

Part B

Syllabus Prescribed for B.Sc. Second Year UG Programme

Programme: B.Sc.

Semester -3

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
PCH(3S) –T	Petrochemical Science 3S	84

COs

By the end of the course, the student will be able to:

1. Understand the objectives of conversion processes like cracking & reforming
2. Apply the concepts, mechanism and chemistry involved in the conversion processes
3. Recognizes of process parameters involved in the conversion processes and optimizing process parameters
to control the product composition and product characteristics as per the requirement

Unit	Content
Unit I	<p>Thermal Cracking</p> <ul style="list-style-type: none"> • Introduction to thermal cracking • Mechanism for thermal cracking • Thermal Cracking reactions • Effect of operating variables on cracking • Properties of cracked material • Vis-breaking: operation and description operating conditions and products <p style="text-align: right;">(14 Periods)</p>
Unit II	<p>Thermal Cracking Processes</p> <ul style="list-style-type: none"> • Coking: Delayed and fluid coking • Steam naphtha cracking: Various routes Chemistry, Process parameters, flow scheme. • Composition of pyrolysis products • Break up of ethylene market • Ethylene product tree <p style="text-align: right;">(14 Periods)</p>
Unit III	<p>Catalytic Cracking</p> <ul style="list-style-type: none"> • Introduction to catalytic cracking • Mechanism for catalytic cracking • Reactions in catalytic cracking • Feed stocks and catalytic cracking conditions • Composition and structure of cracking catalysts (Zeolites) • Difference between amorphous silica-alumina and zeolites <p style="text-align: right;">(14 Periods)</p>
Unit IV	<p>Catalytic cracking processes</p> <ul style="list-style-type: none"> • Various cracking processes • Types and working of catalytic processes • Reaction variables and operating modes • Impact of catalyst to oil contact time on selectivity • Houdry fixed bed cracking unit • Modern fluidized bed catalytic cracking unit • Product profile of catalytic crackers • Recovery of propane and propylene from cracked gases • Relative yields of propylene and ethylene from various hydrocarbon feed stocks

	<ul style="list-style-type: none"> Market for propylene Tree diagram of propylene products <p>(14 Periods)</p>
Unit V	<p>Hydro cracking</p> <ul style="list-style-type: none"> Introduction to hydrocracking. Hydrocracking reactions Advantages of hydrocracking Reactions in catalytic hydrocracking Hydrocracking catalysts Process variables Available hydro-cracking processes Hydro-desulfurization. Hydrotreatment and Hydrofining <p>(14 Periods)</p>
Unit VI	<p>Reforming process: recovery and manufacture of aromatics</p> <ul style="list-style-type: none"> Introduction to thermal reforming Introduction to catalytic reforming Reforming feedstock & catalysts Reforming reactions and chemistry involved process flow and description Reaction conditions: effect of temperature and pressure Separation of aromatics from reformat gasoline Udex process for separation of BTX aromatics Separation of Benzene, Toluene, Xylene and ethyl benzene form mixed aromatic stream Separation of mixed xylenes in to their individual isomers <p>(14 Periods)</p>
<p>*SEM-III</p> <ol style="list-style-type: none"> Study of feed composition, its characteristics to find its suitability for conversion process. Selecting catalyst composition for particular conversion process Optimizing process parameters considering feed and product composition & characteristics Visualization of feed treatment and product stream treatment Visualization of separation processes required Planning the best possible use of by-products produced 	
<p>COs:</p> <p>By the end of this module , student will be able to:</p> <ol style="list-style-type: none"> understand and plan the configuration of set of processes to convert residual hydrocarbons to valuable streams separate different refinery streams and find their suitability as a feed stock for different processes-treatment techniques to convert it to high value products/feed stocks 	
**Activities	<p>Class tests, assignments, Flow diagram of processes, Project, Survey, Group discussion, Industrial visit, or any other innovative pedagogical method.</p> <p>Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.</p>

