INSTRUCTION:
This section consists of **FOUR (4)** questions. Answer **ALL** of them.

ARAHAN:
*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C2

(a) Explain the following terms:
Terangkan maksud istilah berikut:

(i) Measurement / *pengukuran,*
(ii) error detection / *pengesanan ralat,*
(iii) linearity / *linearity,*
(iv) hysteresis / *histerisis,*
(v) span / *span*

[5 marks]
[5 *markah*]

CLO2
C1

(b) Diagram 1 (b) below shows a closed loop control system. Name and state **TWO (2)** examples of element A and B of the system.

*Rajah 1 (b) di bawah menunjukan sistem kawalan gelung tertutup. Nama dan berikan **DUA (2)** contoh elemen A dan B bagi sistem ini.*

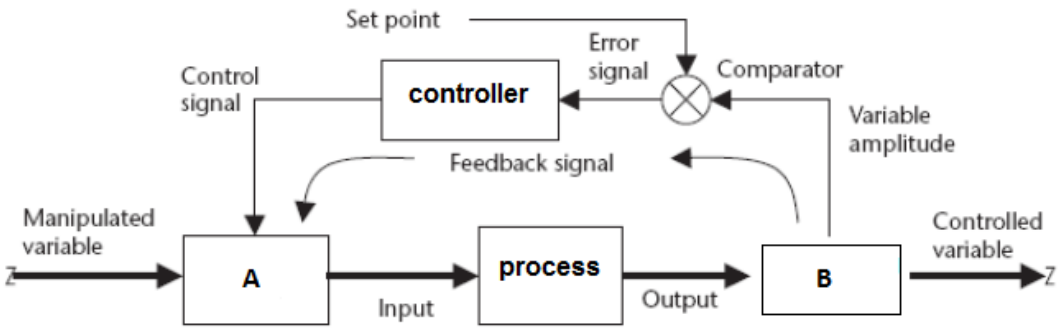

Diagram 1(b)/ *Rajah 1(b)*

[6 marks]
[*6 markah*]

CLO2
C3

(c) The pressure in a system has a range from 0 to 100kPa. Calculate the current value that is equivalent to 59kPa, if the transducer output range is from 4 to 20mA with the aid of graph.

Tekanan dalam sistem adalah dari 0 hingga 100kPa . Kira nilai arus yang setara dengan 59kPa, jika julat keluaran transduser adalah dari 4 hingga 20mA dengan bantuan graf.

[6 marks]
[*6 markah*]

CLO2
C3

(d) A linear pressure sensor has a time constant of 4.4 seconds and a transfer function of 29 mV/kPa.
Sensor tekanan linear mempunyai pemalar masa 4.4 saat dan fungsi pemindahan 29 mV/kPa.

i. Determine the pressure output after 1.4 seconds, if the output changes from 20 to 40kPa.
Tentukan output tekanan selepas 1.4 saat, jika perubahan output dari 20 hingga 40kPa.

ii. Calculate the pressure error at this time with the aid of first order systems graph.
Kira ralat tekanan pada masa ini dengan bantuan graf sistem first order.

[8 marks]
[*8 markah*]

QUESTION 2
SOALAN 2

CLO1 C1

(a) Define hydrostatic pressure and state its **FOUR (4)** units.
*Berikan definisi tekanan hidrostatik dan nyatakan **EMPAT (4)** unitnya.*

[6 marks]
[*6 markah*]

CLO1 C2

(b) Explain the differences between Direct Sensing and Indirect Sensing that applied in level measurement and give the examples of each sensing.
Terangkan perbezaan antara pengesan terus dan pengesan tidak terus yang digunakan dalam pengukuran parasndan berikan contoh untuk setiap pengesan.

[4 marks]
[*4 markah*]

CLO2 C3

(c) Diagram 2 (c) below shows that a conveyor belt is carrying a dry particulate. Determine the flow rate if the conveyor belt is travelling at 27 cm/s and a load cell with a length of 0.72 m is reading 5.4 kg.

