



Name :

Roll No. :

Invigilator's Signature :

**CS/B.Tech(CHE)/SEM-8/CHE-804D/2013
2013**

SAFETY IN CHEMICAL PROCESS INDUSTRIES

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

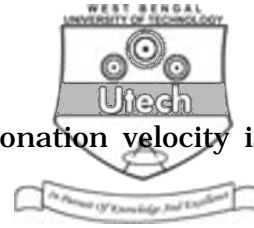
GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :
 $10 \times 1 = 10$
- i) The killer gas which caused Bhopal gas tragedy in 1984 was
 - a) Phosgene
 - b) Carbon monoxide
 - c) Methanol
 - d) Methyl isocyanate.

 - ii) A UVCE is
 - a) same as BLEVE
 - b) a type of fire
 - c) a type of explosion
 - d) a combination of fire & explosion.

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iii) For hydrocarbon-air mixture, the detonation velocity is in the order of

- a) 2000-3000 m/s b) 200-300 m/s
- c) 20-30 m/s d) 2-3 m/s.

iv) Exposure risk concept is defined as

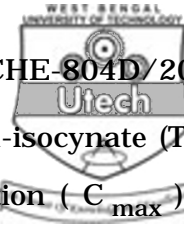
- a) most probable result
- b) frequency of occurrence of hazard
- c) quantitative expression of possible loss
- d) complete accident sequence.

v) The maximum permissible noise level to which a man working in a chemical plant can be exposed for 8 hr/day is dB.

- a) 120 b) 105
- c) 60 d) 90.

vi) Mond index is associated with

- a) Fire b) Explosion
- c) both (a) and (b) d) none of these.



vii) If the vapour pressure of toluene-2, 4-di-isocyanate (TDI) is 35 mm Hg, the maximum concentration (C_{max}) of

TDI in case of leakage or spill will be

- a) 46100 ppm
- b) 4610 ppm
- c) 46 ppm
- d) 4.6 ppm.

viii) Fire triangle consists of

- a) Fuel, oxidizer and source of ignition
- b) Fuel, oxygen and temperature
- c) Coal, oxygen and temperature
- d) Hydrogen, oxygen and source of ignition.

ix) Class D fire means

- a) Fire of solid fuels
- b) Fire of gaseous fuels
- c) Fire of conventional fuels in presence of electrical wiring
- d) Fire that consumes metals.



x) In terms of disaster potential, the principal hazards of chemical process industries can be arranged in ascending order as

- a) Fire < Explosion < Toxic chemical release
- b) Explosion < Fire < Toxic chemical release
- c) Toxic chemical release < Fire < Explosion
- d) Toxic chemical release < Explosion < Fire.

xi) FMECA stands for

- a) Failure modes, effects and causes analysis
- b) Failure modes, effects and criticality analysis
- c) Failure modes and effects analysis
- d) Failure modes and effects corrected analysis.

xii) IDLH means

- a) Immediately dangerous to life or health
- b) Instantaneous death and lethal to health
- c) Intense dark light house
- d) Immune deficiency lethal dose.



GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. Define and distinguish between the following :
 - a) Safety
 - b) Hazard
 - c) Risk in chemical process industries.

3. What do you mean by inherently safe process plant ?
Elaborate the following points : minimize, substitute, moderate & simplify related to inherent safety techniques.

$2 + 3$

4. What are the basic ingredients of a safety programme ?
Discuss them in brief.

5. Briefly describe the hazard identification methods commonly adopted in chemical industry.

6. Write short notes on LOPA.

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GROUP - C
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) What are the several steps for HAZOP analysis ?
- b) Draw a fault tree model of a polymerization reactor which was on fire due to massive vapour solvent release.
- c) The following report has been filed :

Failure of a threaded 1.5" drain connection on a rich oil line at the base of an absorber tower in a large gas producing plant allowed the release of rich oil & gas at 850 psi and 40°F. The resulting vapour cloud probably ignited from the ignition system of engine driven recompressors. The 75' high × 10' diameter absorber tower eventually collapsed across the pipe rack and on two exchanger trains. Breaking pipelines added more fuel to the fire. Severe flame impingement on an 11,000 HP gas turbine-driven compressor, waste heat recovery and superheater train resulted in its near total destruction. Identify the initiation, propagation and termination steps for the accident. $4 + 6 + 5$



8. a) Differentiate between Vapour cloud explosions & BLEVE. 5 + 10
- b) Hierarchy of methods to improve reactive chemical safety (mention different points under inherent, passive, active & procedural methods). 2 + 5
9. a) Write down the general form of probit function. Explain its various terms. 8
- b) A reactor experiences trouble once every 16 months. The protection device fails once every 25 years. Inspection takes place once every month. Calculate the unavailability, the frequency of dangerous coincidences and the mean time between coincidences (MTBC). 8
10. If a building fire occurs, a smoke alarm sounds with probability 0.9. The sprinkler system functions with probability 0.7 whether or not the smoke alarm sounds. The consequences are minor fire damage (alarm sounds, sprinkler works), moderate fire damage with few injuries (alarm sounds, sprinkler fails), moderate fire damage with many injuries (alarm fails, sprinkler works) and major fire damage with many injuries (alarm fails, sprinkler fails). Construct an event tree and indicate the probabilities for each of the four consequences.

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11. Discuss the following concept with respect to control hazards in chemical process plants :



- a) Attenuation
 - b) Intensification
 - c) Substitution.
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