UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	PROCESS SAFETY ENGINEERING
COURSE CODE	:	BNL 40403
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
PROGRAMME CODE	:	BNL
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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

(5 marks)

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

(12 marks)

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

(5 marks)

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

(3 marks)

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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 effectives control.
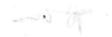
(9 marks)

(b) Fire is a rapid oxidation of material releasing heat, light and various chemical products. In the chemical process industry, accidents of varying degrees relating with 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) What is the LFL and UFL of a gas mixture of 0.8 % hexane, 2.0% methane and 0.5% ethylene by the volume? Given **Table Q2 (c)** the mole fraction of the gases mixture.

(6 marks)

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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 were taken in work area at the times indicated. Discuss has the worker exceeded the TLV specifications?

(10 marks)

(b) TLV is a level to which it is believed a worker can be exposed of a chemical substances day after day for a working life time without adverse health effects. Define 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 differences between Dow Fire and Explosion Index (F&EI) and Dow Chemical Exposure Index (CEI).

(4 marks)

(d) Several incidents are known to occurred at biodiesel plant. Discuss 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. Estimate 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. Sketch the dose response curve completely with the critical points.

(7 marks)

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Q5   (a)   Determine the mixture TLV at 35 ℃ 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). What is the mixture of TLV-TWA and has this level been exceeded?

(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 QUESTION –

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

	Volume (%)	Mole fraction on combustible basis	LFL_i (vol.%)	UFL_i (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