Course Material/Learning Resources

Text books:

- Petroleum refining and Petrochemical. N. K. Sinha, Umesh Publication Delhi
- Advance Petrochemical, Dr. G. N. Sarkar, Khanna Publication, Delhi
- Text on Petrochemical, Dr. B. K. Bhaskararao, Khanna Publication, Delhi
- Introduction to petrochemical, Sukumar Maiti

5. Fuels and combustion, Samir Sarkar,, Orient Longman Ltd. Hyderabad
6. Modern Petroleum Refining Processes, B.K. Bhaskara Rao, Oxford and IBH Publication, New Delhi

Reference Books:

- 1) Chemistry of petrochemical processes 2nd edition by Sami Matar , Lewis F. Hatch Gulf publishing company
- 2) Fundamentals of Petroleum and Petrochemical Engineering by Uttam Ray Chaudhuri CRC press
- 3) Hand book of petroleum Processing Edited by David S. J. “Stan” Jones and Peter R. Pujado Springer
- 4) The Chemistry and technology of Petroleum 4th edition by James G. Speight CRC Press
- 5) Catalyst and chemical process, Ronald Pearcc and William R. Patreson ,Leonard Hill, Glasgow
- 6) Systematic Experimental Physical Chemistry, S. W. Rajbhoj, Dr. T. K. Chondhekar, Anjali Publication, Aurangbad
- 7) Advance Petroleum Refining, Dr. G. N. Sarkar, Khanna Publication, Delhi
- 8) Petroleum Refining technology, Dr. Ram Prasad, Khanna Publication, Delhi
- 9) Unit Operation II, K. A. Gavhane. Nirali Publication, Pune
- 10) Basic Organic Chemistry, Part 5, Industrial Product, J.M. Tedder, A. Nechvatal, and A.H. Jubb, John Wiley, London
- 11) Industrial Organic Chemistry, K. Weissermel, and H. J. Arpe, Veriagchemie, New York
- 12) Chemical From Petroleum, A.L. Waddms, Murry, London
- 13) An Introduction to industrial organic chemistry, P. Wiseman, Applied Science, London
- 14) Modern Petroleum Technology, G. D. Hobson, John Wily, Chichester
- 15) Chemical from Synthesis Gas, R. A. Sheldon, B. Reidel publication company, Dordrecht
- 16) Petroleum Refining Technology & Economics, James H. Gary, Glenn E. Handwerk, Marcel Dekker, Inc.

Weblink to Equivalent MOOC on SWAYAM if relevant:--

Weblink to Equivalent Virtual Lab if relevant:--

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:--

Part B

Syllabus Prescribed for B.Sc. First Year UG Programme

Programme: B.Sc. in Petrochemical Science

Semester -4

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
PCH (4S)-T	Petrochemical Science 4S	84

COs

By the end of course, student will be able to:

1. Understand the role of basic olefins like ethylene, propylene & diolefins like butadiene, isoprene as a building block in the manufacture of various intermediates and consumer commodities
2. Use aromatics like benzene, xylenes a building block in the manufacture of various intermediates and consumer commodities
3. Apply the knowledge of these basic raw materials in manufacturing various petrochemicals of importance in day to day life.
4. Apply various physical and chemical methods of separation and treatments where heat, pressure, catalysts and chemicals may be applied under widely varying process designs, operating conditions, and chemical reactions to convert these building blocks (hydrocarbons) into consumer commodities.
5. Recognize and optimize the various processes and process designs to manufacture the various petrochemicals

