UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2020

Course: Hazop & Hazan Technique   Semester: III
Program: M.Tech(HSE)
Course Code:HSFS8003
Time: 03 hrs.   Max. Marks: 100
Instructions: Please read all instructions carefully

SECTION A

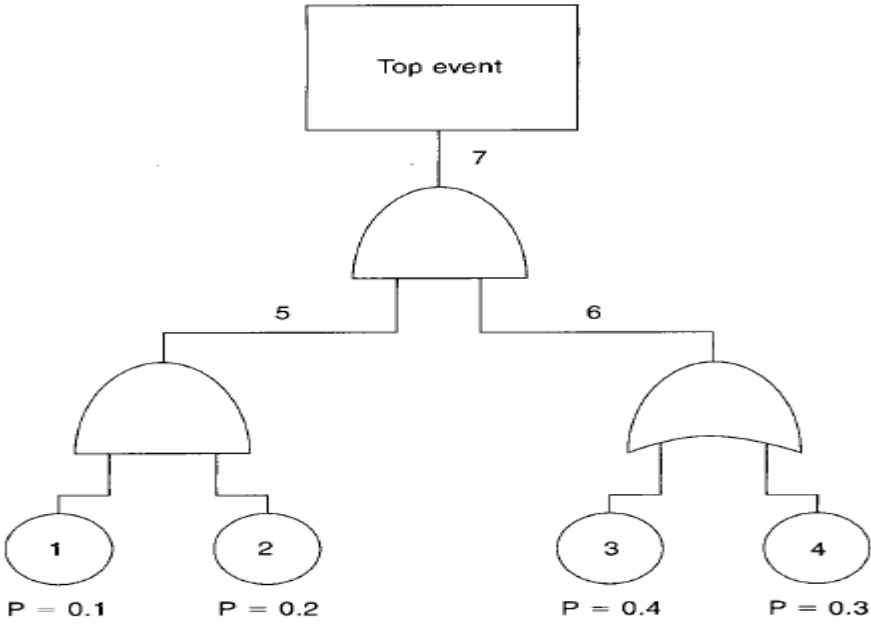1. **Each question carry 10 Marks**
2. **Instruction: Choose the correct answer**

S. No.		CO

Q 1	Describe the following terms in brief:
	
	   i) HAZCHEM
	   ii) IDLH
	   iii) LD 50
		CO1

Q 2	Explain the following terms i) Jet fire ii) Pool fire	**CO1**
Q 3	Explain the classification of Petroleum as per Petroleum Act? Discuss about EPA Compatibility chart for Hazardous chemicals?	**CO1**
Q 4	Describe the salient features of MSIHC rules? Discuss about Accident Investigation process?	**CO1**
Q 5	Fill in the blanks: Major _____ hazards (MAH) installations means - _____ storage and industrial activity at a site handling (including transport through carrier or pipeline) of hazardous chemicals equal to or, in excess of the _____ quantities specified in, Column _____ of schedule _____ and 3 respectively.	**CO1**
Q 6	Briefly explain the accident investigation techniques	**CO2**

SECTION B

3. **Each question carry 10 Marks**
4. **Instruction: Write short/brief notes**

Q 7	Consider a leak of benzene from 0.58 cm orifice-like hole in a tank at a height of 05 meters. If the pressure in the pipe is 100 psig, Evaluate the amount of benzene that would be spilled in 60 minutes? The density of benzene is 879 kg/m^3.	**CO4**
Q 8	In a de-volatilizer, a solvent (60% cyclohexane and 40% pentane) (Material factor of Cyclohexane is 16 and pentane is 21) is removed from a polymer and sent to the solvent recycle section of the plant for treatment and recovery. The de-volatilizer is located in an open structure with good access for firefighting (credit factor =0.94). The process area has a 1% sloping concrete surface with a remote impounding area capable of handling all of a spill and 30 min of fire water. The process is run above the flash point of the solvent at 300 mm	**CO4**

