UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER 1
SESI 2012/2013

NAMA KURSUS	:	KEJURUTERAAN KESELAMATAN DAN PENYELENGGARAAN
KOD KURSUS	:	DAM20702
PROGRAM	:	2 DAM
TARIKH PEPERIKSAAN	:	OKTOBER 2012
JANGKA MASA	:	2 ½ JAM
ARAHAN	:	JAWAB **EMPAT (4)** SOALAN SAHAJA DARI **LIMA (5)** SOALAN *ANSWER **FOUR (4)** QUESTIONS ONLY FROM **FIVE (5)** QUESTIONS*

KERTAS SOALAN INI MENGANDUNGI ENAM BELAS (16) MUKA SURAT

SOALAN DI DALAM BAHASA MELAYU

S1 (a) Satu bahan kimia mempuyai nilai TLV-TWA = 180 ppm, TLV-STEL = 200 ppm, dan TLV-C = 310 ppm. Seorang pekerja bertugas di dalam satu syif bermula pada pukul 8.00 pagi dan berakhir pada 5.00 petang. Satu jam masa rehat diberikan dari pukul 1.00 hingga 2.00 petang. Dalam tempoh masa rehat, tiada dedahan kepada bahan kimia dialami oleh pekerja tersebut.

Satu pemeriksaan bahaya dijalankan di dalam tempat kerja tersebut dengan data dedahan ditunjukkan seperti di dalam **JADUAL S1**.

(i) Tentukan nilai TLV bagi bahan kimia tersebut.

(ii) Adakah nilai dedahan tersebut masih dibenarkan? Nyatakan alasan anda.

(13 Markah)

(b) Terdapat 3 unit proses dalam sebuah loji. Setiap unit mempunyai FAR bernilai 0.5, 0.3, 1.0 masing-masing.

(i) Tentukan FAR keseluruhan untuk loji tersebut dengan mengandaikan pekerja terdedah kepada ketiga-tiga unit secara berterusan.

(ii) Andaikan setiap unit adalah saling berjauhan, di mana kemalangan di sesuatu unit tidak memberi kesan kepada unit lain. Tentukan FAR keseluruhan sekiranya pekerja menghabiskan 20% daripada masa kerja dalam unit 1, 40% dalam unit 2 dan 40% dalam unit 3.

(12 Markah)

S2 (a) Nyatakan perbezaan antara api dan letupan. Lakarkan rajah "segitiga api" dan berikan 2 contoh bagi setiap satu komponen.

(10 Markah)

(b) Bandingkan proses mengosong dan juga mengisikan tangki bahan mudah terbakar menggunakan "gambarajah kebolehbakaran". Terangkan perbezaan ini dengan lengkap.

(10 Markah)

(c) Nyatakan maksud "UFL" dan "LFL". Bagaimanakah kedua-dua faktor ini mempengaruhi sesuatu keadaan kebolehbakaran?

(5 Markah)

S3 (a) Untuk mencegah limpahan bendalir, sebuah tangki penyimpanan seperti dalam **RAJAH S3** dilengkapi dengan satu sistem kawalan aliran dan satu sistem penutupan (shutdown) paras tinggi. Sistem penutupan paras tinggi ini mempunyai satu injap solenoid yang berguna untuk menghentikan aliran bahan suapan jika sistem kawalan aliran gagal berfungsi. Sistem kawalan aliran terdiri daripada satu pengukur aliran, kawalan penunjuk aliran (FIC) dan satu injap kawalan (CV). Sistem penutupan paras tinggi terdiri daripada satu injap solenoid dan satu pengawal penunjuk paras (LIC).

(i) Kira kebarangkalian kadar kegagalan (P) dan keboleharapan (R) bagi setiap komponen.

(ii) Bina satu fault tree dengan kejadian paling atas adalah "Tangki penyimpanan melimpah".

(iii) Tentukan bila sistem kawalan aliran perlu diselenggara selepas masa pemasangan.

(iv) Berapa kali dalam setahun keseluruhan sistem dijangka gagal berfungsi?

(20 Markah)

(b) Berapa nilai FAR bagi sebuah industri yang mempunyai 3 kadar kematian per tahun per 100,000 pekerja?

(5 Markah)

S4 (a) Persamaan probit bagi kadar kematian akibat dedahan radiasi haba bagi suatu loji janakuasa adalah seperti di bawah:

$$Y = -14.9 + 2.56 \ln \left(\frac{tI^{\frac{4}{3}}}{10^4} \right)$$

di mana I adalah intensiti radiasi (W/m^2) dan t adalah masa dedahan (s).
Rujuk **JADUAL S4 (a)**.

