PETROCHEMICAL TECHNOLOGY **Course Code : 316306**

Programme Name/s : Chemical Engineering
Programme Code : CH
Semester : Sixth
Course Title : PETROCHEMICAL TECHNOLOGY
Course Code : 316306

I. RATIONALE

Every chemical engineer learns about petroleum refining and petrochemical technology in order to run a plant effectively, safely, and economically. The appropriate selection of equipment and processes enhances the efficiency of plant. By gaining knowledge of this subject, students will be able to evaluate the performance of a variety of refinery products, choose the appropriate process, and ensure that the equipment is handled safely in order to produce the required petrochemical.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcomes through various teaching learning experiences : Use of specified techniques and operations to enhance the quality of petroleum products and petrochemicals required for the market.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the components of petroleum.
- CO2 - Identify fractions and its properties after fractionation of petroleum.
- CO3 - Use the different refinery processes to enhance the properties of refinery fractions.
- CO4 - Demonstrate the manufacturing of pure chemicals from C1 to C4 chemicals through flow chart.
- CO5 - Use Udex process to separate aromatic hydrocarbons from reformate.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
316306	PETROCHEMICAL TECHNOLOGY	PCT	DSE	3	-	2	1	6	3	03	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain history of petroleum reserves in India. TLO 1.2 Describe exploration of petroleum. TLO 1.3 Compare cable tool and Rotary table drilling method. TLO 1.4 State the Physical properties of petroleum. TLO 1.5 Describe Composition of petroleum. TLO 1.6 List Indian petroleum refineries with their location and capacity. TLO 1.7 List Global crude oil producer countries.	**Unit - I Introduction to Petroleum** 1.1 Overview of petroleum reserves in India 1.2 Exploration methods of petroleum: Seismic method, Gravity method, Magnetic method, Electrical method 1.3 Drilling methods of petroleum: Cable tool method and Rotary table method. 1.4 Physical properties of petroleum: Appearance, API (American Petroleum Institute) gravity and viscosity 1.5 Composition of petroleum: Hydrocarbons, Non-hydrocarbons, Metallic constituents 1.6 Indian petroleum refineries with their location and capacity. 1.7 Global crude oil producer countries (Name only).	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Case Study Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain different methods of dehydration and desalting of petroleum. TLO 2.2 Describe the specified type of fractionation of petroleum with flow diagram. TLO 2.3 Select petroleum fractions with their boiling range, carbon number. TLO 2.4 State the test Properties of petroleum fractions with their significance. TLO 2.5 Sketch the specified petroleum test properties apparatus.	**Unit - II Petroleum Refining** 2.1 Primary processing of petroleum: Methods of dehydration and desaltification (Gravity settling, Chemical treatment, Centrifugal separation and Electric desalter) 2.2 Fractionation of petroleum (Atmospheric and Vacuum): Process flow diagram, Process description 2.3 Petroleum fractions with their boiling range, carbon number and uses. 2.4 Test properties of each petroleum fractions with definition and significance: API gravity, Viscosity, Flash point, Fire point, Aniline point, Smoke point, Pour point, Cloud point, Octane number, Cetane number, Diesel index, Drop melting point of wax, Calorific value, Carbon residue, Penetration index. 2.5 Petroleum test properties apparatus (Sketch only): Redwood viscometer, Flash and fire point apparatus (Pensky-Martens apparatus, Abel's apparatus, Cleveland open cup), Cloud point apparatus, Pour point apparatus, Drop melting point apparatus, Smoke point apparatus, Aniline point apparatus, Conradson carbon residue apparatus.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Case Study Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe specified thermal cracking process with flow diagram and chemical reactions. TLO 3.2 Describe fluidized catalytic cracking process with flow diagram and chemical reactions. TLO 3.3 Describe catalytic reforming process with flow diagram and chemical reactions. TLO 3.4 Describe isomerization process with flow diagram and chemical reactions. TLO 3.5 Describe polymerization process with flow diagram and chemical reactions. TLO 3.6 Describe hydrocracking process with flow diagram and chemical reactions. TLO 3.7 Describe alkylation process with flow diagram and chemical reactions. TLO 3.8 Describe esterification process with flow diagram and chemical reactions.	**Unit - III Petroleum Refinery Processes** 3.1 Thermal cracking: Visbreaking and Delayed coking. 3.2 Catalytic cracking: Fluidized catalytic cracking (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.3 Catalytic reforming process (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.4 Isomerization process (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.5 Polymerization process (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.6 Hydrocracking (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.7 Alkylation: Sulphuric acid process (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 3.8 Esterification process (Flow sheet, Process description, Reactions, and Thermodynamic aspects)	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Case Study Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain specified petrochemicals derived from C1 with flow diagram and chemical reactions. TLO 4.2 Explain specified petrochemicals derived from C2 with flow diagram and chemical reactions. TLO 4.3 Explain specified petrochemicals derived from C3 with flow diagram and chemical reactions. TLO 4.4 Explain specified petrochemicals derived from C4 with flow diagram and chemical reactions.	**Unit - IV Petrochemicals from C1 to C4 chemicals** 4.1 Petrochemical from C1 chemicals (Flow sheet, Process description, Reactions, and Thermodynamic aspects) a) Methanol b) Formaldehyde 4.2 Petrochemical from C2 chemicals (Flow sheet, Process description, Reactions, and Thermodynamic aspects) a) Ethanol from chemical synthesis route (Hydration of ethylene). b) Ethylene oxide. 4.3 Petrochemical from C3 chemicals (Flow sheet, Process description, Reactions, and Thermodynamic aspects) a) Acetaldehyde b) Cumene (Isopropyl benzene) 4.4 Petrochemical from C4 chemicals (Flow sheet, Process description, Reactions, and Thermodynamic aspects) a) Butadiene b) Methyl tertiary butyl ether	Lecture Using Chalk-Board Video Demonstrations Case Study Presentations Site/Industry Visit
