

**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  
C1

- (a) State the examples for each element of closed loop control that labelled on A, B, C, D, and E shown in **Figure 1 (a)**.

*Nyatakan elemen-elemen dalam kawalan gelung tertutup berlabel A, B, C, D, dan E seperti yang ditunjukkan **Rajah 1 (a)**.*

Control element / Elemen kawalan	Measuring element / Elemen pengukuran
<b>A</b>	<b>C</b>
<b>B</b>	<b>D</b>
	<b>E</b>

Figure 1(a)

*Rajah 1(a)*

[5 marks]

*[5 markah]*

CLO2  
C2

(b) **Figure 1 (b)** below shows a closed loop control system. Briefly explain the basic function of elements A, B, and C of the system.

*Rajah 1 (b) di bawah menunjukkan sistem kawalan gelung tertutup. Terangkan fungsi asas bagi elemen A, B, and C bagi sistem ini.*

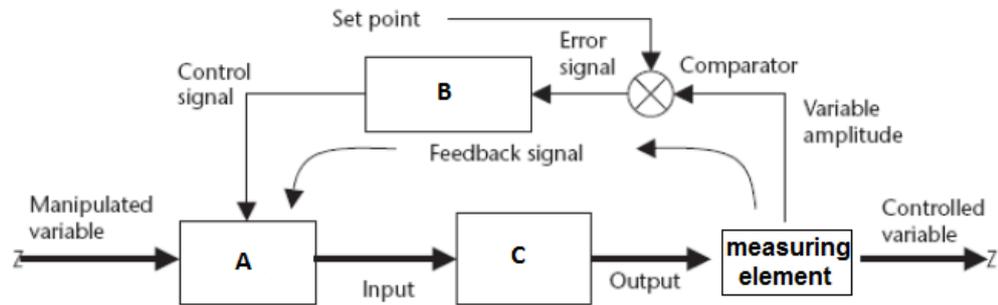


Figure 1(b)

Rajah 1(b)

[6 marks]

[6 markah]

CLO2  
C3

(c) A pressure sensor was operated with the pressure and current as shown in **Figure 1 (c)**. Calculate the value of X.

*Pengesan tekanan beroperasi seperti ditunjukkan dalam Rajah 1(c). Kirakan nilai X .*

Pressure (kPa)	5	31	105
Current (mA)	5	X	19

[6 marks]

[6 markah]

CLO2  
C3

- (d) A linear pressure sensor has a time constant of 4 seconds and a transfer function of 25mV/kPa. Determine the pressure output after 2 seconds, if the output changes from 10 to 40kPa and calculate the pressure error between time,  $t$  with aid of first order systems graph.

*Sensor tekanan linear mempunyai pemalar masa 4 saat dan fungsi pemindahan 25 mV/kPa. Tentukan output tekanan selepas 2 saat, jika output berubah dari 10 hingga 40kPa dan kira ralat tekanan pada masa,  $t$  ini dengan bantuan graf sistem first order.*

[8 marks]

[8 markah]

## QUESTION 2

## SOALAN 2

CLO1  
C1

- (a) Identify the types of pressure that labelled as A, B, C, D, E, and F as shown in **Figure 2 (a)**.

*Kenalpasti jenis-jenis tekanan yang dilabel A, B, C, D, E, and F seperti ditunjukkan dalam Rajah 2 (a).*

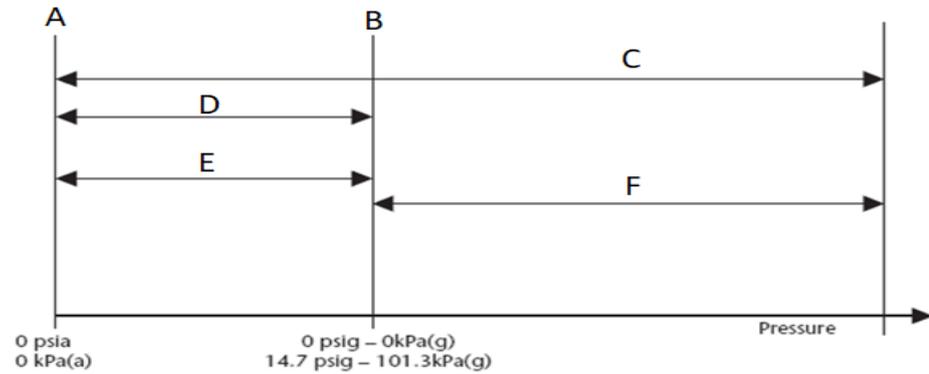


Figure 2(a)

Rajah 2(a)

[6 marks]

[6 markah]

CLO1  
C2

- (b) Explain the operational principle of type c bourdan tube with the aid of a relevant diagram.