(i) Berapa peratus pekerja yang dianggarkan akan mati sekiranya mereka terdedah pada kadar radiasi 15,000 W/m^2 dalam 1 minit?

(ii) Berapa masa dedahan maksimum yang boleh menyebabkan 10% daripada populasi pekerja tersebut mati dengan mengambilkira bahawa kadar radiasi adalah sama seperti soalan (i).

(10 Markah)

(b) Data pengukuran bagi Hexane adalah merujuk kepada **JADUAL S4 (b)**.

(i) Terbitkan persamaan stoichiometri bagi bahan kimia ini.

(ii) Bandingkan data pengiraan untuk LFL dan UFL Hexane dengan data pengukuran yang telah disediakan.

(15 Markah)

SOALAN DI DALAM BAHASA INGGERIS

Q1 (a) A chemical substance has the values of TLV-TWA = 180 ppm, TLV-STEL = 200 ppm, dan TLV-C = 310 ppm. A worker works in a shift starting from 8.00 a.m. in the morning and ends at 5.00 p.m. One hour break is allocated for rest from 1.00 until 2.00 pm. During break time, there is no chemical substance exposure. **TABLE Q1** shows the data resulting from a measurement of the concentration level of the substance.

(i) Determine TLV value for the chemical substance.

(ii) Is the concentration level is still permissible? State your reason.

(13 Marks)

(b) Three process units in a power plant. The unit have FAR's of 0.5, 0.3 and 1.0 respectively.

(i) What is the overall FAR for the plant, assuming worker exposure to all three units simultaneously?

(ii) Assuming now that the unit far enough apart, that an accident in one unit would not affect the workers in another. Determine overall FAR if a worker spends 20% of his time in process area 1, 40% in process area 2 and 40% in process area 3.

(12 Marks)

Q2 (a) State the different between fire and explosion. Draw "fire triangle" diagram and give 2 examples for each related component.

(10 Marks)

(b) Compare between the process of "taking vessel out of service" and "bringing vessel into service" using "Flammability Diagram". Explain the difference clearly.

(10 Marks)

(c) Explain definition of "UFL" and "LFL". How these two factors influence the flammability condition?

(5 Marks)

Q3 (a) To prevent liquid overfilling, the storage tank as shown in **FIGURE Q3** is equipped with a flow control system and a high-level shutdown system. The high-level shutdown system has a solenoid valve that stops the flow of feed stock if the flow control system fails to function. The flow control system consists of a flow meter, a flow indicator controller (FIC) and a control valve (CV). The high-level shutdown system consists of a solenoid valve and a level indicator controller (LIC).

(i) Calculate the failure rate probability (P) and the reliability (R) of each component.

(ii) Develop a fault tree for the top event of "storage tank overflow".

(iii) Determine when the flow control system shall be maintained after installation.

(iv) How often will the entire system expected fail to function in a year?

(20 Marks)

(b) What is FAR value for the industry with 3 fatalities rate per year per 100,000 workers?

(5 Marks)

Q4 (a) The probit equation for fatalities resulting from exposure to thermal radiation at a power plant as below:

$$Y = -14.9 + 2.56 \ln \left(\frac{tI^{\frac{4}{3}}}{10^4} \right)$$

where I is the intensity of radiation (W/m^2) and t is the exposure time (s).
Refer to **TABLE Q4 (a)**.

(i) What percentage of the exposed worker predicted to be death if they were exposed to 15,000 W/m^2 for 1 minute?

(ii) What would be the maximum exposure time to ensure 10% of the exposed worker population is killed at the same level of radiation as question (i)?

(10 Marks)

(b) Measurement data for Hexane as stated in **TABLE Q4 (b)**.

(i) Derive stoichiometric equation for this chemical substance.

(ii) Compare calculation value of LFL and UFL with the measurement data.

(15 Marks)

Q5 (a) A study have been conducted at a chemical industry related to Ammonia concentration level to 500 workers. According to normal working hours (8 hour/1shift), data for time period and concentration exposure level could be referred to **TABLE Q5 (a)**. For calculation refer to **TABLE Q5 (b)** and **TABLE Q5 (c).**

(i) How many deaths will be expected?

(ii) Calculate the 'TWA concentration' if the TLV for Ammonia itself is 2,000 ppm.

(iii) Is it the worker overexposed? State the reason why.

