ENGINEERING CHEMISTRY SYLLABUS

Module 1: Chemical Thermodynamics and Kinetics

- Laws of Thermodynamics
    - Entropy change (selected processes)
    - Spontaneity of a chemical reaction
    - Gibbs free energy
    - Heat transfer
- Kinetics
    - Concept of activation energy and energy barrier
    - Arrhenius equation
    - Effect of catalysts
        - Homogeneous
        - Heterogeneous
    - Enzyme catalysis
        - Michaelis-Menten Mechanism

Module 2: Metal Complexes and Organometallics

- Inorganic Complexes
    - Structure
    - Bonding
    - Applications
- Organometallics
    - Introduction
    - Stability
    - Structure
    - Applications of:
        - Metal carbonyls
        - Ferrocene
        - Grignard reagents
- Metals in Biology

    - Haemoglobin
    - Chlorophyll
        - Structure
        - Properties

Module 3: Organic Intermediates and Reaction Transformations

- Organic Intermediates
    - Stability and structure of:
        - Carbocations
        - Carbanions
        - Radicals
- Aromatics and Heterocycles
    - Aromaticity
    - Heterocycles (3, 4, 5, 6 membered and fused systems)
- Organic Transformations
    - Making useful drugs for specific disease targets (two examples)
    - Dyes (addition, elimination, substitution, and cross-coupling reactions)

Module 4: Energy Devices

- Electrochemical and Electrolytic Cells
    - Electrode materials (e.g., semiconductors)
    - Electrode-electrolyte interface
- Chemistry of Energy Storage
    - Li-ion secondary batteries
    - Supercapacitors
- Fuel Cells
    - H_2-O_2 Fuel Cells
    - Solid Oxide Fuel Cells (SOFC)
- Solar Cells
    - Photovoltaic Cells (silicon-based)
    - Photoelectrochemical Cells
    - Dye-Sensitized Cells

Module 5: Functional Materials

- Oxides
    - AB, AB2, ABO3 types (specific examples)
- Composites
    - Types
    - Properties
- Polymers
    - Thermosetting and thermoplastic polymers
    - Synthesis and application (e.g., TEFLON, BAKELITE)
- Conducting Polymers
    - Polyacetylene
    - Effect of doping
- Chemistry of Display Devices
    - Specific to OLEDs
- Nanomaterials
    - Introduction
    - Bulk vs Nano (quantum dots)
    - Top-down and bottom-up approaches for synthesis
    - Properties of Nano Au

Module 6: Spectroscopic, Diffraction, and Microscopic Techniques

- Fundamental Concepts
    - Spectroscopic and instrumental techniques
- Principle and Applications
    - UV-Visible Spectroscopy
    - X-Ray Diffraction (XRD) techniques
        - Numerical problems
- Overview of Various Techniques
    - Atomic Absorption Spectroscopy (AAS)
    - Infrared Spectroscopy (IR)
    - Nuclear Magnetic Resonance (NMR)
    - Scanning Electron Microscopy (SEM)

- Transmission Electron Microscopy (TEM)

Module 7: Industrial Applications

- Water Purification Methods
  - Zeolites
  - Ion-exchange resins
  - Reverse osmosis
- Fuels and Combustion
  - Low Calorific Value (LCV)
  - High Calorific Value (HCV)
  - Bomb calorimeter (numerical problems)
  - Anti-knocking agents
- Protective Coatings for Corrosion Control
  - Cathodic and anodic protection
  - Physical Vapor Deposition (PVD) technique
- Chemical Sensors for Environmental Monitoring
  - Gas sensors
- Overview of Computational Methodologies
  - Energy minimization
  - Conformational analysis