BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
SEMESTER I, 2016-17
CHE F413: PROCESS PLANT SAFETY
COMPREHENSIVE EXAMINATION

Date: 08/12/2016 **Duration: 3 Hrs**
Day: Thursday **Max. Marks: 100**

Instructions:
1. **Take suitable assumption wherever necessary.**
2. **Use separate answer books for Closed/Open book section.**
3. **Start a new answer on a new page.**
4. **Numbers in square bracket to the right indicate marks allotted to that question.**

CLOSED BOOK

Q.1)

A. How will you distinguish a good safety program and an outstanding safety program. **[2]**

B. Noise in an area measures 90 dBA for 2 hr a day, 97 dBA for 2 hr a day, and for the remaining 4 hr there are alternate noise levels of 95 dBA for 10 min and of 80 dBA for 10 min. Does this exposure exceed the permissible limit? **[5]**

Table. 1. Sound Intensity Levels for a Variety of Common Activities[1]

Source of noise	Sound intensity level (dB)
Riveting (painful)	120
Punch press	110
Passing truck	100
Factory	90
Noisy office	80
Conventional speech	60
Private office	50
Average residence	40
Recording studio	30
Whisper	20
Threshold of good hearing	10
Threshold of excellent youthful hearing	0

[1]B. A. Plog, ed., *Fundamentals of Industrial Hygiene,* 3d ed. (Chicago: National Safety Council, 1988), p. 168.

Table .2 Permissible Noise Exposures[1]

Sound level (dBA)	Maximum exposure (hr)
90	8
92	6
95	4
97	3
100	2
102	1.5
105	1
110	0.5
115	0.25

[1]B. A. Plog, ed., *Fundamentals of Industrial Hygiene,* 3d ed. (Chicago: National Safety Council, 1988), p. 176.

Q.2) A storage tank contains propane at 0.95 MPa. Assume the storage pressure is equal to the vapor pressure at 25^{o}C. Calculate the mass flux for a leak in the tank. The following data is known at the given conditions:- Heat of vaporization, ΔH_v (J/kg): 333 kJ/kg; Difference in specific volume between vapor and liquid, v_{fg} (m^3/kg): 0.048; Heat capacity, C_p (kJ/kg K): 2.23.
Derive an expression for the mass flux in the given system in terms of ΔH_v, C_p and v_{fg}. **[15]**

Q.3)

A. Draw a neat schematic of vacuum purge cycle. Also, derive expressions for: **[10]**
   a. Oxidant concentration after '*j*' purge cycles.
   b. Total moles of nitrogen added in each cycle.

B. Discuss the various methods by which charge accumulation can occur in a chemical plant. **[5]**

Q.4)

A. Give your recommendations for specifying relief positions. **[5]**

B. Draw a neat schematic of pressure variations in a reaction vessel on the behavior of runaway reactions, as a function of time for: (a) relieving vapor; (b) relieving froth. **[5]**

Q.5) 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. **[9]**

a. Draw a sketch of the coffee machine, and identify the study nodes.

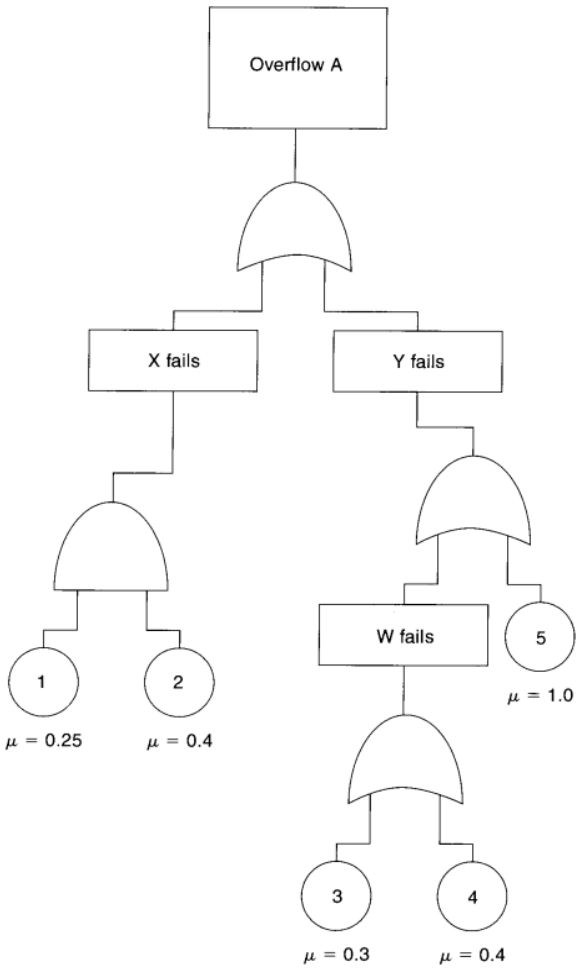
b. Perform a HAZOP study on a common coffee maker. Use as a design objective hot, fresh-brewed coffee in the coffee pot.

Q.6)

A. Derive an expression to show that, on average, for unrevealed failures the process or component is unavailable during a period equal to half the inspection interval. Also draw neat schematics for component cycles for revealed and unrevealed failures. **[10]**

B. What are the major steps of a QRA study? **[5]**

Q.7) Determine P, R, μ, and the MTBF for the top event of the system shown in Figure 1. Also list the minimal cut sets. **[10]**



OPEN BOOK

Q.8) Determine the duration times, in minutes, that a group of 100 people can be exposed to 1500 ppm of carbon monoxide to result in (a) 0% fatalities and (b) 50% fatalities. **[5]**

Q.9) Pumps can be shut-in by closing the valves on the inlet and outlet sides of the pump. This can lead to pump damage and/or a rapid increase in the temperature of the liquid shut inside the pump. A particular pump contains 4 kg of water. If the pump is rated at 1 HP, what is the maximum temperature increase expected in the water in ^{o}C/hr? Assume a constant water heat capacity of 1 kcal/kg/^{o}C. What will happen if the pump continues to operate? **[5]**

Q.10) A lab worker has left an open beaker containing 1.5 liters of carbon disulfide on the desk in his lab office at the end of the workday, and he closed his office door when he left. To save energy, the company turns off the office ventilation systems at the end of the workday. If the CS_2 evaporates, it might form a flammable mixture in air, and an explosion might result if the worker turns the light switch on in the morning. The temperature is 30^{o}C and the ambient pressure is 1 atm. The floor area of the room is 3 m by 3 m, and the ceiling height is 3 m. **[9]**

a. Estimate the resulting concentration of CS_2 in the room, in volume %. Compare to the flammability limit.
b. Estimate the equivalent amount of TNT from the vapor. Make sure you clearly state any assumptions.
c. If the vapor explodes, at what distance is the 3 psi overpressure found?

Data: Physical property data for CS_2 at 30^{o}C:
Vapor pressure: 420 mm Hg; Liquid density: 1261 kg/m^3; Molecular weight: 76.13; Normal boiling point: 46.3^{o}C

************Best of Luck************