Rajah 2 (c) di bawah menunjukkan sebuah tali sawat membawa patikel kering. Tentukan kadar alir jika tali sawat bergerak pada 27 cm/s dan sel beban dengan panjang 0.72 m memberi bacaan 5.4 kg.

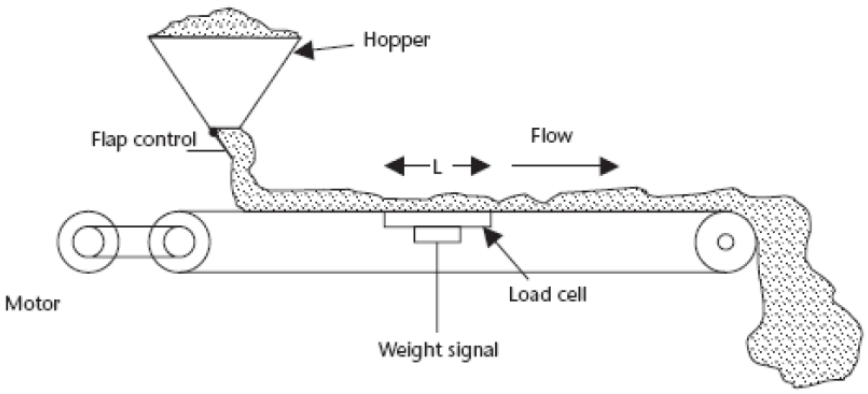

Diagram 2(c)/ *Rajah 2(c)*

[5 marks]
[*5 markah*]

CLO2
C3

(d) Volume of a cylindrical tank is 20000 ft^3. The maximum capacity of the tank is 80% of tank volume. Determine the pressure span in Diagram 3 (b) below.
Sebuah tangki berbentuk silinder mempunyai isipadu 20000 ft^3. *Kapasiti maksimum tangki tersebut ialah 80% dari isipadu tangki. Kenalpasti span tekanan pada Rajah 3 (b) di bawah.*

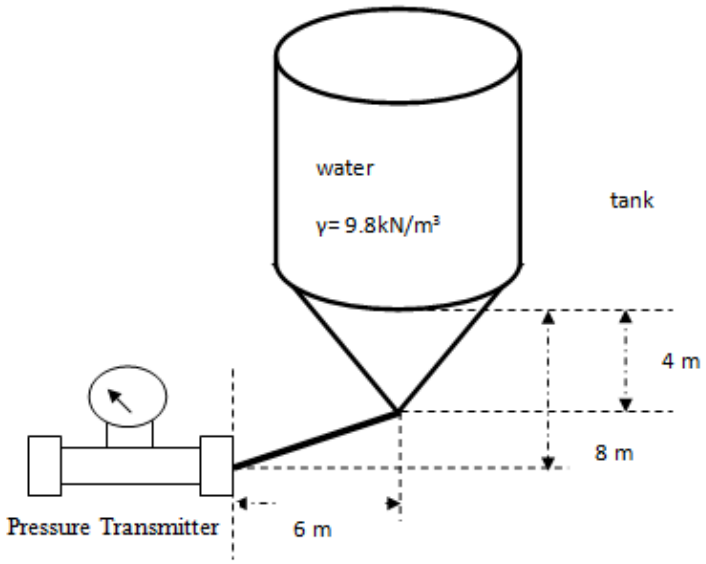

Diagram 3(b)/ *Rajah 3(b)*

[10 marks]
[*10 markah*]

QUESTION 3
SOALAN 3

CLO1
C1

(a) Define control valve and state **THREE (3)** sources to operate it.
Definisikan injap kawalan dan berikan ***TIGA (3)*** *sumber untuk menggerakkannya .*

[5 marks]
[5 *markah*]

CLO1
C2

(b) Describe the operation of self-balancing pneumatic mechanism with the aid of suitable diagram.
Jelaskan operasi mekanisma imbangan-sendiri pneumatik dengan bantuan gambarajah yang sesuai.

[8 marks]
[*8 markah*]

CLO2
C2

(c) Diagram 3 (c) shows the two conditions of fail safe valve. Interpret the operation of the system.

