Petrochemical processes

1. **Course number and name:** 020PPCCS4 Petrochemical processes

2. **Credits, contact hours:** 4 credits, 2x1:15 contact hours

3. **Names of instructors:** Khaled Karaky

4. **Instructional materials:**
   - Course handouts
   - Reference: The chemistry and technology of petroleum; J. G. Speight, 1999

5. **Specific course information**
   a. **Catalog description:**
   Introduction to Chemical Process Industries. Raw material for Organic Chemical Industries. Profile of petrochemical Industry and its structure. Feedstocks: present and emerging. Overview of unit processes with applications, Nitration- nitrobenzene, nitrotoluenes, Halogenation- DCM, MCA, VCM, chlorobenzene. Esterification- C1 to C4 alcohols Production of Olefins and Derivatives, Naphtha and gas cracking for production of olefins. Recovery of chemicals from FCC and steam cracking. Ethylene derivatives: Ethylene Oxide, Ethylene glycol, Vinyl chloride, Propylene and Propylene oxide. Production of Aromatics, Aromatics separation train. Aromatics product Profile-Benzene, Toluene, Xylene, Ethyl benzene &Styrene, Cumene and phenol, Bisphenol, Aniline Unit – V Polymers and Elastomers. Polymers: Polyethylene, Polypropylene, Polystyrene, Polyvinylchloride, polycarbonate, Thermoset resin: phenol formaldehyde, uriaformaldehyde and melamine formaldehyde Elastomers: Styrene Butadiene Rubber (SBR), Poly butadiene, Nitrile rubber Unit – VI Fibers. Polyimides or Nylons (PA), DMT and Terephthalic Acid, Polyester, Acrylic Fiber, Modified Acrylic Fiber, Acrylonitrile, Acrolein, Viscose Rayon and Acetate rayon.

   b. **Prerequisites:** 020CHPCS1 Polymer Chemistry - 020PRPCS3 Refining processes

   c. **Required/Selected Elective/Open Elective:** Required

6. **Specific goals for the course**
   a. **Specific outcomes of instruction:**
   At the end of this course, students should:
   - Acquire the essential concepts of petrochemicals
   - Know the main classes of chemical reactions involved in the petrochemical industry. List the main industrial processes involving each class of reactions
   - Develop basic skills related to the techniques and processes used in the processing of petrochemicals...
   - Become familiar with the processes for obtaining raw materials and monomers: cracking, steam-cracking, etc.

b. PIs addressed by the course:

PI	7.1	7.2
Covered	x	x
Assessed	x	x

7. Brief list of topics to be covered

- Chapter 0: introduction to petrochemicals, petrochemical synthesis, synthetic products, classification of petrochemicals.
- Chapter I: 1. Production of ethylene by cracking.
  2. Major products based on ethylene (production and applications).
  - Oxidation of ethylene (ethylene oxide, ethylene glycol, ethoxylates, ethanolamines, 1,3-propanediol, acetaldehyde, acetic acid, vinyl acetate, poly(vinyl acetate), acrylic acid, polyacrylates.
  - Chlorination of ethylene (vinyl chloride, perchloro and trichloroethylene).
  - Hydration of ethylene (ethanol).
  - Oligomerization of ethylene (alpha olefins, linear alcohols, 1-butene).
  - Alkylation using ethylene
- Chapter II: Propylene and petrochemical products based on propylene (production and applications).
  - Oxidation of propylene (acrolein, acrylic acid)
  - Ammoxidation of propylene (acrylonitrile, propylene oxide)
  - Chlorination of proylene (allyl chloride)
  - Hydration of propylene (isopropanol, acetone)
  - Addition of organic acids to propylene: (Isopropyl acetate, isopropyl acrylate)
  - Hydroformylation of propylene (butyraldehyde)
  - Disproportionation of propylene
  - Alkylation using propylene
- Chapter III: Aromatic compounds. Benzene and its derivatives, toluene and xylene isomers, (BTX).

  1. Reactions and chemicals of benzene :
     - Alkylation
     - Nitration
     - Chlorination
     - Hydrogenation
     - Oxidation
  2. Reactions and chemicals of toluene :
     - Oxidation
     - Dealkylation
     - Disproportionation
     - Chlorination
     - Nitration
     - Carbonylation

3. Reactions and chemicals of toluene :
    - Terephtalic acid
    - Phtalic anhydride
    - Isophtalic acid

- Chapter IV : Methane
    1. Chemicals based on direct reaction of methane;
        - Carbone disulfide
        - Hydrogen cyanide
        - Chloromethane
    2. Synthesis gas
        - Hydrogen
        - Methanol
    3. Reactivity of methanol
        - Formaldehyde
        - Methyl chloride
        - Acetic acid
        - MTBE
        - TAME
        - Methylamine…
- Chapter V : Non-hydrocarbon intermediates:
    - Hydrogen
    - Sulfur
    - Carbon black
    - Synthesis gas
- Chapter VI : Paraffins
    - Ethane
    - Propane
    - butane…

Chapter VII : C4 Olefins and diolefins-Based Chemicals

- 1-Butene
- Isobutene
- Butadiene….