

SULIT



**KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI**

**BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENGAJIAN TINGGI**

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI II : 2022/2023

DJJ20063: THERMODYNAMICS

TARIKH : 19 JUN 2023

MASA : 8.30 PG - 10.30 PG (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula, Buku Stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:

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

ARAHAN :

Bahagian ini mengandungi EMPAT (4) soalan. Jawab SEMUA soalan.

QUESTION 1**SOALAN 1**

CLO1

- (a) Define the following terms and give **ONE (1)** example for each property.

Takrifkan istilah-istilah berikut dan berikan SATU (1) contoh bagi setiap sifat tersebut.

- (i) Intensive property [2 marks]

Sifat intensif [2 markah]

- (ii) Extensive property [2 marks]

Sifat ekstensif [2 markah]

CLO1

- (b) Explain the Zeroth Law of Thermodynamics aided with the suitable diagram.

Terangkan Hukum Sifar Termodinamik dengan bantuan gambarajah yang sesuai.

[4 marks]

[4 markah]

CLO2 (c) Interpolate the value of steam at pressure 10 bar and temperature 380°C for the following solution :

Interpolasikan nilai bagi stim pada tekanan 10 bar dan suhu 380°C untuk penyelesaian berikut:

(i) Specific volume [4 marks]

Isipadu tentu [4 markah]

(ii) Specific enthalpy [4 marks]

Entalpi tentu [4 markah]

CLO2 (d) Given the pressure and the specific entropy of wet steam is 175 bar and 4.832 kJ/kgK. Relate the values given for solution of:

Diberi tekanan dan entropi tentu ialah 175 bar dan 4.832 kJ/kgK.

Hubungkaitkan nilai yang diberi untuk penyelesaian:

(i) Dryness fraction [3 marks]

Pecahan kekeringan [3 markah]

(ii) Specific volume [3 marks]

Isipadu tentu [3 markah]

(iii) Specific internal energy [3 marks]

Tenaga dalam tentu [3 markah]

QUESTION 2**SOALAN 2**

CLO2

- (a) Based on First Law of Thermodynamics, give **FOUR (4)** characteristics of closed system.

*Berdasarkan Hukum Termodinamik Pertama, berikan **EMPAT (4)** ciri sistem tertutup.*

[4 marks]

[4 markah]

CLO2

- (b) Explain the following terms.

Terangkan istilah-istilah berikut.

- (i) Heat

[2 marks]

Haba

[2 markah]

- (ii) Specific heat

[2 marks]

Haba tentu

[2 markah]

CLO2

- (c) A certain perfect gas has an initial volume of 0.05 m^3 at pressure of 7 bar and temperature of 131°C . The gas is cooled at a constant pressure until its final volume is 0.04 m^3 . Calculate:

Sejenis gas sempurna mempunyai isipadu awal sebanyak 0.05 m^3 pada tekanan 7 bar dan suhu 131°C . Gas tersebut disejukkan pada tekanan tetap sehingga isipadu akhir ialah 0.04 m^3 . Kirakan:

- (i) Final temperature ($^\circ\text{C}$)

[3 marks]

Suhu akhir ($^\circ\text{C}$)

[3 markah]

- (ii) Work done

[2 marks]

Kerja yang dilakukan

[2 markah]

CLO2

- (d) A Nitrogen ($M=28 \text{ kg/kmol}$) expands reversibly in a pneumatic cylinder at a constant pressure of 2 bar. The initial temperature was 35°C with a volume of 0.05 m^3 . Then the temperature rises to 400°C after the process. Assuming nitrogen to be a perfect gas ($C_p = 1.045 \text{ kJ/kgK}$), calculate:

Nitrogen ($M = 28\text{kg/kmol}$) dikembangkan secara boleh balik di dalam silinder pneumatik pada tekanan tetap 2 bar. Suhu awal adalah 35°C dengan isipadu 0.05 m^3 . Kemudian suhu meningkat kepada 400°C selepas proses tersebut. Andaikan nitrogen sebagai gas sempurna ($C_p = 1.045 \text{ kJ/kgK}$), kirakan:

- (i) Mass of Nitrogen [6 marks]

Jisim Nitrogen [6 markah]

- (ii) Work done [3 marks]

Kerja yang dilakukan [3 markah]

- (iii) Heat transfer [3 marks]

Haba yang dipindahkan [3 markah]

QUESTION 3

SOALAN 3

CLO2

- (a) Identify **TWO (2)** characteristics of an open system and give **TWO (2)** examples of the equipment involved.

