

## KIT 356/4 - Chemical Processes

**Course Objective:** To know and understand various chemical processes in the productions of industrial chemicals.

Topic	Content	Number of lecture hours	Expected outcome – upon completion of this course, the student should be able to:
1. Introduction to Industrial Processes; Raw Materials and Energy	<ul style="list-style-type: none"><li>• Role of chemical industries.</li><li>• Products of chemical industries.</li><li>• Inorganic and organic raw Materials.</li></ul>	2	<ul style="list-style-type: none"><li>• Know the availability of supply of natural raw materials.</li><li>• Know the primary products from these materials.</li></ul>
2. Basics of industrial C <sub>1</sub> Syntheses	<ul style="list-style-type: none"><li>• Syn gas.</li><li>• The C<sub>1</sub> units: methanol, formaldehyde, formic acid, hydrocyanic acid, methylamines, chloromethane and chlorofluoromethane.</li></ul>	2	<ul style="list-style-type: none"><li>• Know the generation, purification and use of synthesis gas.</li><li>• Discuss the production of the pure synthesis gas components, CO<sub>2</sub> and H<sub>2</sub>.</li><li>• Discuss the manufacture and use of these C<sub>1</sub> materials.</li></ul>
3. Olefins	<ul style="list-style-type: none"><li>• Olefins via cracking of hydrocarbons.</li><li>• Ethylene, propene, butanes and higher olefins.</li><li>• Acetylene.</li><li>• 1,3-Diolefins.</li><li>• Isoprene.</li></ul>	3	<ul style="list-style-type: none"><li>• Know the manufacturing processes for olefins.</li><li>• Understand the manufacturing processes and their utilization.</li><li>• Discuss the synthesis and utilization of 1,3-butadiene.</li></ul>
4. Synthesis involving Carbon Monoxide	<ul style="list-style-type: none"><li>• Hydroformylation of olefins.</li></ul>	1	<ul style="list-style-type: none"><li>• Explain the chemical basis of hydroformylation &amp; the utilization of 'Oxo' products.</li></ul>

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5. Oxidation Products of Ethylene	<ul style="list-style-type: none"> <li>• Ethylene oxide.</li> <li>• Secondary products of ethylene oxide.</li> <li>• Acetaldehyde.</li> <li>• Secondary products of acetaldehyde.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the synthesis of ethylene oxide.</li> <li>• Discuss the synthesis of ethylene glycol and higher ethylene glycols, polyethoxylates, ethanolamines, ethylene glycol ethers.</li> <li>• Discuss the synthesis of acetaldehyde via oxidation of ethylene and ethanol.</li> <li>• Discuss the synthesis and uses of acetic acid, acetic anhydride and ethyl acetate.</li> <li>• Discuss the Aldol condensation of acetaldehyde and secondary products.</li> </ul>
6. Alcohols	<ul style="list-style-type: none"> <li>• Lower alcohols.</li> <li>• Higher alcohols.</li> <li>• Polyhydric alcohols.</li> </ul>	2	<ul style="list-style-type: none"> <li>• Understand the synthesis and uses of all these alcohols.</li> </ul>
7. Vinyl-Halogen and Vinyl-Oxygen Compounds	<ul style="list-style-type: none"> <li>• Vinyl-halogen compounds.</li> <li>• Vinyl esters and ethers.</li> </ul>	2	<ul style="list-style-type: none"> <li>• Know the synthesis and utilization of vinyl chloride.</li> <li>• Know the synthesis and utilization of vinyl esters and ethers.</li> </ul>
8. Components for Polyamides	<ul style="list-style-type: none"> <li>• Dicarboxylic acids.</li> <li>• Diamines &amp; Aminocarboxylic acids.</li> <li>• Lactams.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the production of polyamides from the polycondensation of diamines with dicarboxylic acids, or of aminocarboxylic acids.</li> <li>• Know the formation of polyamides via ring-opening polymerization of lactams.</li> </ul>
9. Propene Conversion Products	<ul style="list-style-type: none"> <li>• Oxidation products of propene and secondary products of propylene oxide.</li> <li>• Acetone, acrolein and their secondary products.</li> <li>• Allyl compounds and secondary products.</li> <li>• Acrylonitrile and its secondary products.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Understand the synthesis, uses and properties of all the products.</li> </ul>