Rajah 3 (c) *menunjukkan dua keadaan injap gagal selamat. Terangkan operasi sistem tersebut.*

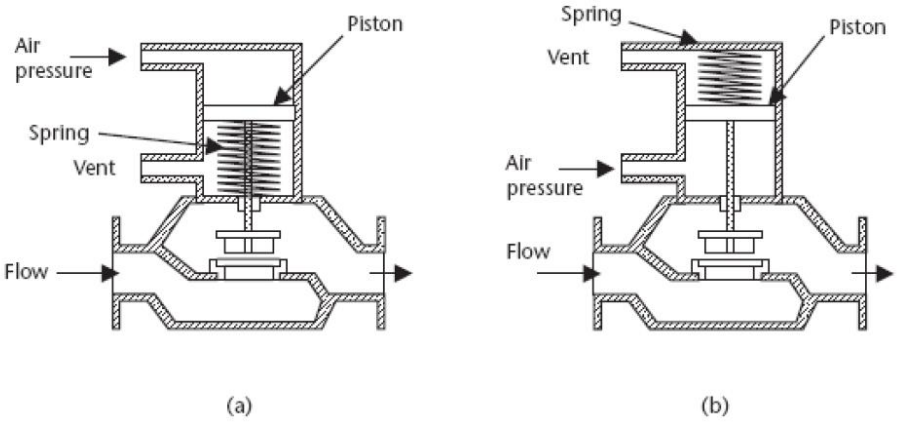

Diagram 3(c)/ *Rajah 3(c)*

[6 marks]
[*6 markah*]

CLO2
C3

(d) By referring to Diagram 3 (d) below, assume that we are using a control valve to throttle the flow of crude oil through a heating process, fired by natural gas burners.

Merujuk kepada Rajah 3 (d) di bawah, andaikan kita menggunakan injap kawalan untuk mengawal aliran minyak mentah melalui proses pemanasan yang dipanaskan menggunakan pembakar gas asli.

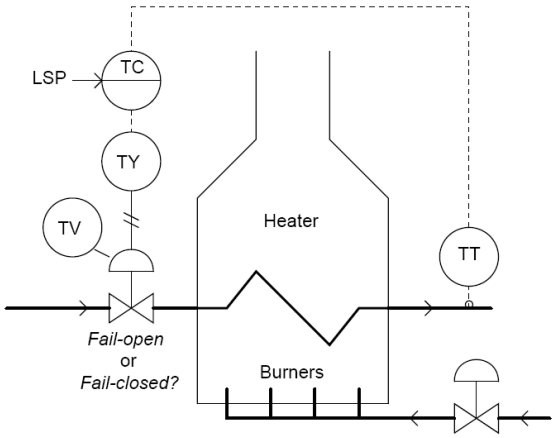

Diagram 3(d)/ *Rajah 3(d)*

The flow is normally controlled on the basis of the crude oil's output temperature from the heater. In this particular application, determine your suggestion whether to use a fail-closed or a fail-open valve and explain the reason for your suggestion.

Aliran biasanya dikawal oleh suhu keluaran minyak mentah dari pemanas. Dalam aplikasi ini, tentukan cadangan anda sama ada menggunakan injap gagal-tutup atau injap gagal-buka dan terangkan cadangan anda.

[6 marks]
[*6 markah*]

QUESTION 4
SOALAN 4

CLO1
C1

(a) State the relationship between the proportional mode, integral mode, derivate mode, PI mode and PD mode with error correction controller by using formula.

Nyatakan hubungan antara mod berkadar, mod pembezaan, mod kamiran, mod PI dan mod PD dengan pembetulan ralat pengawal dengan menggunakan formula.

[5 marks]
[*5 markah*]

CLO2
C3

(b) By referring to Diagram 4 (b), determine the controller output value for a three mode controller having Kp as 4, Ki as 0.6/s, K_d as 0.5 s. A set point output of 50% and subject to the error change in Diagram below if immediately the change starts to occur.