*Kenalpasti **DUA (2)** ciri sistem terbuka dan berikan **DUA (2)** contoh peralatan yang terlibat.*

[4 marks]

[4 markah]

CLO2

- (b) Compare **TWO (2)** differences between steady and unsteady flow process.

*Bandingkan **DUA (2)** perbezaan di antara proses aliran mantap dengan proses aliran tidak mantap.*

[4 marks]

[4 markah]

CLO2

- (c) A fluid enters a nozzle with specific enthalpy 3020 kJ/kg, velocity 50 m/s and specific volume of $0.15 \text{ m}^3/\text{kg}$. The fluid exit a nozzle with specific enthalpy 2780 kJ/kg and specific volume of $0.85 \text{ m}^3/\text{kg}$. If the inlet area of the nozzle is 0.1 m^2 , calculate:

Bendalir memasuki muncung dengan entalpi tentu 3020 kJ/kg, halaju 50 m/s dan isipadu tentunya $0.15 \text{ m}^3/\text{kg}$. Bendalir keluar muncung dengan entalpi tentu 2780 kJ/kg dan isipadu tentunya $0.85 \text{ m}^3/\text{kg}$. Jika luas bahagian masukan muncung adalah 0.1 m^2 , kirakan:

- (i) Exit velocity of the fluid [3 marks]

Halaju keluaran bendalir [3 markah]

- (ii) Outlet area of the nozzle [3 marks]

Luas keluaran muncung [3 markah]

CLO2

- (d) The power output of an adiabatic steam turbine is 5 MW, with the inlet and the outlet values of the steam are as indicated in Figure Q3(d). If the given the value of $g = 9.81 \text{ m/s}^2$, calculate:

Kuasa keluaran suatu turbin adiabatik ialah 5MW dengan nilai-nilai pada masukan dan keluaran stim adalah seperti di Rajah Q3(d). Sekiranya diberi nilai $g = 9.81 \text{ m/s}^2$, kirakan:

- (i) The specific enthalpy of the turbine outlet [4 marks]

Entalpi tentu pada keluaran turbin [4 markah]

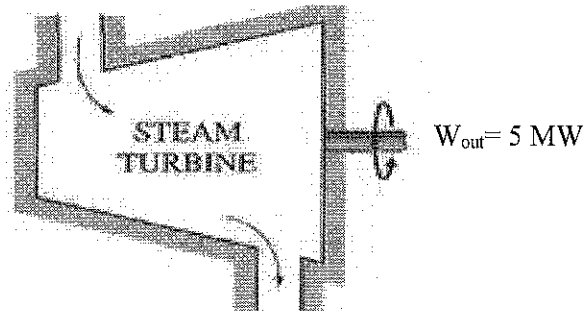
- (ii) The mass flow rate of the steam [7 marks]

Jisim aliran stim [7 markah]

$$h_1 = 3248 \text{ kJ/kg}$$

$$C_1 = 50 \text{ m/s}$$

$$z_1 = 10 \text{ m}$$



$$P_2 = 16 \text{ kPa}$$

$$U_2 = 956 \text{ kJ/kg}$$

$$V_2 = 0.356 \text{ m}^3/\text{kg}$$

$$C_2 = 180 \text{ m/s}$$

$$Z_2 = 6 \text{ m}$$

Figure Q3(d)

Rajah Q3(d)

QUESTION 4**SOALAN 4**

CLO2

- (a) List **FOUR (4)** reversible processes for the Carnot cycle.

Senaraikan EMPAT (4) proses boleh balik Kitar Carnot.