*Terangkan prinsip operasi tiub bourdon jenis c dengan bantuan gambarajah yang berkaitan.*

[4 marks]

[4 markah]

CLO2  
C3

- (c) Use the information given in **Figure 2 (c)** to calculate the value of pressure at each of the following percentage as 0%, 50%, 75% and 100%. Then, find the span value for the elevation tank as shown in

*Menggunakan maklumat yang diberi dalam **Rajah 2 (c)**, kira nilai tekanan pada setiap nilai peratusan seperti 0%, 50%, 75% dan 100%. Kemudian, cari julat span bagi tangki tersebut.*

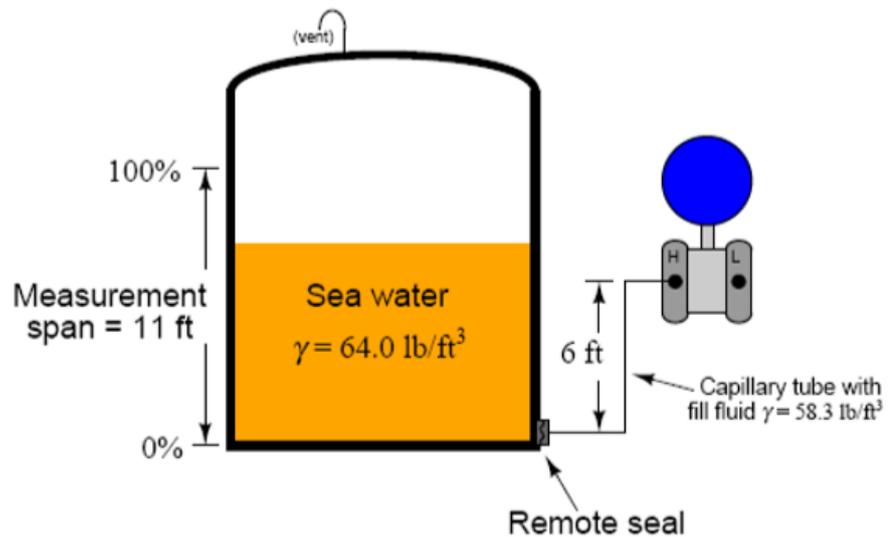


Figure 2(c)

*Rajah 2(c)*

[10 marks]

*[10 markah]*

CLO2  
C3

- (d) The differential pressure transmitter that attached at the closed vessel can give the correct reading with aid of compensated leg as shown in **Figure 2 (d)**. Prove the statement with the manipulated formula of the hydrostatic pressure.

*Sebuah pengantar perbezaan tekanan yang dipasang pada sebuah vassel tertutup boleh memberikan bacaan yang tepat dengan bantuan kaki pemampas seperti yang ditunjukkan pada **Rajah 2 (d)**. Buktikan kenyataan ini dengan memanipulasikan rumus tekanan hidrostatik.*

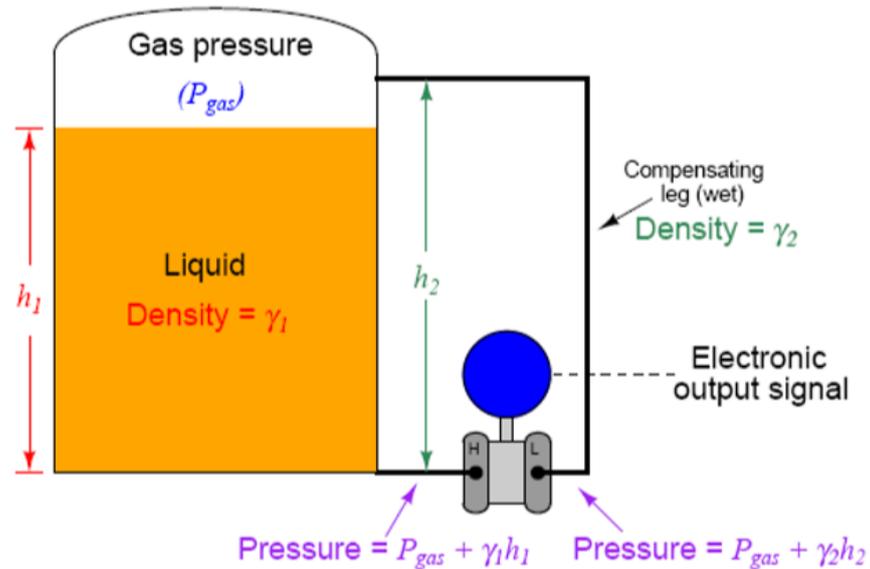


Figure 2(d)/ *Rajah 2(d)*

[5 marks]