5	TLO 5.1 State the Physical properties and industrial applications of specified chemicals. TLO 5.2 Explain Udex process for recovery of BTX from the specified reformates. TLO 5.3 Describe aniline manufacturing process from hydrogenation of nitrobenzene.	**Unit - V Aromatics** 5.1 Physical properties and industrial applications of benzene, toluene, xylene, and ethyl benzene 5.2 Separation of aromatics (benzene, toluene, xylene, and ethyl benzene) from reformate by using Udex process (Flow sheet, Process description, Reactions, and Thermodynamic aspects) 5.3 Aniline manufacturing process from hydrogenation of nitrobenzene.	Lecture Using Chalk-Board Video Demonstrations Case Study Presentations Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure specific gravity of given sample using digital weight balance and then evaluate API gravity.	1	Determination of API gravity of given petroleum sample using density bottle.	2	CO1 CO2 CO4 CO5
LLO 2.1 Measure the time required to collect 50 ml of sample. By using the time, calculate viscosity of given sample at different temperatures.	2	* Determination of viscosity of given petroleum sample at different temperatures using Redwood viscometer.	2	CO1 CO2 CO4 CO5
LLO 3.1 Measure the minimum temperature at which the vapours of given oil will give momentary flash and oil will burn at least for 5 seconds on the application of standard flame.	3	Determination of the flash point and fire point of the given sample using Pensky Martens apparatus.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Measure the minimum temperature at which the vapours of given oil will give momentary flash and oil will burn at least for 5 seconds on the application of standard flame.	4	* Determination of the flash point and fire point of the given sample using Abel's apparatus.	2	CO2
LLO 5.1 Measure the minimum temperature at which the vapours of given oil will give momentary flash and oil will burn at least for 5 seconds on the application of standard flame.	5	Determination of the flash point and fire point of the given sample using Cleveland open cup apparatus.	2	CO1 CO2
LLO 6.1 Measure the maximum height of the flame in millimeter at which the vapours of given oil will burn without giving smoke.	6	* Determination of smoke point of given sample.	2	CO2
LLO 7.1 Measure the minimum temperature at which the equal volume of anhydrous aniline and given oil sample is completely miscible.	7	* Determination of aniline point of the given sample.	2	CO2 CO5
LLO 8.1 Measure the minimum temperature at which oil appears a cloudy nature and ceases to flow.	8	* Determination of cloud point and pour point of the given sample.	2	CO2 CO3
LLO 9.1 LLO 9.1: Measure the weight of carbon residue of given sample on digital balance by evaporating light components from it by means of heating.	9	* Determination of carbon residue of a given sample using Conradson apparatus.	2	CO1 CO2
LLO 10.1 Measure initial and final boiling point of given sample.	10	Determination of the initial and final boiling points of a given sample using ASTM distillation.	2	CO2
LLO 11.1 Measure the minimum temperature at which the wax melts and drop falls within test tube by providing paraffin liquid bath as a heating media.	11	* Determination of drop melting point of wax using drop point apparatus.	2	CO2
LLO 12.1 After the completion of reaction, ethyl acetate layer is washed with water, filter it with filter paper and after drying then measure the yield of ethyl acetate.	12	Synthesis of ethyl acetate from acetic acid and ethyl alcohol using the esterification process.	2	CO3
LLO 13.1 After the completion of reaction, PF resin layer is washed with water, filter it with filter paper and after drying measure the yield of phenol formaldehyde resin.	13	* Preparation of phenol formaldehyde resin.	2	CO3
LLO 14.1 Separate the layer of biodiesel and glycerine by means of separating funnel and then measure the volume of biodiesel layer.	14	* Preparation of biodiesel from used vegetable oil using a transesterification process.	2	CO4
LLO 15.1 Separate benzene-toluene liquid mixture using DWSIM chemical process simulator.	15	Separation of benzene and toluene using DWSIM chemical process simulator.	2	CO1 CO5
LLO 16.1 Measure the API gravity and aniline point of given sample and then calculate diesel index mathematically.	16	* Determination of the diesel index of a given sample.	2	CO1 CO2 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a report on the composition of petroleum.
- Prepare a model of a drilling rig of petroleum.
- Prepare a chart of various refinery fractions based on boiling range, carbon content, and cost.
- Prepare a chart on the properties of petroleum fractions.
- Prepare a chart on Indian petroleum refineries' location and capacity.
- Prepare a model of a petroleum fractionation unit using waste material.
- Prepare a report on the separation of BTX.
- Prepare a chart of petrochemicals derived from C1 to C4.
- Prepare a report on the cost of ten petrochemicals.
- Prepare a report on safety precautions in the petroleum industry.
- Prepare a report on the synthesis of fuel oil from waste engine oil.
- Prepare a report on hazardous waste treatment in the petrochemical industry.
- Visit to the nearby petrochemical industry.
- Make a report on wastewater treatment of the petrochemical industry.
- Visit to nearby petrol pump.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Specific gravity bottle , capacity of 10ml / 25 ml.	1,16
2	ASTM distillation set up as per ASTM standard.	10
3	Drop point apparatus: Drop Point apparatus as per IP-132 and ASTM-D-566 20 to 120 °C x 1°C Or 100 to 230 °C x 1°C.	11
4	Conical flash (500 ml), beaker (500 ml), separating funnel, filter paper, weighing balance, dropper.	12,13,14
5	DWSIM Chemical process simulator	15
6	Redwood viscometer: electronic digital indicator and controller and FHP motor stirrer.	2
7	Pensky Marten Flash Point Apparatus: electric heater with temp, regulator. Suitable for operation on 220 Volts 50 cycles AC Circuits.	3
8	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
9	Cleveland open cup flash point apparatus: as per ASTM standards	5
10	Smoke point apparatus: as per ASTM standards	6

