UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BCE 4173
COURSE	: PROCESS PLANT SAFETY
SEMESTER/SESSION	: 2-2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Find the suitable term for each situation:

i. A construction site implements strict protocols for the proper use of personal protective equipment (PPE) to prevent injuries.

ii. In a chemical manufacturing plant, the presence of highly reactive substances without proper containment measures poses a significant risk to workers due to the potential for chemical leaks or spills, leading to harmful exposure or even explosions.

iii. A shipping company evaluates the risk of transporting hazardous materials through densely populated urban areas, considering factors such as traffic congestion, potential accidents, and the likelihood of adverse environmental impacts in the event of a spill.

iv. While operating heavy machinery at a construction site, a worker fails to follow safety procedures, resulting in the machine tipping over and causing injury to the operator and damage to surrounding structures.

v. In a laboratory conducting experiments with volatile chemicals, a minor spill occurs during a routine procedure, prompting an immediate response to contain the spill and ensure the safety of personnel and the integrity of the experiment.

(5 marks)

b) Determine OSHA Incident Rate (OSHA IR):

i. In one year, a company with a workforce of 50 employees documented 10 incidents of injuries among its staff.

ii. A company with 10 workers recorded 10 injuries in one year.

iii. A company with 50 workers recorded 10 injuries in 6 months.

(10 marks)

c) A mountain adventure club, with a membership of 1000 individuals primarily employed in the chemical industry, spends an average of 3 hours per day driving and 2 hours per month engaged in hiking activities. Over a span of 10 years, calculate number of fatalities for:

i. hiking accidents if Fatal Accidents Rates (FAR) is 4000
ii. road accidents if Fatal Accidents Rates (FAR) is 57
iii. occupational accidents Fatal Accidents Rates (FAR) is 1.2

(10 marks)

QUESTION 2

a) Inherently safety is a design philosophy that prioritizes the intrinsic safety of systems and processes.

i. Explain the strategies used in inherently safety. (8 marks)
ii. Determine the two examples for each strategy. (8 marks)

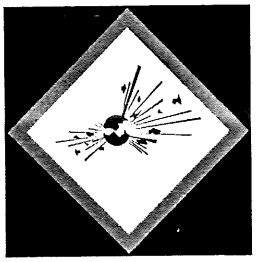
b) Analyse how automobile travel is inherently safer than air travel. (9 marks)

QUESTION 3

a) Pictograms are important in hazard communication. Identify (3) **three** applications for the pictograms below:

i.

ii.



iii.

iv.

v.

(15 marks)

b) The relief system plays a crucial role in process plants due to its significant importance.

i. Explain a relief system and its operational principles. (4 marks)

ii. Give three example of relief used in industry. (3 marks)

iii. Determine the phase of matter for relief valve, safety valve and safety relief valve. (3 marks)

QUESTION 4

a) Serious accidents (such as Bhopal) emphasize the importance of planning for emergencies and of designing plants to minimize the occurrence and consequences of a toxic release. Based on the predictions of toxic release model, analyse **(5) five** options can be made to minimize the occurrence and consequences of a toxic release.

(5 marks)

b) Calculate the reliability, unreliability, overall failure rate and mean time between failures (MTBF) for the water flow control system depicted in Figure 1. Assume a 1-year period of operation.

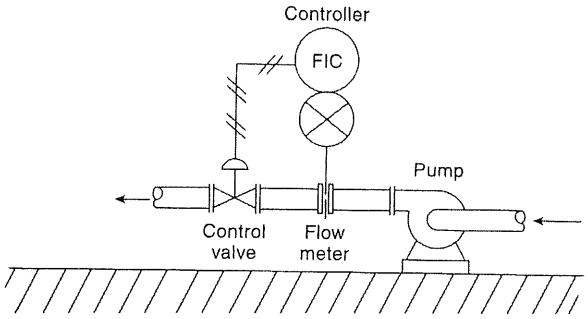


Figure 1: Flow control system. The components of the control system are linked in series.

Table 1: Failure rates

Component	Failure rate μ (faults/yr)	Reliability $R = e^{-\mu t}$	Failure probability $P = 1 - R$
Control valve	0.60	0.55	0.45
Controller	0.29	0.75	0.25
DP cell	1.41	0.24	0.76

(10 marks)

c) A flat tire on an automotive is caused by two possible events, which are driving over debris on the road, such as a nail, and tire failure. Tire failure is caused by either defective tire or a worn tire. Illustrate a fault tree describing the events contributing to a flat tire.

(10 marks)

----------End of question----------

ATTACHMENTS

OSHA Incidents Rates (OSHA IR)

Based on cases per 100 worker years.

$$1 \text{ worker year} = \frac{50 \text{ work weeks}}{\text{yr}} \frac{40 \text{ hrs}}{\text{week}} = 2000 \text{ hrs}$$

100 worker years = 100x2000 = 200,000 hrs worker exposure to hazard

$$\text{OSHA IR(1)} = \frac{\text{Number of injuries/illness/fatalities x } 200000}{\text{Total hrs work by all employees during period covered}}$$

$$\text{OSHA IR(2)} = \frac{\text{Number of lost workdays x } 200000}{\text{Total hrs work by all employees during period covered}}$$

$$\text{FAR} = \frac{\text{Number of fatalities x } 10^8}{\text{Total working hrs by all employees during period covered}}$$

$$R = \prod_{i=1}^{3} R_i$$

$$P = 1 - R$$

$$0.10 = e^{-\mu}$$

$$\text{MTBF} = \frac{1}{\mu}$$