[5 markah]

## QUESTION 3

## SOALAN 3

CLO1  
C1

- (a) Identify the control valve components A, B, C, D, and E as labelled in **Figure 3 (a)**.  
*Kenalpasti komponen injap kawalan A, B, C, D, dan E seperti dilabelkan pada **Rajah 3 (a)**.*

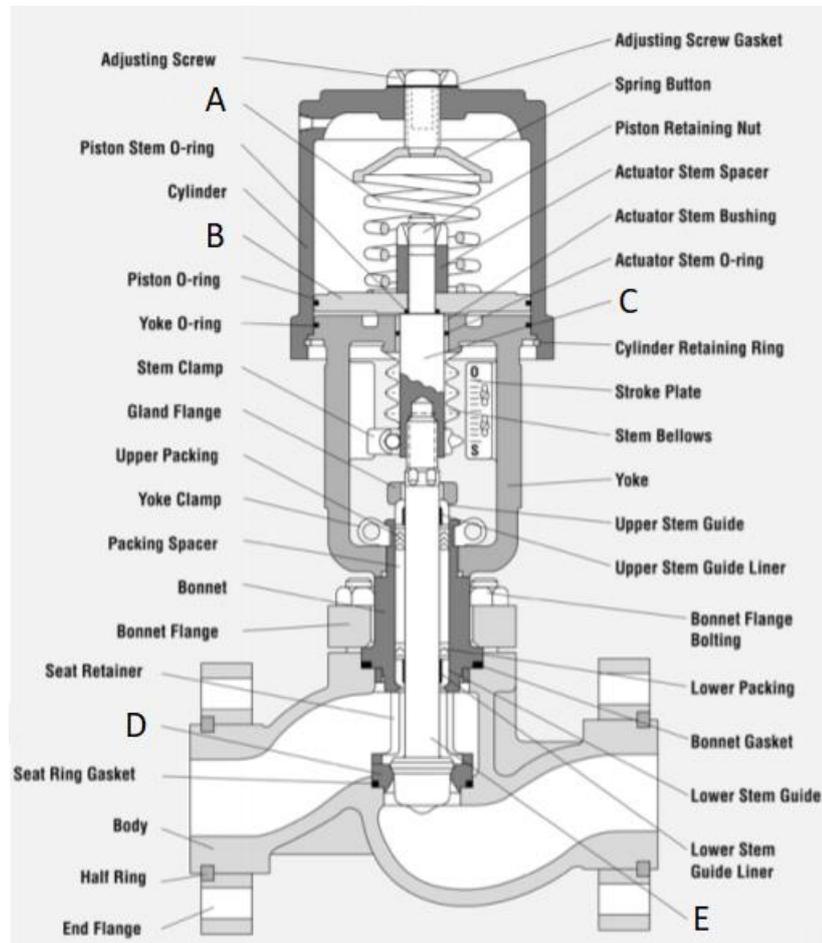


Figure 3(a)

*Rajah 3(a)*

[5 marks]

[5 markah]

CLO2  
C2

- (b) **Figure 3 (b)** shows a self-balancing pneumatic mechanism. Identify and explain the element A, B, C and D of the system.