Dengan merujuk kepada Rajah 4 (b) di bawah, tentukan nilai keluaran pengawal bagi tiga mod pengawal yang mempunyai Kp sebanyak 4, Ki sebanyak 0.6/s, Kd sebanyak 0.5 saat. Nilai tetapan keluaran ialah 50% dan perubahan ralat ditunjukkan pada rajah 4(b) jika perubahan permulaan berlaku dengan segera.

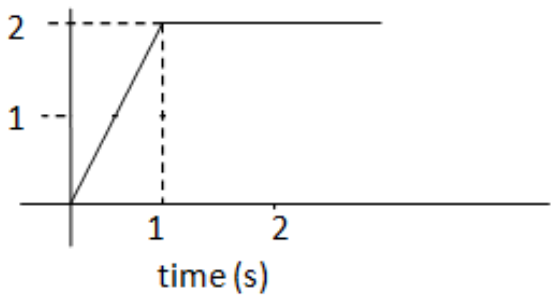

Diagram 4(b)/ *Rajah 4(b)*

[3 marks]
[*3 markah*]

CLO2
C3

(c) If the set point is suddenly changed from 50% to 35% with a proportional band setting at 50%, determine the output change of the proportional controller.
Jika nilai tetapan berubah dari 50% ke 35% dengan jalur yang berkadaran 50%, tentukan perubahan keluaran pada pengawal berkadar tersebut.

[5 marks]
[*5 markah*]

(d) Sketch a ladder diagram for a set of red and green light in the following manner :
Lakar gambarajah tetangga untuk satu set lampu merah dan hijau mengikut turutan berikut :

CLO2
C3

Sequence of operation:
Turutan operasi:

a. Red light : 12 seconds ON
Lampu merah : 12 saat ON
b. Green light : 8 seconds ON
Lampu hijau : 8 saat ON
c. This process will repeat in 10 times before turn off automatically.
Proses ini akan berulang 10 kali sebelum tamat secara automatik.

Time in second

RED	GREEN
12 sec.	8 sec.

[12 marks]
[*12 markah*]

SOALAN TAMAT

Appendix/ Lampiran

Pressure Conversion:

1Pa = 1.4504 x 10^{-4} psi
1 psi = 1 lb/in^2
1 Atm = 101.3 kPa = 14.7 psi
1 Bar = 100 kPa = 100 N/m^2

Length Conversion :

1cm = 10 mm
1 m = 100 cm
1 ft = 12 inch
1 inch = 0.0254m

Level Formula:

$h = P/\gamma$
$F = \gamma\pi d^2 h/ 4$
$W = \gamma V$

Heat Energy Conversion:

1 Btu = 252 cal
1 Joule = 0.000948 Btu
1 Watt = 1 J/s

Pressure Formula:

$P = \gamma h = F/A = \rho gh$
$B = \gamma V$

Flow Formula:

$R = VD\rho/ \mu$
$Q = VA$
$F = \rho Q$

$P_a / \gamma_a + V_a^2/ 2g + h_a = P_b / \gamma_b + V_b^2/ 2g + h_b$

$V = \sqrt{(2gh)}$

$Q = k\ (\pi/4)(d_s/d_p)^2 \sqrt{(2gh)}$

$Q = WR/ L$

Temperature Formula:

°C = (°F -32) 5/9
°R = °F +459.6
°K = °C + 273.15
°R = °K * 9/5

$W_{TH} = 3/2\ kT$

$V_{TH} = \sqrt{(3kT/m)}$

k = Boltzmann's constant = 1.38 x 10^{-23} J/K
$Q = WC(T_2 - T_1)$
$Q = -kA(T_2-T_1)/L$
$Q = hA\ (T_2-T_1)$

$Q = CA\ (T_2^4 - T_1^4)$
$L_2 = L_1[1 + \alpha\ (T_2 - T_1)]$
$V_2 = V_1[1 + \beta\ (T_2 - T_1)]$

$R_{T2} = R_{T1}\ [\ 1 + Coeff.(T_2 - T_1)]$