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	Hg. The vessel has a relief device set at 50 psig. Assume a potential spill of 8000 lb of flammable material with a heat of combustion of 19.4 X 103B ~ U J I ~ . The process unit has many loss control features. Take the GPH as 3.17 and PUH as 4.20, Take the damage factor as 0.65(C1=0.7, C2=0.98, C3=0.65) **a**. Determine the Dow F&EI value for this process to estimate the relative degree of hazard. **b.** Assuming an equipment value within the radius of exposure of $1 million, estimate the maximum probable property damage.	
Q 9	Illustrate in detail the layers of protection analysis (LOPA) with suitable example? **OR** Compute the overall failure probability and process Reliability of the above mentioned flow diagram?(P= Failure Probability)	**CO2**
Q 10	Compare the different types of EIA. Critically analyze the procedure for getting Environment clearance for category A projects?	**CO3**
Q 11	A diagram of the safety systems in a certain chemical reactor is shown in Figure 11-5.This reactor contains a high-pressure alarm to alert the operator in the event of dangerous reactor pressures. It consists of a pressure switch within the reactor connected to an alarm light indicator. For additional safety an automatic high-pressure reactor shutdown system is installed. This system is activated at a pressure somewhat higher than the alarm system and consists of a pressure switch connected to a solenoid valve in the reactor feed line. The automatic system stops the flow of reactant in the event of dangerous pressures. Compute the overall failure rate, the failure probability, the reliability, and the MTBF for a high-pressure condition. (Assume a 1-yr period of operation)	**CO5**
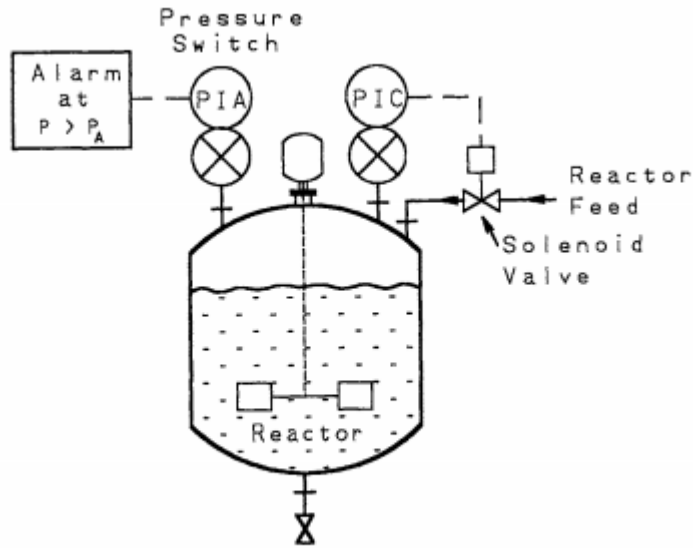
Figure 11-5 A chemical reactor with an alarm and an inlet feed solenoid. The alarm and feed shutdown systems are linked in parallel.

Component	Failure rate μ (faults/yr)	Reliability $R = e^{-\mu t}$	Failure probability $P = 1 - R$
1. Pressure switch 1	0.14	0.87	0.13
2. Alarm indicator	0.044	0.96	0.04
3. Pressure switch 2	0.14	0.87	0.13
4. Solenoid valve	0.42	0.66	0.34

SECTION-C

1. **Each question carry 20 Marks**
2. **Instructions: Write long answer.**

| Q 12 | A coffee maker has a reservoir where a quantity of clean water is poured. A small heater percolates the water up to the top of the coffee maker, where it drips down through the coffee grounds and filter assembly. The coffee product is collected in the coffee pot.

a. Draw a sketch of the coffee machine, and identify the study nodes.
b. Perform a HAZOP study on a common coffee maker. Use as a design objective hot, fresh-brewed coffee in the coffee pot