*Rajah 3 (b) menunjukkan mekanismaimbangan sendiri pneumatik. Kenalpasti dan terangkan element A, B, C, dan D dalam sistem tersebut.*

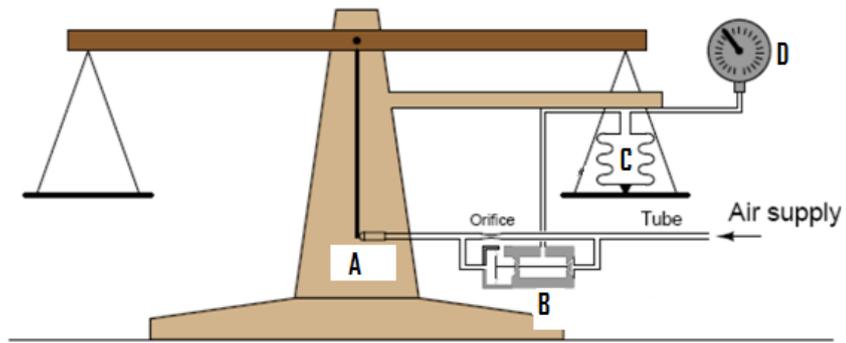


Figure 3(b)

*Rajah 3(b)*

[8 marks]

[8 markah]

CLO2  
C2

- (c) **Figure 3 (c)** shows two conditions of failsafe valve. Explain the operation of the system.

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

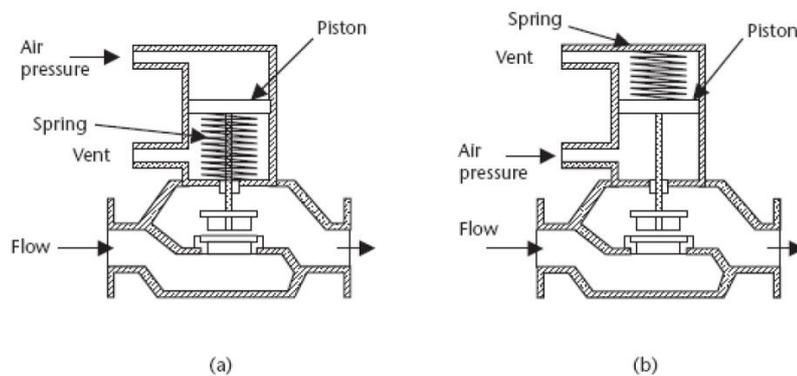


Figure 3(c)

*Rajah 3(c)*

[6 marks]

[6 markah]

CLO2  
C3

- (d) Refer to **Figure 3 (d)** below, assume that we are using a control valve to throttle the flow of crude oil through a separation process. The flow is normally controlled on the base of the crude oil to get the end product. In this particular application, suggest whether it is appropriate to use a fail-closed or a fail-open valve, and explain the reason for your suggestion.

*Merujuk kepada **Rajah 3 (d)** di bawah, andaikan kita menggunakan injap kawalan untuk mengawal aliran minyak mentah melalui proses pengasingan. Aliran biasanya dikawal pada dasar minyak mentah untuk mendapatkan produk terakhir. Dalam aplikasi ini, cadangkan sama ada sesuai menggunakan injap gagal-tutup atau injap gagal-buka dan terangkan sebab untuk cadangan anda.*

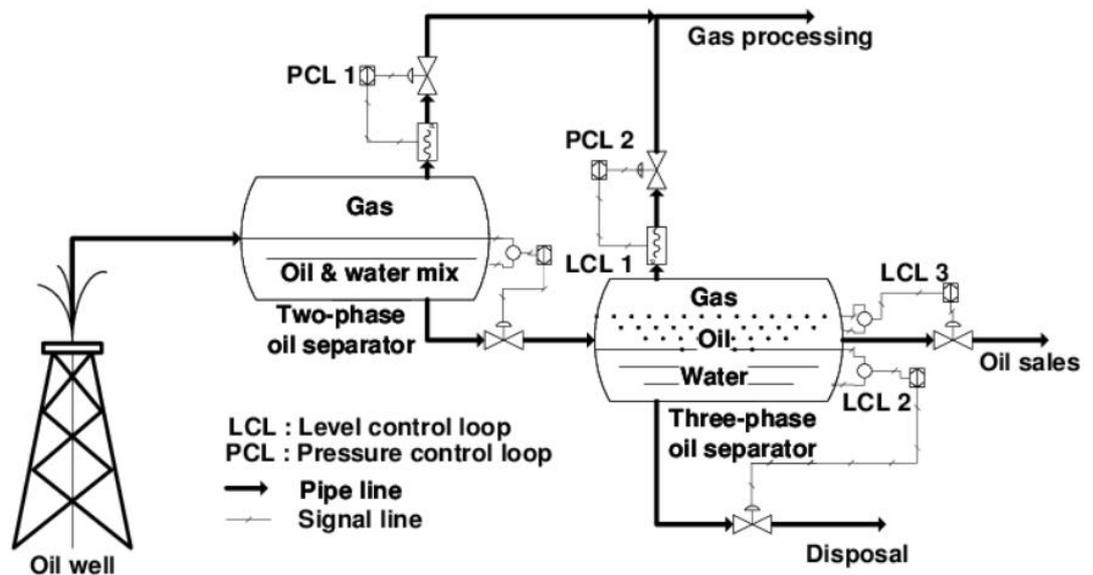


Figure 3(d)