(20 Marks)

(b) Differentiate 2 major roles between OSHA and NIOSH in safety engineering and maintenance in Malaysia.

(5 Markah)

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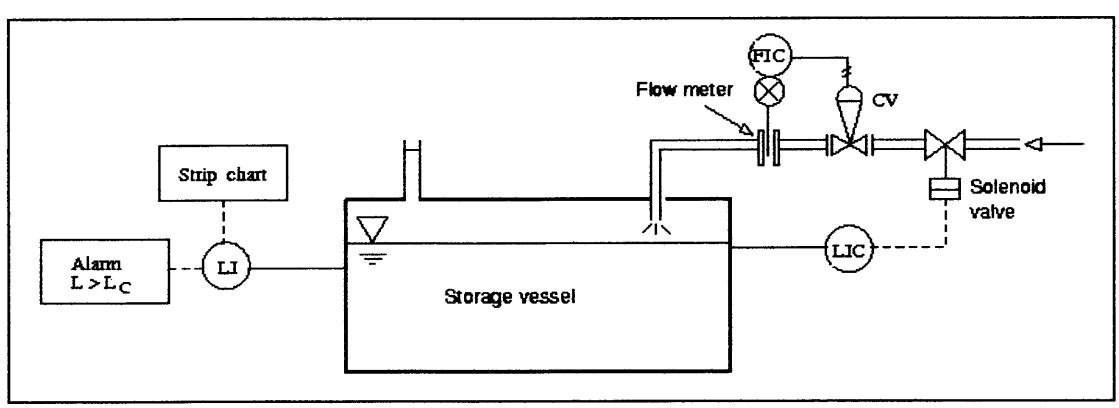
JADUAL S1 / TABLE Q1

Time	Concentration [ppm]
8.00	189
8.15	190
9.15	195
10.00	240
11.30	230
12.30	210
13.15	210
13.45	170
14.30	190
15.00	200
17.10	190



RAJAH S3 / FIGURE Q3

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JADUAL S4 (a) / TABLE Q4 (a)

%	0	1	2	3	4	5	6	7	8	9
0	-	2.67	2.95	3.12	3.25	3.36	3.45	3.52	3.59	3.66
10	3.72	3.77	3.82	3.87	3.92	3.96	4.01	4.05	4.08	4.12
20	4.16	4.19	4.23	4.26	4.29	4.33	4.36	4.39	4.42	4.45
30	4.48	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.69	4.72
40	4.75	4.77	4.80	4.82	4.85	4.87	4.90	4.92	4.95	4.97
50	5.00	5.03	5.05	5.08	5.10	5.13	5.15	5.18	5.20	5.23
60	5.25	5.28	5.31	5.33	5.36	5.39	5.41	5.44	5.47	5.50
70	5.52	5.55	5.58	5.61	5.64	5.67	5.71	5.74	5.77	5.81
80	5.84	5.88	5.92	5.95	5.99	6.04	6.08	6.13	6.18	6.23
90	6.28	6.34	6.41	6.48	6.55	6.64	6.75	6.88	7.05	7.33
%	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
99	7.33	7.37	7.41	7.46	7.51	7.58	7.65	7.75	7.88	8.09

JADUAL S4 (b) / TABLE Q4 (b)

Material	Formula	Tenaga letupan (kJ mol)	Haba pembakaran (kJ mol)	Flammability limit (vol.% in air)		Flash point temperature (°C)	Autoignition temperature.AIT (°C)
				Lower	Upper		
Hexane	C_6H_{14}	-4030.3	-4194.5	1.2	7.5	-230.0	487
Methane	CH_4	-818.7	-890.3	5.3	15.0	-222.5	632
Ethane	C_2H_6	-1468.7	-1599.8	3.0	12.5	-130.0	472
Propane	C_3H_8	-2110.3	-2219.9	2.2	9.5	-104.4	493
Butane	C_4H_{10}	-2750.2	-2877.5	1.9	8.5	-60.0	408
Pentane	C_5H_{12}	-3389.8	-3536.6	1.5	7.8	-40.0	579
Acetylene	C_2H_2	-1236.0	-1299.9	2.5	80.0	-17.8	305
Benzene	C_6H_6	-3210.3	-3301.4	1.4	7.1	-11.1	740
Toluene	C_7H_8	-3835.1	-3947.9	1.4	6.7	4.4	810
Hydrogen	H_2	-237.4	-285.8	4.0	75.0	-	572
Ammonia	NH_3	-339.7	-382.6	15.0	28.0		651
Methanol	CH_4OH	-707.8	-764.0	7.3	36.0	12.2	574
Carbon monixide	CO	-	-	12.5	74	-	-