Unit	Content
Unit I	<p>Ethylene Derivatives</p> <ul style="list-style-type: none"> • Vinyl Chloride Monomer by direct chlorination of ethylene • Vinyl chloride monomer by oxy-chlorination of ethylene, Market for Vinyl chloride monomer • Manufacture of Vinyl acetate monomer from ethylene and other sources • Role of PdCl₂ and CuCl₂ in VAM synthesis, Application and uses of VAM • Acetaldehyde manufacture through oxidation of ethyl alcohol (Wacker's Process), Market for acetaldehyde • Ethanol manufacture by direction of ethylene (Shell process) Market for ethanol • Ethylene oxide by direct oxidation of ethylene • Ethylene oxide through chlorohydrin process • Comparison between direct oxidation and chlorohydrin routes for ethylene oxide manufacture • Uses of ethylene oxide • Production aspects of ethylene glycol, Market for ethylene glycol • Manufacture , chemistry , properties and uses of ethanol amine <p style="text-align: right;">(14 Periods)</p>
Unit II	<p>Propylene Derivatives</p> <ul style="list-style-type: none"> • Production of propylene oxide through direct oxidation

	<ul style="list-style-type: none"> • Production of propylene oxide by chlorohydrin process • Halcon and oxirane process for propylene oxide manufacture • Properties of propylene oxide like molecular formula, molecular weight, melting point, boiling point, density, solubility, flash point, ignition temperature, explosive limits • Production aspects of Isopropyl alcohol by direct and catalytic hydration of propylene • Sulfuric acid, Veba process, Tokayama, ICI, Taxaco process for Isopropyl alcohol Market for Isopropyl alcohol • Manufacture of acetone from Isopropyl alcohol • Acrylonitrile manufacture by amoxidation of propylene (Sohio process and other routes) Market for acrylonitrile • Acrylamide manufacture with respect to chemistry catalyst and optimum conditions and market <p style="text-align: right;">(14 Periods)</p>
Unit III	<p>Benzene derivatives</p> <ul style="list-style-type: none"> • Chemistry, operating conditions, flow scheme, description and market for the following benzene derivatives • Production of phenol by cumene route • Phenol manufacture through chlorobenzene • Aniline manufacture • Caprolactum preparation <p style="text-align: right;">(14 Periods)</p>
Unit IV	<p>Xylene derivatives</p> <ul style="list-style-type: none"> • Chemistry, operating conditions, flow scheme, description and market for the following xylene derivatives • Terephthalic acid: para-xylene oxidation route, Toray industries process, Lummus process • Di-methyl Terephthalate through para-xylene • Phthalic anhydride from o-xylene and naphthalene Comparison of the o-xylene and naphthalene routes <p style="text-align: right;">(14 Periods)</p>
Unit V	<p>Manufacture and recovery of Butadiene and Isoprene</p> <ul style="list-style-type: none"> • Recovery of butadiene from naphtha steam cracking effluent stream • Dehydrogenation of butane (Houdray process) • Dehydration of ethyl alcohol • Separation of butadiene using technique :selective extraction and extractive distillation • Production of butanol through conventional (Oxo-process) process and BASF process • Relative comparison based on operating parameters catalysts and its uses • Synthesis of isoprene by various routes

	<ul style="list-style-type: none"> • Good-Year Scientific design process , dehydrogenation of tert-amylenes (Shell process) /dehydrogenation of C₅ stream, acetone-acetylene route • Manufacture of adipic acid, sulpholane, chloroprene from butadiene • Chemistry process flow and market for above products <p style="text-align: right;">(14 Periods)</p>
Unit VI	<p>Introduction of Third generation petrochemicals</p> <ul style="list-style-type: none"> • Resin and rubber chemicals • Synthetic detergents:- Introduction, Hard and Soft detergent • Pesticides from Petroleum:- Introduction, Raw materials, Synthesis, and future of pesticides • Organic Dyes :- Introduction, Raw materials, Synthesis, and application • Explosives :- Introduction, Raw materials, Synthesis, and application <p style="text-align: right;">(14 Periods)</p>
<p>*SEM- IV</p> <ol style="list-style-type: none"> 1. Understand the various basic petrochemicals that can be used as basic building blocks to manufacture the various products as per the market requirement. 2. Identify the characteristics of basic raw materials that may act as a basic building block in the manufacture of intermediates 3. Understand the various chemicals and catalysts that may play the important role in conversion of basic raw materials into various consumer commodities 4. Compare various processes to manufacture the particular product and study these processes and find their utility, suitability and sustainability 5. Study the market and demand of consumer commodities 	
<p>COs: By the end of this module student will be able to:</p> <ol style="list-style-type: none"> 1. Understand different processes to manufacture and convert various basic petrochemicals in consumer commodities 2. Apply various economical, environment friendly and sustainable processes to manufacture various products 	
**Activities	<p>Class tests, assignments, Flow diagram of processes, Project, Survey, Group discussion, Industrial visit or any other innovative pedagogical method. Any two activities be conducted from above. Class tests are compulsory. Equal weightage for each activity.</p>

