SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI I : 2025/2026

DJJ30293: THERMODYNAMICS

TARIKH : 26 NOVEMBER 2025
MASA : 08.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula dan Jadual Steam

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) State **THREE (3)** differences of Reversible Process and Irreversible Process.
*Nyatakan **TIGA (3)** perbezaan antara Proses Boleh Balik dan Proses Tak Boleh Balik.*

[6 marks]
[*6 markah*]

CLO1 (b) Given the pressure and specific internal energy of wet steam is 8 bar and 2450 kJ/kg. Calculate:
Diberi tekanan dan tenaga dalam tentu bagi stim basah adalah 8 bar dan 2450 kJ/kg. Kirakan:

i. Dryness fraction
Pecahan Kekeringan

[3 marks]
[*3 markah*]

ii. Specific volume
Isipadu tentu

[3 marks]
[*3 markah*]

iii. Specific enthalpy
Entalpi tentu

[3 marks]
[*3 markah*]

CLO1

(c) Superheated steam at pressure 46 bar and 420 °C. Calculate:
Stim panas lampau pada tekanan 46 bar dan 420 °C. Kirakan:

i. Degree of superheat (D.O.S)
Darjah panas lampau

[2 marks]
[*2 markah*]

ii. Specific enthalpy of steam
Entalpi tentu stim

[8 marks]
[*8 markah*]

QUESTION 2

SOALAN 2

CLO2 (a) With a suitable diagram, explain Closed System and Open System.

Dengan rajah yang sesuai, terangkan Sistem Tertutup dan Sistem Terbuka.

[6 marks]

[*6 markah*]

CLO2 (b) Figure 2 (b) shows the interactions of energy in a system. Calculate:

Rajah 2 (b) menunjukkan interaksi tenaga dalam sebuah sistem. Kirakan:

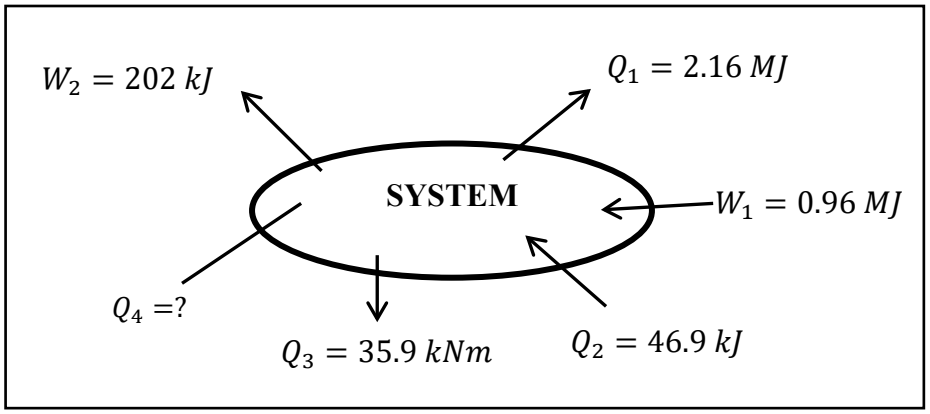

Figure 2 (b) / *Rajah 2 (b)*

i. Total amount of work in kJ

Jumlah kerja dalam kJ

[4 marks]

[*4 markah*]

ii. Value of Q4 if the internal energy is increased by 120 kJ

Nilai Q4 jika tenaga dalam bertambah sebanyak 120 kJ

[5 marks]

[*5 markah*]

CLO2

(c) A gas with mass of 0.15 kg (M = 32) at pressure of 1.6 bar is compressed until its pressure is 6.5 bar. Initial temperature is 40 ºC. If the compression process is according to law $PV^{1.35}$ = constant, assume c_v = 0.65 kJ/kgK, determine:

Gas berjisim 0.15 kg (M = 32) pada tekanan 1.6 bar dimampatkan sehingga tekanannya ialah 6.5 bar. Suhu awal ialah 40 °C. Jika proses mampatan adalah mengikut undang-undang $PV^{1.35}$ *= malar, andaikan* c_v *= 0.65 kJ/kgK, tentukan:*

i. Final temperature.
Suhu akhir.

[4 marks]
[*4 markah*]

ii. Work done.
Kerja yang dilakukan.

[6 marks]
[*6 markah*]

QUESTION 3

SOALAN 3

CLO2 (a) Referring to the Steady Flow Energy Equation below, express the name of each symbol and its unit.

Merujuk kepada Persamaan Tenaga Aliran Mantap dibawah, nyatakan nama setiap simbol dan unitnya.

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

[6 marks]

[*6 markah*]

CLO2 (b) A steam enters a boiler with specific enthalpy of 1350 kJ/kg at velocity of 20 m/s. It leaves the system with at pressure of 10kPa, specific internal energy 2750 kJ/kg, specific volume of 0.03m^3/kg and velocity of 35 m/s. If the mass flow rate is 3168 kg/hr, calculate:

Stim memasuki dandang dengan entalpi tentu 1350 kJ/kg pada kelajuan 20 m/s. Ia meninggalkan system pada tekanan 10 kPa, tenaga dalam tentu 2750kJ/kg.K, isipadu tentu 0.03 m^3/kg dan kelajuan 35 m/s. Jika kadar aliran jisim ialah 3168 kg/J, hitungkan:

i. Final enthalpy.

