

( 3 Hours )

[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

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a. Draw and explain the block diagram of SIS.

b. Define the following terms:-

i) PFD      ii) RRF      iii) MTTF      iv) MTBF      v) Failure rate

c. Compare demand mode and continuous mode operation of SIS.

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).

2. a. Write short note on "ALARP".

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b. A process incident may result in the breakage of a pipe elbow, which will then allow a mixture of ethane and propane to escape continuously at high velocity. If the release is ignited immediately (5% chance), the incident will result in a jet fire causing \$5 million worth of equipment damage. If the ignition is delayed, the release will result in either a flash fire or vapor cloud explosion. Delayed ignition has a probability of 25%. A flash fire would result in \$850000 of equipment damage, while a vapor cloud explosion would result in \$45 million in equipment damage. The calculations from a very detailed computational fluid dynamics model of the process area and release have yielded an estimate that 15% of the delayed ignition events will result in a vapor cloud explosion rather than a fire. What is the average consequence of this pipe elbow breakage incident? Also draw event tree for the same.

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

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b. Write short note on "Prevention Layers".

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

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b. Discuss the following terms in detail:-

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i. HSE-PES

ii. AIChE-CCPS

TURN OVER

5. a. Explain the following terms with respect to SIS technology:- 10
- Relay system
  - Pneumatic System
- b. Explain in detail the SIL determination using risk graph method. 10
6. a. Draw an event tree and quantify the outcome for overfilling a flammable materials tank. Define the initiating event as the delivery of the flammable material. Events that will determine the potential outcomes include: 10
- The tank may not have enough room to hold the delivery (10%)
  - The operator may not detect that not enough room exists before starting the transfer (5%)
  - The operator may not supervise the transfer and thus will not detect the high level in the tank (15%)
- (Assume an initiating event frequency of 52 times per year.)
- b. Discuss the following terms:- 10
- Complementary event
  - Mutually exclusive event
  - Non mutually exclusive event