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Weblink to Equivalent Virtual Lab if relevant:--

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Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for First Year UG Programme

Programme: B.Sc.

Semester 3

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	(No. of Periods/Week)
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PCH (3S) Pr

Petrochemical Science

26

COs:

At the end of the Lab/Practical course, the student will be able to:

1. Identify and compare the boiling range of petroleum samples
2. Determine the volatility of petroleum samples
3. Determine the corrosivity of petroleum samples
4. Calculate and compare the unsaturates present in the particular petroleum fraction
5. Calculate the consistency of petroleum samples in terms of kinematic viscosity

*** List of Practical/Laboratory Experiments/Activities etc.**

1	Simple distillation
2	ASTM distillation of Petroleum Sample
3	Reid vapor pressure of volatile petroleum sample
4	Copper strip corrosion test for petroleum sample
5	Viscosity determination of petroleum sample by Redwood method II
6	Determination of kinematic viscosity of petroleum samples
7	Determination of Refractive index of given petroleum sample
8	Determination of Bromine number
9	Determination of Iodine value given sample

Distribution of Marks for Practical Examination

Time : 04 hours (One Day Examination)

Total Practical Marks 50, Duration of Exam 04 Hours	
Internal Practical Exam (25 Marks)	External Practical Exam (25 Marks)
Attendance, Students Performance, Activity, Practical Record Book /Laboratory Manual/Journal Report : 20 Internal Viva/Assignment/Quiz/Test :05	Experiment 1 Performance/Demonstration : 10 Experiment 2 Performance/Demonstration : 10 External Viva (by External and Internal Examiner) : 05
Total : 25	Total : 25

Sant Gadge Baba Amravati University, Amravati

Syllabus Prescribed for First Year UG Programme

Programme: B.Sc.

Semester 4

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	(No. of Periods/Week)
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PCH (4S) Pr	Petrochemical Science 4S	26
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COs:

At the end of Lab/Practical course, students will be able to –

1. Determine the consistency of various petroleum samples in terms of viscosity
2. Determine and identify the composition of coal and its combustion products
3. Understand the carbon formation tendency of petroleum samples
4. Determine the low temperature flow characteristics of petroleum samples

*** List of Practical/Laboratory Experiments/Activities etc.**

1	Viscosity index determination
2	Melting point determination of wax by various method
3	Proximate analysis of coal
4	Determination of carbon residue of lubricating oil using Conradson's apparatus
5	Determination of cloud and pour point of given petroleum sample
6	Preparation of soap
7	Preparation of dyes
8	Ash content in lube oil
9	Biodiesel synthesis

Distribution of Marks for Practical Examination

Time : 04 hours (One Day Examination)

Total Practical Marks 50, Duration of Exam 04 Hours	
Internal Practical Exam (25 Marks)	External Practical Exam (25 Marks)
Attendance, Students Performance, Activity, Practical Record Book /Laboratory Manual/Journal Report : 20 Internal Viva/Assignment/Quiz/Test :05	Experiment 1 Performance/Demonstration : 10 Experiment 2 Performance/Demonstration : 10 External Viva (by External and Internal Examiner) : 05
Total : 25	Total : 25