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JADUAL S5 (a) / TABLE Q5 (a)

No.	Time (hr)	Concentration (ppm)
1	1	1000
2	2	2000
3	3	2300
4	2	2500

JADUAL S5 (b) / TABLE Q5 (b)

%	0	1	2	3	4	5	6	7	8	9
0	-	2.67	2.95	3.12	3.25	3.36	3.45	3.52	3.59	3.66
10	3.72	3.77	3.82	3.87	3.92	3.96	4.01	4.05	4.08	4.12
20	4.16	4.19	4.23	4.26	4.29	4.33	4.36	4.39	4.42	4.45
30	4.48	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.69	4.72
40	4.75	4.77	4.80	4.82	4.85	4.87	4.90	4.92	4.95	4.97
50	5.00	5.03	5.05	5.08	5.10	5.13	5.15	5.18	5.20	5.23
60	5.25	5.28	5.31	5.33	5.36	5.39	5.41	5.44	5.47	5.50
70	5.52	5.55	5.58	5.61	5.64	5.67	5.71	5.74	5.77	5.81
80	5.84	5.88	5.92	5.95	5.99	6.04	6.08	6.13	6.18	6.23
90	6.28	6.34	6.41	6.48	6.55	6.64	6.75	6.88	7.05	7.33
%	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
99	7.33	7.37	7.41	7.46	7.51	7.58	7.65	7.75	7.88	8.09

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JADUAL S5 (c) / TABLE Q5 (c)

Causative variable, V = $\sum C^a T$		Probit Parameters	
Type of Injury	a	k_1	k_2
Ammonia Death	2.0	-35.9	1.85
Carbon Monoxide Death	1.0	-37.98	3.7
Chlorine Death	2.0	-8.29	0.92
Ethylene Oxide Death	1.0	-6.19	1.0
Hydrogen Chloride Death	1.0	-16.85	2.0
Nitrogen Dioxide Death	2.0	-13.79	1.4
Phosgene Death	1.0	-19.27	3.69
Propylene Oxide Death	2.0	-7.42	0.51
Sulfur Dioxide Death	1.0	-15.67	1.0
Toluene	2.5	-6.79	0.41

*Note: C =Concentration (ppm); T=*Time Interval* (min)

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- **Fatality Accident Rate (FAR)**

$$\text{FAR} = \frac{N * 10^8 \text{ hr}}{T\ [hr]}$$

$$\text{FAR} = \frac{N}{P}$$

N: Number of fatalities;

T: Exposed Time

P : Population

- **Time-weighted average, TWA**

$$\text{TWA} = \frac{C_1T_1 + C_2T_2 + \cdots + C_iT_i}{8 \text{ jam}}$$

$$\sum_{i=1}^{n} \frac{C_i}{\text{TLV} - \text{TWA}}$$

$$(TLV - TWA)_{mix} = \frac{\sum_{i=1}^{n} C_i}{\sum_{i=1}^{n} \frac{C_i}{(\text{TLV-TWA})_i}}$$

- **Probit equation**

$$Y = k_1 + k_2 \ln V$$

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- **Reliability**

$$R(t) = e^{-\mu t}$$

$$\mu = -\ln R/t$$

- **Components linkage**
  - OR Gate:
    - Failure Probability: $P = 1 - \prod_{i=1}^{n}(1 - P_i)$
    - Reliability: $R = \prod_{i=1}^{n} R_i$
    - Failure Rate: $\mu = \sum_{i=1}^{n} u_i$
  - AND Gate:
    - Failure Probability: $P = \prod_{i=1}^{n} P_i$
    - Reliability: $R = 1 - \prod_{i=1}^{n}(1 - R_i)$
    - Failure Rate: $\mu = -\ln R/t$

- **Mean Time Between Failures (MTBF):**

$$MTBF = 1/\mu$$

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- **Failure Rate Data:**

Instruments	**μ (Failure/year)**
Controller (FIC,LIC)	0.29
Control valve (CV)	0.60
Flow meter	1.14
Hand Valve	0.13
Level Indicator (LI)	1.70
Pressure measurement	1.41
Pressure relief valve	0.022
Pressure switch	0.14
Solenoid valve	0.41
Thermocouple temperature measurement	0.52
Thermometer temperature measurement	0.027
Oxygen analyzer	5.62
Strip chart recorder	0.22
Indicator Lamp	0.044