*Rajah 3(d)*

[6 marks]

[6 markah]

## QUESTION 4

## SOALAN 4

CLO1  
C1

- (a) Identify the types of controller in **Figure 4 (a)** and name the components A, B, and C.

*Kenalpasti jenis pengawal dalam **Rajah 4 (a)** dan namakan komponen A, B, dan C.*

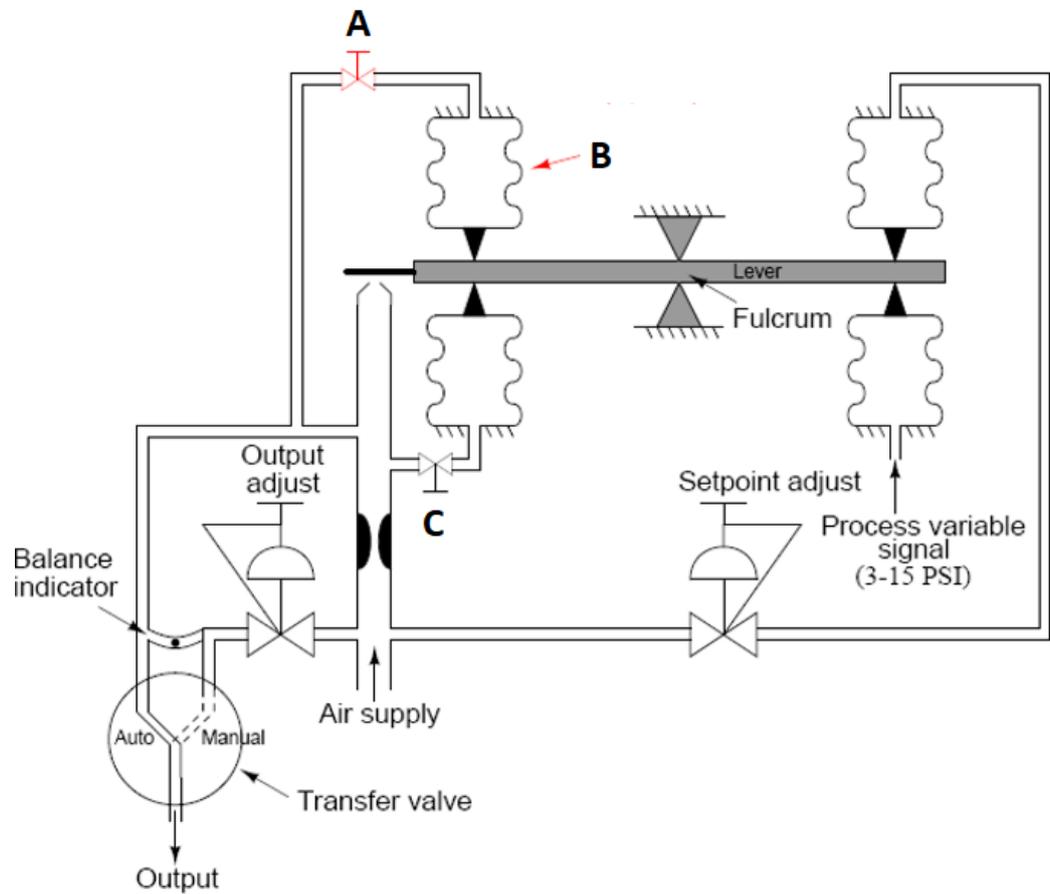


Figure 4(a)

Rajah 4(a)

[5 marks]

[5 markah]

CLO2  
C3

- (b) Refer to **Figure 4 (b)** below to calculate the controller output value at the first second after it starts for a three mode controller having  $K_p$  as 4,  $K_i$  as 0.6/s,  $K_D$  as 0.5 s and a set point output of 50%.