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10. Aromatics and Derivatives	<ul style="list-style-type: none"> <li>• Importance and production of aromatics.</li> <li>• Conversion processes for aromatics.</li> <li>• Alkylation and hydrogenation products of benzene.</li> <li>• Oxidation and secondary products of benzene.</li> <li>• Nitrobenzene, aniline and diisocyanates.</li> <li>• Phthalic anhydride and terephthalic acid.</li> </ul>	4	<ul style="list-style-type: none"> <li>• Know the sources of feedstocks for aromatics.</li> <li>• Explain the reactions of hydrodealkylation, isomerisation, disproportionation &amp; transalkylation.</li> <li>• Explain the synthesis and uses of ethylbenzene, styrene, cumene, cyclohexane.</li> <li>• Know the production, uses of phenol and its secondary products.</li> <li>• Know the production, uses of maleic anhydride.</li> <li>• Know their syntheses and uses.</li> </ul>
11. Industrial Gases	<ul style="list-style-type: none"> <li>• Air as raw materials.</li> <li>• Components separation via liquefaction and distillation.</li> <li>• Industrial production of carbon dioxide.</li> <li>• Economics of production of industrial gases.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Appreciate and know               <ul style="list-style-type: none"> <li>-air as the important source of various industrial gases and their separation techniques.</li> <li>-other types and productions of industrial gases.</li> <li>-uses and importance of industrial gases.</li> </ul> </li> </ul>
12. Salts and Chlor-Alkali Industries	<ul style="list-style-type: none"> <li>• Sources, types, purification and uses of NaCl.</li> <li>• Electrolysis of brine; types of cell used, separation, purification and storage of products.</li> <li>• Economy and uses of gaseous products.</li> <li>• NaOH and related industries.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the origin, types and various preparations and purifications of NaCl.</li> <li>• Know the major commercial uses of NaCl.</li> <li>• Know the separation process to obtain industrially important chemicals from electrolysis of brine.</li> <li>• Know the various chemical industries related to the products obtained from the electrolysis of brine.</li> </ul>

Topic	Content	Number of lecture hours	Expected outcome – upon completion of this course, the student should be able to:
13. Nitrogen-Based Industries	<ul style="list-style-type: none"> <li>• Sources of nitrogen for the production of ammonia.</li> <li>• Industrial production of ammonia and urea.</li> <li>• Production of nitric acid and inorganic nitrates.</li> <li>• Nitrogen-based fertilizers.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the types and the various sources of feedstocks used in the nitrogen-based industries.</li> <li>• Know the synthesis, major uses and properties of all the products related to nitrogen-based industries.</li> <li>• Understand the economic importance of nitrogen-based industries.</li> </ul>
14. Sulphur-Based Industries	<ul style="list-style-type: none"> <li>• Sources and extraction of elemental sulphur.</li> <li>• Production and uses of sulphuric acid and inorganic sulphates.</li> </ul>	2	<ul style="list-style-type: none"> <li>• Know sulphur as a raw material.</li> <li>• Know the synthesis, uses and properties of all the products related to sulphur-based industries.</li> <li>• Understand the economic importance of sulphur-based industries.</li> </ul>
15. Phosphate- Based Industries	<ul style="list-style-type: none"> <li>• Sources of phosphate.</li> <li>• Production of elemental phosphorus from inorganic phosphates.</li> <li>• Industrial production of phosphoric acid and phosphatic fertilizers.</li> <li>• Uses of phosphorus, phosphoric acid and phosphatic fertilizers.</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the sources and steps of extraction and purification of phosphorus.</li> <li>• Know the synthesis, uses and properties of all the products related to phosphorus-based industries.</li> <li>• Understand the economic importance of phosphate-based industries.</li> </ul>

Topic	Content	Number of lecture hours	Expected outcome – upon completion of this course, the student should be able to:
16. Extractive Metallurgy	<ul style="list-style-type: none"> <li>• Types of ores in extractive metallurgy</li> <li>• Alternatives raw materials</li> <li>• Types of metals extraction</li> <li>• Examples of metal extractions               <ul style="list-style-type: none"> <li>- Industrial processing of iron</li> <li>- Industrial processing of aluminium</li> </ul> </li> <li>• Hydrometallurgical extractions</li> </ul>	3	<ul style="list-style-type: none"> <li>• Know the various techniques applied in obtaining metals from ores and recycled metals with emphasis on specific examples of extraction methods.</li> </ul>
17. Metals and Their Specialty Chemicals	<p>Any two of the following:</p> <ul style="list-style-type: none"> <li>• Silicon and silicon compounds               <ul style="list-style-type: none"> <li>- Production of various grades of elemental silicon</li> <li>- Silicon in electronic industries</li> <li>- Production and uses of silicon and organosilicon compounds</li> </ul> </li> <li>• Tin and tin compounds               <ul style="list-style-type: none"> <li>- Production and Industrial uses of tin and organotin compounds</li> </ul> </li> <li>• Titanium and titanium compounds               <ul style="list-style-type: none"> <li>- Industrial production of titanium and its compounds and their industrial uses</li> </ul> </li> </ul>	6	<ul style="list-style-type: none"> <li>• Know what is termed as the specialty chemicals.</li> <li>• Know their origin and production and purification methods.</li> <li>• Know the productions of the related compounds and specialty chemicals.</li> <li>• Know the uses and importance of specialty chemicals.</li> </ul>
	<b>TOTAL</b>	<b>48</b>	