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
11	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	7,16
12	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.	8
13	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.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Petroleum	CO1	8	2	4	4	10
2	II	Petroleum Refining	CO2	10	4	6	8	18
3	III	Petroleum Refinery Processes	CO3	12	2	8	10	20
4	IV	Petrochemicals from C1 to C4 chemicals	CO4	10	2	6	8	16
5	V	Aromatics	CO5	5	2	2	2	6
Grand Total				**45**	**12**	**26**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two Class Test of 30 Marks Each, Term Work Assessment of 25 Marks, and Self learning assessment of 25 marks

Summative Assessment (Assessment of Learning)

- End Term Theory Examination, End Term Practical Examination

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	1	1	-	2			
CO2	3	2	3	3	3	2	3			
CO3	3	2	3	2	2	2	3			
CO4	3	3	2	2	3	2	3			
CO5	3	3	3	2	3	2	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	B. K. Bhaskara Rao	Modern Petrochemical Refining processes	Oxford – IBH Publications, Delhi ISBN:9788120417115
2	B. K. Bhaskara Rao	A Text on Petrochemicals	Khanna Publishers, Delhi ISBN-9788174090444
3	W. L. Nelson	Petroleum Refinery Engineering	McGraw Hill, New York Publications, ISBN: 9780070855366
4	Gary, James H Glenn E Handwork Mark J Kai sen	Petroleum Refining Technology and Economics	CRC Press, USA Publications, ISBN -9780849370380
5	M. Gopal Rao and Sitting, Marshal	M. Gopal Rao and Sitting, Marshal	East-West Press Pvt. Ltd., Delhi Publications, ISBN- 9788185938790
6	Austin G.T.	Shreve's Chemical Process Industries	McGraw Hill India, Pune Publications, ISBN-9781259029455
7	Dr. Ram Prasad	Petroleum Refining Technology	Khanna Publishers, Delhi ISBN-9788174090645
8	Sukumar Maiti	Introduction to Petrochemicals	Oxford - IBH Publications, Delhi ISBN:9788120406636
9	James G. Speight	Handbook of petrochemical processes	CRC Press Publications, ISBN: 10: 1498729703

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc23_ch64/preview https://nptel.ac.in/courses/103105221 https://nptel.ac.in/courses/114106042 https://www.youtube.com/watch?v=Js4cxZRtk5Q https://archive.nptel.ac.in/courses/103/102/103102022/ https://archive.nptel.ac.in/content/syllabus_pdf/103102022.p df http://digimat.in/nptel/courses/video/103107081/L15.html http://kcl.digimat.in/nptel/courses/video/103103220/L19.html https://www.youtube.com/watch?v=az-q9ga5M0g https://www.youtube.com/watch?v=JAZTQhIoEd8 https://www.youtube.com/watch?v=CZCdDpm3SmE https://www.youtube.com/watch?v=LpWRMYgSatw https://archive.nptel.ac.in/courses/103/107/103107082/ https://onlinecourses.nptel.ac.in/noc23_ch46/preview https://archive.nptel.ac.in/courses/103/103/103103217/ https://archive.nptel.ac.in/courses/103/107/103107082/ https://digimat.in/nptel/courses/video/103107081/L27.html http://acl.digimat.in/nptel/courses/video/103107212/L58.html https://www.youtube.com/watch?v=s1N_VhgbWv4	Petrochemical Technology

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students