[4 marks]

[4 markah]

CLO2

- (b) Aided with a suitable diagram, explain the Principle of Heat Engine.

Dengan bantuan gambarajah yang sesuai, terangkan Prinsip Enjin Haba.

[6 marks]

[6 markah]

CLO2

- (c) A dry saturated steam is supplied at 50 bar to turbine and the condenser pressure is 0.060 bar. If the plant operates with the Rankine Cycle, aided with T-s diagram, calculate:

Stim tepu kering dibekalkan pada tekanan 50 bar kepada turbin dan tekanan pemeluwap 0.060 bar. Sekiranya loji ini beroperasi dengan Kitar Rankine, dengan bantuan gambarajah T-s, kirakan:

- (i) The work for turbine

Kerja turbine

[11 marks]

[11 markah]

- (ii) The pump feed work

Kerja pam suapan

[2 marks]

[2 markah]

- (iii) The specific steam consumption (s.s.c)

Pengunaan Stim Tentu

[2 marks]

[2 markah]

SOALAN TAMAT

1. PROPERTIES OF PURE SUBSTANCE

Steam

$$v = xv_g \quad h = h_f + xh_{fg} \quad u = u_f + x(u_g - u_f) \quad s = s_f + xs_{fg}$$

Ideal Gas

$$PV = mRT \quad R = \frac{R_o}{M} \quad R = C_p - C_v \quad \gamma = \frac{C_p}{C_v}$$

2. FIRST LAW OF THERMODYNAMICS

$$\Sigma Q = \Sigma W \quad Q - W = U_2 - U_1$$

Flow Process

$$\dot{m} = \rho CA = \frac{CA}{V}$$

$$h = u + pv$$

$$h = C_p \Delta T$$

$$Q - W = \dot{m} \left[(h_2 - h_1) + \left(\frac{C_2^2 - C_1^2}{2} \right) + (Z_2 - Z_1)g \right]$$

Non-Flow Process

1. Isothermal Process ($PV = C$)

$$U_2 - U_1 = 0 \quad Q = W$$

$$W = P_1 V_1 \ln \left(\frac{V_2}{V_1} \right) \quad @ \quad W = P_1 V_1 \ln \left(\frac{P_1}{P_2} \right)$$

$$W = mRT \ln \left(\frac{V_2}{V_1} \right) \quad @ \quad W = mRT \ln \left(\frac{P_1}{P_2} \right)$$

2. Adiabatic Process ($PV^\gamma = C$)

$$U_2 - U_1 = mC_v(T_2 - T_1) \quad W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$$

$$Q = 0 \quad \frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2} \right)^{\gamma-1}$$

3. Polytropic Process ($PV^n = C$)

$$U_2 - U_1 = mC_v(T_2 - T_1) \quad W = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{mR(T_1 - T_2)}{n-1}$$

$$Q = \frac{\gamma - n}{\gamma - 1} \times W \quad \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}$$

4. Isobaric Process

$$U_2 - U_1 = Q - W$$

$$W = P(V_2 - V_1) = mR(T_2 - T_1)$$

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

5. Isometric Process

$$U_2 - U_1 = Q$$

$$W = 0$$

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

3. SECOND LAW OF THERMODYNAMICS

$$W_{net} = Q_H - Q_L$$

Heat Engine

$$\eta_{th} = \frac{W_{net, out}}{Q_H} = 1 - \frac{Q_L}{Q_H}$$

Refrigerator

$$COP_{R, rev} = \frac{T_L}{T_H - T_L} = \frac{1}{T_H/T_L - 1}$$

Heat Pump

$$COP_{HP, rev} = \frac{T_H}{T_H - T_L} = \frac{1}{1 - T_L/T_H}$$

Power Cycle

$$\eta_{Rankine} = \frac{W_T - W_P}{Q_B} = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)}$$

$$Work\ ratio = \frac{W_T - W_P}{W_T} = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$$

$$s.s.c = \frac{3600}{W_T - W_P} = \frac{3600}{(h_1 - h_2) - (h_4 - h_3)}$$