide and Styrene from C ₂ 4.4 List of chemicals from C ₃ , manufacturing of Propylene Oxide and Acetaldehyde.
Unit –V Petrochemicals from C₄ and aromatics	5a. State the chemical obtained from specified fraction of petrochemical C ₄ or aromatics. 5b. Describe with flow sheet the manufacturing of specified of petrochemical C ₄ or aromatics. 5c. Explain with sketch manufacturing of specified petrochemical C ₄ or aromatics. 5d. Explain Udex process for recovery of BTX from the specified reformates gasoline.	5.1 Chemicals from C ₄ and manufacturing of Butadiene and Methyl Tertiary Butyl Ether 5.2 List of chemicals from aromatics 5.3 Production and separation of Benzene Toluene and Xylene. 5.4 Manufacture of aniline from phenol 5.5 Manufacture of benzoic acid from toluene.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Petroleum and Refinery	6	02	02	04	8
II	Distillation of crude oil	12	06	04	08	18
III	Processes in Refinery	12	02	04	12	18
IV	Petrochemicals (from C ₁ to C ₃)	10	02	04	10	16
V	Petrochemicals from C ₄ and aromatics	8	02	02	06	10
Total		48	14	16	40	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Download the videos related to the Petroleum refinery/ petrochemical industry hazards and safety.
- b) Conduct/ participate in MCQ/Quiz
- c) Give seminar on relevant topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b) '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in Lab.
- i) Demonstrate students thoroughly before they start doing the practice.
- j) Encourage students to refer different websites to have deeper understanding of the subject.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:



- a) **Industry visit:** Visit nearby petroleum refinery/ petrochemical industry and prepare the report on manufacturing processes used.
- b) **Collection of sample:** Collect samples of different refinery product and prepare a report based on composition & cost.
- c) **Prepare model:** Prepare a model of crude oil distillation unit using waste material.
- d) **Prepare charts:** Prepare charts showing list of petrochemicals from C₁ to C₂ fraction along with reaction and process.
- e) **Prepare charts:** Prepare charts showing list of petrochemicals from C₃ to C₄ fraction along with reaction and process.
- f) **Chemical Engineering aspects in Petroleum refinery/Petrochemical Industry**
- g) **(Internet based assignment):** Identify a Petroleum refinery/Petrochemical Industry, make the list of product manufactured and make the list of unit operations and unit processes and safety precautions. Identify the job role for a chemical engineer in Petroleum refinery/Petrochemical Industry.
- h) **Preparation of list of fractions obtained from crude oil and their uses:** Prepare list of fractions obtained from crude oil with their boiling point range and uses
- i) Any other micro-projects suggested by course faculty on similar line.

13. SUGGESTED LEARNING RESOURCES :

S. No.	Title of Book	Author	Publication
1	Modern Petrochemical Refining processes	Rao, B. K. Bhaskara	Oxford – IBH Publications, Delhi ISBN:9788120417115
2	Petroleum Refinery Engineering	Nelson, W. L.	McGraw Hill, Newyork ISBN: 9780070855366
3	A Text on Petrochemicals	B. K. Bhaskara Rao	Khanna Publishers, Delhi ISBN- 9788174090444
4	Petroleum Refining Technology and Economics	Gary, James H Glenn E Handwork Mark J Kaisen	CRC Press,USA ISBN -9780849370380
5	Dryden's Outlines of chemical Technology	Rao, M. Gopal. & Sitting, Marshal	East-West Press Pvt. Ltd., Delhi ISBN- 9788185938790
6	Shreve's Chemical Process Industries	Austin G.T.	McGraw Hill India, Pune ISBN - 9781259029455
7	Petroleum Refining Technology	Prasad, Ram	Khanna Publishers, Delhi ISBN- 9788174090645

14. SOFTWARE/LEARNING WEBSITES

- a) **Petroleum Refining Overview:** <http://nptel.ac.in/courses/103103029/pdf/mod2.pdf>
- b) **Composition of crude oil:** <http://www.kau.edu.sa/Files/0053956/Subjects/Chapter%201%20petro.pdf>
- c) **Petrochemical from C1 to C4:** <http://nptel.ac.in/courses/103103029/pdf/mod3.pdf>