Entalpi akhir.

[2 marks]

[*2 markah*]

ii. Heat transfer.

Pemindahan haba.

[7 marks]

[*7 markah*]

CLO2 (c) A fluid flows steadily in a turbine with 4.17 kg/s at pressure 6.5 bar, specific volume 0.25 m^3/kg and cross-sectional area 0.35 m^2. The fluid leaves with pressure 5.2 bar and specific volume 0.40 m^3/kg. If the internal energy changed is 800 kJ/kg, heat transfer to the surroundings is 255 kJ/s and exit velocity is neglected, determine:

Satu bendalir mengalir dengan mantap dalam turbin dengan 4.17kg/s pada tekanan 6.5 bar, isipadu tentu 0.25 m^3/kg dan luas keratan rentas 0.35 m^2. Bendalir tersebut keluar pada tekanan 5.2 bar dan isipadu tentu 0.40 m^3/kg. Jika perubahan tenaga dalam tentu adalah 800 kJ/kg, pemindahan haba ke persekitaran ialah 255 kJ/s dan halaju keluar diabaikan, tentukan:

i. Inlet velocity.
Halaju masukan.

[3 marks]
[*3 markah*]

ii. Power transfer.
Kuasa yang dipindahkan.

[7 marks]
[*7 markah*]

QUESTION 4

SOALAN 4

CLO2 (a) Describe **TWO (2)** types of thermal reservoirs.

*Huraikan **DUA (2)** jenis takungan haba*.

[4 marks]

[*4 markah*]

CLO2 (b) A heat engine receives 2950 kJ/min of heat from a steam boiler and produces 25 kW of power.

Sebuah enjin haba menerima 2950 kJ/min haba daripada dandang stim dan menghasilkan 25 kW kuasa.

i. Sketch the schematic diagram for the heat engine

Lakarkan rajah skematik bagi enjin haba

[2 marks]

[*2 markah*]

and calculate;

dan hitungkan;

ii. The heat that is absorbed by the river.

Haba yang diserap oleh sungai.

[4 marks]

[*4 markah*]

iii. Thermal efficiency.

Kecekapan haba.

[2 marks]

[*2 markah*]

CLO2 (c) A steam power plant operates with Carnot cycle at a boiling pressure of 50 bar. The steam condition expands in the turbine until the pressure decreased to 0.055 bar. Based on the power plant statement above, calculate

Sebuah loji kuasa wap beroperasi dengan kitar Carnot pada tekanan didih 50 bar. Keadaan wap mengembang dalam turbin sehingga tekanan menurun kepada 0.055 bar. Berdasarkan pernyataan loji janakuasa di atas, *hitungkan*

i. The heat required.
Haba yang diperlukan.

[5 marks]
[*5 markah*]

ii. The work input.
Kerja masukan.

[8 marks]
[*8 markah*]

SOALAN TAMAT

1.0 PROPERTIES OF PURE SUBSTANCES

Wet Steam

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

Superheat Steam

$$Degree\ Of Superheat = T_{superheat} - T_{saturated}$$

Ideal Gas

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

$$C_v = \frac{R}{(\gamma - 1)} \qquad C_p = \frac{\gamma R}{(\gamma - 1)}$$

2.0 FIRST LAW OF THERMODYNAMICS

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

Flow process

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

$$\dot{m} = \rho CA \qquad h = u + pv \qquad h = C_p(T_2 - T_1)$$

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

Non-Flow process

1. **Isothermal Process (PV=C)**

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

$$W = P_1V_1 \ln\left(\frac{V_2}{V_1}\right) \quad @ \quad W = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$$

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

2. **Isobaric Process**

$$U_2 - U_1 = Q - W$$

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

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

3. **Isometric Process**

$$U_2 - U_1 = Q$$

$$W = 0$$

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

4. Adiabatic Process

$$U_2 - U_1 = -W$$

$$U_2 - U_1 = mC_v(T_2 - T_1)$$

$$Q = 0$$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$$

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

5. Polytropic Process

$$U_2 - U_1 = mC_v(T_2 - T_1)$$

$$Q = \frac{\gamma - n}{\gamma - 1} \times W$$

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

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

3.0 SECOND LAW OF THERMODYNAMICs

Heat Engine

$$Thermal\ efficiency, \eta_{th} = \frac{W_{net}}{Q_H} = \frac{Q_H - Q_L}{Q_H} = 1 - \frac{Q_L}{Q_H} \qquad \eta_{th,rev} = 1 - \frac{T_L}{T_H}$$

Refrigerator

$$COP_R = \frac{Q_L}{W_{net}} = \frac{Q_L}{Q_H - Q_L} \qquad COP_{R,rev} = \frac{T_L}{T_H - T_L}$$

Heat Pump

$$COP_{HP} = \frac{Q_H}{W_{net}} = \frac{Q_H}{Q_H - Q_L} \qquad COP_{HP,rev} = \frac{T_H}{T_H - T_L}$$

Power Cycle

$$Cycle\ efficiency, \eta = \frac{W_{net}}{Q_{in}} = \frac{W_T - W_p}{Q_B} \qquad specific\ steam\ consumption = \frac{3600}{W_{net}} = \frac{3600}{W_T - W_p}$$

$$work\ ratio, r_w = \frac{W_{net}}{W_{gross}}$$

$$r_w = \frac{W_T - W_p}{W_T}$$