*Merujuk pada Rajah 4 (b) di bawah untuk mengira nilai keluaran pengawal pada saat pertama selepas bermula bagi tiga mod pengawal yang mempunyai  $K_p$  sebanyak 4,  $K_i$  sebanyak 0.6/s,  $K_d$  sebanyak 0.5 saat, dan nilai tetapan keluaran ialah 50%.*

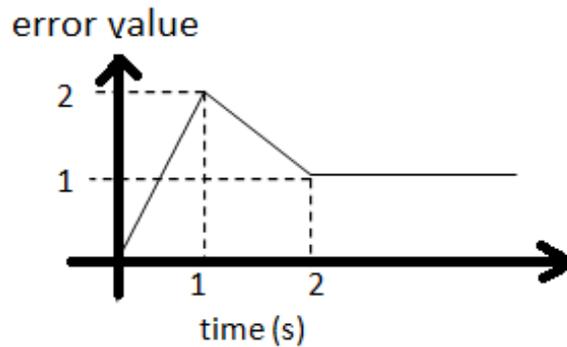


Figure 4(b)

*Rajah 4(b)*

[5 marks]

*[5 markah]*CLO2  
C3

- (c) Determine the output change of the proportional controller if the set point is suddenly changed from 50% to 35% with a proportional band setting at 50%.

*Nyatakan perubahan keluaran pada pengawal berkadar tersebut jika nilai tetapan berubah dari 50% to 35% pada jalur berkadar yang bertetapan 50%.*

[5 marks]

*[5 markah]*

CLO2  
C3

- (d) The control system used for filling / draining operation is shown in the **Figure 4 (d)**. Design a ladder diagram for a PLC to perform the below control function.
- i) As the PB1 is pressed, MV1 opens and the water begins to fill the tank. At the same time, the stirring motor M starts to operate.
  - ii) When the water level passes TLB2 and reaches TLB1, the MV1 will close and the stirring motor stops.
  - iii) Next MV2 opens and starts draining the water. When the water level drops below TLB2, MV2 will close.
  - iv) When the cycle of operation has repeated for four times, the operation END indicator will light up and the filling and draining operation will not restart even if PB1 is pressed

*Suatu sistem untuk mengawal operasi pengisian / pembuangan ditunjukkan dalam **Rajah 4 (d)**. Anda dikehendaki untuk merekabentuk sebuah gambarajah tetangga bagi sebuah PLC untuk menjalankan fungsi kawalan di bawah.*

- i) Setelah PB1 ditekan, MV1 akan terbuka dan air mula mengisi tangki. Pada masa yang sama, motor pengacau M akan mula beroperasi.*
- ii) Apabila paras air melepasi TLB2, dan mencapai TB1, MV1 akan tertutup dan motor pengacau akan berhenti.*
- iii) Kemudian MV2 akan terbuka dan akan mula untuk membuang air. Apabila paras air turun melepasi TLB2, MV2 akan tertutup.*
- iv) Apabila kitaran tersebut berulang sebanyak 4 kali, operasi penunjuk END akan menyala dan operasi pengisian dan pembuangan tidak akan mula semula walaupun PB1 ditekan.*

