(Time: 3 Hours)   **Total Marks: 80**

N.B.: (1) Question No.1 is compulsory.

       (2) Attempt any **Three** out of remaining questions.

       (3) Assume any suitable data if necessary and indicate it clearly.

       (4) Draw neat sketches wherever required.

       (5) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

Q.1   (a)   List out the activities that process engineer has to carry out during process development.   **(05)**

     (b)   Discuss in brief about different types of heating utilities.   **(05)**

     (c)   Draw and explain control strategy for distillation column.   **(05)**

     (d)   What are the design heuristics related to number of reactor system to be used in process and recycle of reversible by-product during synthesis of process flow sheet?   **(05)**

Q.2   Given the following feed stream at 8 atm and temperature 310 K.   **(20)**

Component (k)	Flowrate (gmol/s)	Vapour Pressure (mm Hg)
n-butane	150	2590
Di-ethyl ether	10	830
n-butanol	5	14
Water	2	46

Design an absorber to recover 80% of the Di-ethyl ether in the liquid stream using water as solvent; find theoretical number of trays, flow rate and composition of liquid and vapour streams leaving the absorber.

Q.3   (a)   Discuss the common features of (i) Chlorination and (ii) Sulphonation Process and develop the PPS for any one process considering any suitable example.   **(15)**

     (b)   Discuss the design heuristics to select between Batch and Continuous Process.   **(05)**

Q.4   (a)   Evaluate minimum hot and cold utility requirement as well as pinch temperature at $\Delta Tmin = 20°C$ for the process streams whose data is given below: **(15)**

MC_p (KW/°C)	T_{in} (°C)	T_{out} (°C)
6	180	60
2	150	30
4	20	135
10	80	140

     (b)   Explain the concept of Pinch temperature and Minimum utility requirement for the process system where multiple hot and cold streams are being cooled and heated simultaneously.   **(05)**

Q.5 (a) What is layer of protective analysis (LOPA) and what are major steps to be **(10)** followed in LOPA ? Explain with one example

 (b) Explain the concept of fire triangle and types of fire and give importance of **(10)** fire safety in a process industry.

Q.6 For any chemical manufacturing process, number of alternative routes may **(20)** exist. With the help of following 5 points, Explain how to select the most feasible route :
(i) Economic analysis
(ii) Environmental foot prints
(iii) Safety aspects
(iv) Controllability
(v) Flexibility.