OR | **CO4** |

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                    ┌──────────────┐
                    │   Explosion  │
                    └──────┬───────┘
                          ╱‾‾‾╲  (OR gate)
            ┌─────────────┘     └──────────────┐
            │                          ┌────────────────┐
        ╭────────╮                     │    Chemical    │
       ╱ Chemical ╲                    │  deflagration  │
      │ detonation │                   └───────┬────────┘
       ╲          ╱                           ╱‾‾‾╲  (AND gate)
        ╰────────╯                 ┌──────────┘     └──────────┐
      μ = 0.1 fault/yr         ╭─────────╮              ╭─────────╮
                              ╱ Flammable ╲            ╱   Open    ╲
                             │   vapor     │          │   flame    │
                              ╲           ╱            ╲           ╱
                               ╰─────────╯              ╰─────────╯
                             μ = 0.2 fault/yr         μ = 10 fault/yr
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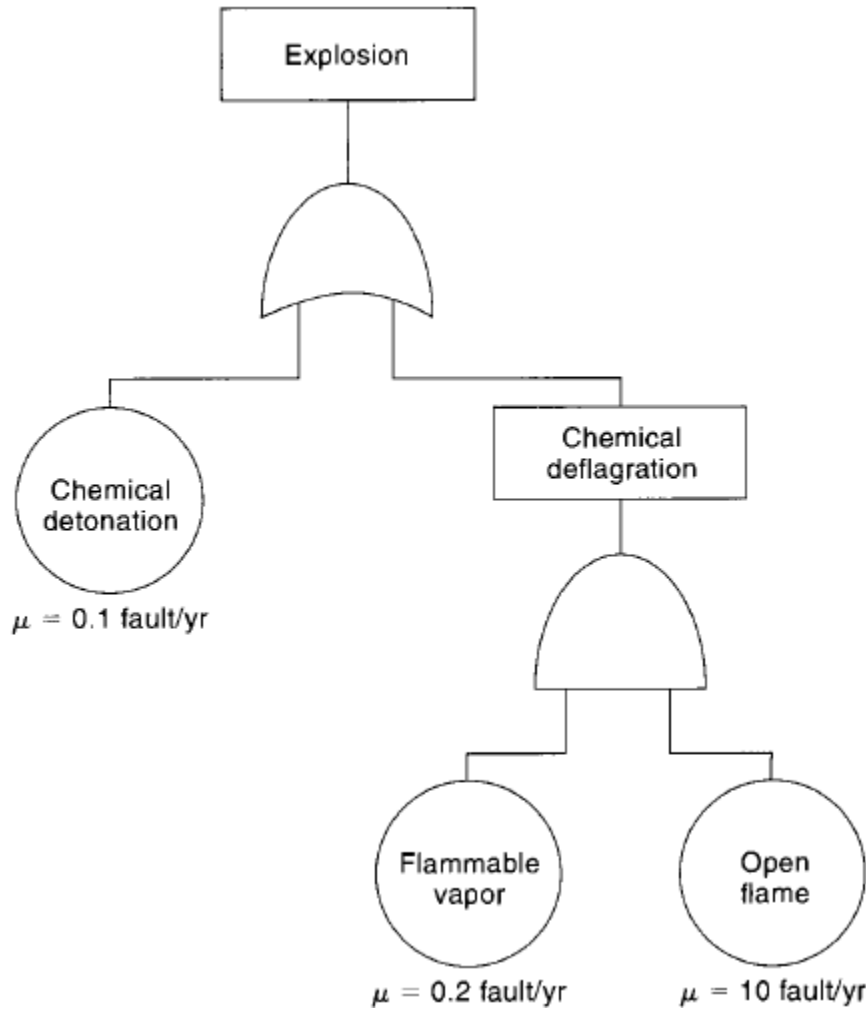
Evaluate the MTBF of the Top event (Explosion) of the system given in the above diagram?