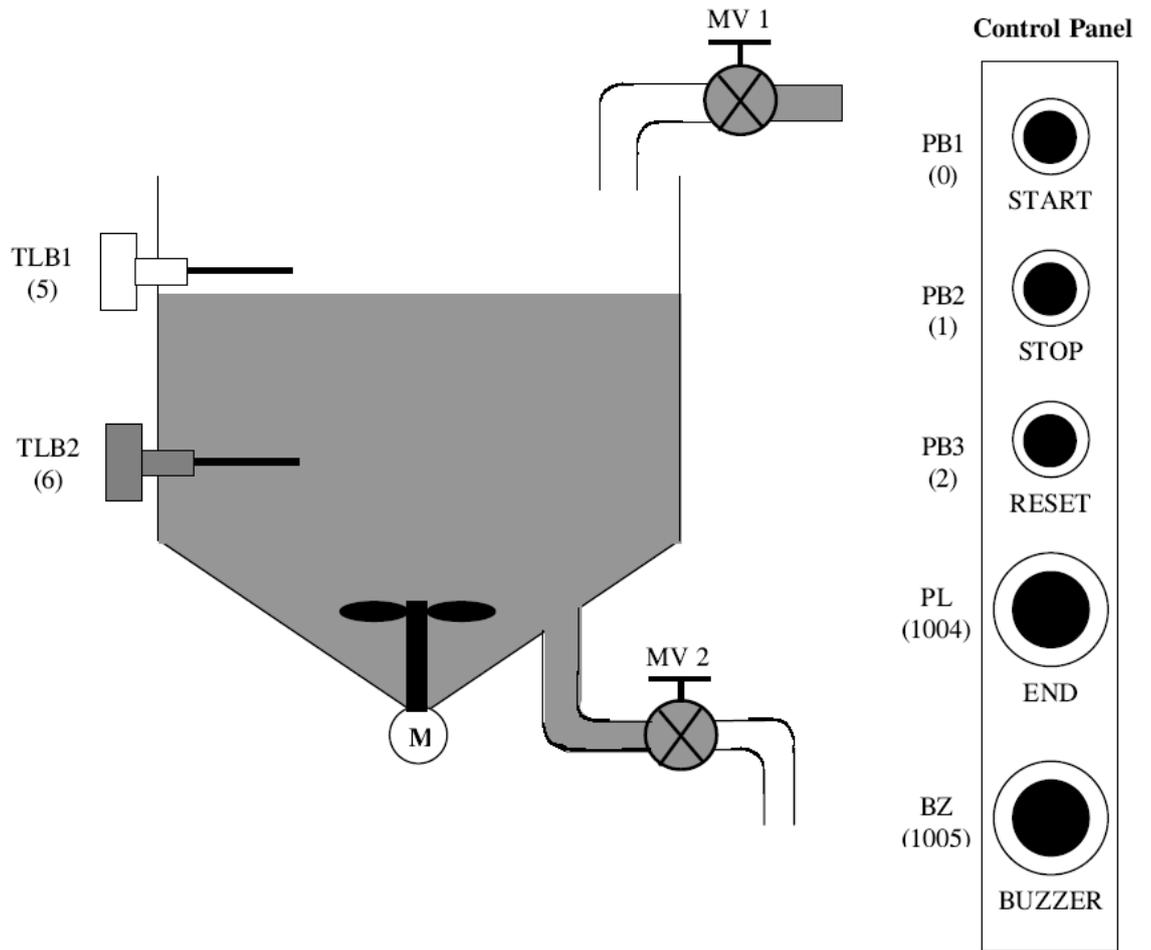


Figure 4(d)

Rajah 4(d)

[10 marks]

[10 markah]

**SOALAN TAMAT**

## Appendix/ Lampiran

### Pressure Conversion:

$$1\text{Pa} = 1.4504 \times 10^{-4} \text{ psi}$$

$$1 \text{ psi} = 1 \text{ lb/in}^2$$

$$1 \text{ Atm} = 101.3 \text{ kPa} = 14.7 \text{ psi}$$

$$1 \text{ Bar} = 100 \text{ kPa} = 100 \text{ N/m}^2$$

### Length Conversion :

$$1\text{cm} = 10 \text{ mm}$$

$$1 \text{ m} = 100 \text{ cm}$$

$$1 \text{ ft} = 12 \text{ inch}$$

$$1 \text{ inch} = 0.0254\text{m}$$

### Level Formula:

$$h = P/\gamma$$

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

$$W = \gamma V$$

### Heat Energy Conversion:

$$1 \text{ Btu} = 252 \text{ cal}$$

$$1 \text{ Joule} = 0.000948 \text{ Btu}$$

$$1 \text{ Watt} = 1 \text{ J/s}$$

### Pressure Formula:

$$P = \gamma h = F/A = \rho g h$$

$$B = \gamma V$$

### 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:**

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \frac{5}{9}$$

$$^{\circ}\text{R} = ^{\circ}\text{F} + 459.6$$

$$^{\circ}\text{K} = ^{\circ}\text{C} + 273.15$$

$$^{\circ}\text{R} = ^{\circ}\text{K} * \frac{9}{5}$$

$$W_{\text{TH}} = \frac{3}{2} kT$$

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

$k = \text{Boltzmann's constant} = 1.38 \times 10^{-23} \text{ J/K}$

$$Q = WC(T_2 - T_1)$$

$$Q = -kA(T_2 - T_1)/L$$

$$Q = hA (T_2 - T_1)$$

$$Q = CA (T_2^4 - T_1^4)$$

$$L_2 = L_1[1 + \alpha (T_2 - T_1)]$$

$$V_2 = V_1[1 + \beta (T_2 - T_1)]$$

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