CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	PROCESS SAFETY ENGINEERING
COURSE CODE	:	BNL 40403
PROGRAMME CODE	:	BNL
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY **OPEN BOOK EXAMINATION**

Q1 (a) Safety engineering involves eliminating the initiating step and replacing with the propagation steps with termination events. In general, the safety of the process relies on multiple layers of protection where one of the safety processes is inherent safety. Define inherent safety and list **FOUR (4)** types of inherent safety techniques.

(4 marks)

(b) Major route of exposure is through the skin (topical), lung (inhalation) or gastrointestinal tract (ingestion). Analyze in more details regarding the skin absorption, inhalation and ingestion routes of chemical exposure in the human body and gives **TWO (2)** examples of pollutants that involves for each types of routes.

(12 marks)

(c) Ethics is one of the important aspects in the safety engineering field. Gives exact definition of engineering ethics and **THREE (3)** purpose of applying engineering ethics in the workplace.

(6 marks)

(d) OSHA strongly encourages employers to investigate all incidents in which a worker was hurt including near misses incident. Interpret **THREE (3)** reasons for importance in investigating the workplace incident.

(3 marks)

Q2 (a) Effective controls in safety might protect workers from workplace hazards, avoid incidents; minimize or eliminate safety and health risks; and help employers provide workers with safe and healthful working conditions. Construct the flow of hierarchy control from least effective to most effective control.

(9 marks)

(b) Fire is rapid oxidation of material releasing heat, light and various chemical products. In the chemical process industry, accidents of varying degrees relating to fire explosion continue to occur at a surprisingly high rate. In your own words, express the terms:

(i) Flash point
(ii) Minimum ignition energy
(iii) Adiabatic compression
(iv) Deflagration
(v) Blast Damage

(10 marks)

(c) Calculate LFL and UFL of a gas mixture of 0.8 % hexane, 2.0% methane and 0.5% ethylene by the volume based on **Table Q2 (c),** the mole fraction of the gases mixture.

(6 marks)

Q3 (a) The TLV-TWA for a substances is 150 ppm. A worker begins a work shift at 8 a.m. and complete the shift at 5 p.m. A one hour lunch break is included between 12 noon and 1 p.m., where it can be assumed that no exposure to the chemical occurs. **Table Q3 (a)** shows the data that was taken in the work area at the times indicated. Examine either the worker had exceeded or not the TLV specifications.

(10 marks)

(b) TLV is a level to which it is believed a worker can be exposed to a chemical substances day after day for a working life time without adverse health effects. Discuss the time weighted average (TLV_{TWA}), short term exposure limit (TLV_{STEL}) and ceiling limit (TLV_c).

(7 marks)

(c) A hazard survey can be as simple as an inventory of hazardous materials in a facility or as complicated as a rigorous procedure. Explain the different between Dow Fire and Explosion Index (F&EI) and Dow Chemical Exposure Index (CEI).

(4 marks)

(d) Several incidents are known to occur at a biodiesel plant. Classify several types of hazards in a biodiesel plant that may require use a Personal Protective Equipment (PPE).

(4 marks)

Q4 (a) A survey at biodiesel laboratory UTHM is made and several chemical species are identified such as hydrochloric acid, phenol, sodium hydroxide and benzene. Identify the potential hazard for each of the chemicals.

(8 marks)

(b) A large open tank with a 5 ft diameter contains toluene. Calculate the evaporation rate (Q_m) from this tank. Assuming a temperature of 77°F and a pressure of 1 atm. If the ventilation rate (Q_v) is 3000 ft^3/m, estimate the concentration of the toluene in this workplace enclosure.

(10 marks)

(c) The concept of the dose-response curve is one of the most important parts of pharmacology. There are a few phases charted on a simple x-y axis where the most curves are graphed on a logarithmic scale. Generalize the dose-response curve completely with the critical points.

(7 marks)

Q5 (a) Solve the mixture TLV at 35 °C and 1 atm pressure of a mixture derived from the methanol and benzene liquid. Given the saturation vapor pressure for Methanol and Benzene are 208.41 mm Hg and 142.88 mm Hg. **Table Q5 (a)** shows the mole percent of methanol and benzene.

(10 marks)

(b) Air contains 5 ppm of diethylamine (TLV-TWA of 10 ppm), 20 ppm of cyclohexanol (TLV-TWA of 50 ppm), and 10 ppm of propylene oxide (TLV-TWA of 20 ppm). Examine either the mixture of TLV level been exceeded or not.

(7 marks)

(c) A hazard and operability study (HAZOP) is a structured and systematic examination of a complex planned or existing process. Briefly describe the types of HAZOP in process safety engineering fields.

(8 marks)

- END OF QUESTIONS –

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Table Q2 (c): Volume an mole fraction for hexane, methane and ethylene.

	Volume (%)	Mole fraction on combustible basis	LFL_1 (vol.%)	UFL_1 (vol. %)
Hexane	0.8	0.24	1.1	7.5
Methane	2.0	0.61	5.0	15
Ethylene	0.5	0.15	2.7	36
Total combustibles	3.3			
Air	96.7			

Table Q3 (a): Data for worker exposure

Time	Concentration (ppm)
8.01 a.m.	185
9.17 a.m.	240
10.05 a.m.	270
11.22 a.m.	230
12.08 p.m.	190
1.06 p.m.	150
2.05 p.m.	170
3.09 p.m.	165
4.00 p.m.	160
5.05 p.m.	130

Table Q5 (a): Mole percentage of methanol and benzene

Component	Mole Percent	Species TLV (ppm)
Methanol	50	200
Benzene	50	10