Total Marks: 80

N.B. 1. **Question No.01 is compulsory**

    2. Attempt any **Three** questions from remaining **Five** questions

    3. Assume suitable data wherever required

1.   Answer the following (Any Four)   20

    a.   Explain in detail the need of safety instrumented system.

    b.   What do you understand by operation phase of safety life cycle? Explain.

    c.   Compare process control system and safety control system.

    d.   A plant has identical solenoid valves, each of which is subjected to an annual function test. Over the course of 15 years, 75 dangerous failures have occurred. What is the failure rate and probability of failure on demand (maximum) for solenoid valves? (Assume there are enough failure for a simple failure rate calculation to be valid).

    e.   What is consequence analysis? What are the factors to be considered for good impact consequence analysis

2.   a.   Explain SIL determination using ALARP method.   10

    b. Explain the following terms with suitable examples:-   10

        i.   Mutually Exclusive Events

        ii.   Non Mutually Exclusive Events

3.   a.   Draw and explain the safety life cycle of IEC-61511.   10

    b.   What is a protection layer? Explain in detail.   10

4.   a.   Explain in detail fault propagation modelling for likelihood analysis.   10

    b.   Write short note on safety instrumented function.   10

5.   a.   Compare SIS technology based on relay system and solid state device system.   10

    b.   Explain the following terms with respect to consequence analysis:-   10

        i.   Hazards

        ii.   Initiating events

        iii.   Intermediate events

        iv.   Incident

        v.   Incident outcome

6.   a.   A process hazards analysis (PHA) has determined that a distillation column   10
can rupture, causing the release of flammable materials and a pool fire. The PHA identified that the initiating event for the column rupture is loss of cooling water, which has been determined with a frequency of 0.5 per year. The layers of protection that can prevent the cooling water loss from propagating into a column rupture include the following:-

Process Design	PFD = 0.01
Operator Response	PFD = 0.2
Pressure Relief Valve	PFD = 0.07
Initiation Probability	PFD = 0.3

Determine the outcome frequency and draw the LOPA diagram.

    b.   Explain in detail the SIL determination using risk graph method.   10