



**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 II : 2025/2026

DJJ20063: THERMODYNAMICS

TARIKH : 13 MEI 2026

MASA : 02.30 PETANG – 04.30 PETANG (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. Answers **ALL** questions.

ARAHAN:

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

QUESTION 1**SOALAN 1**

CLO1

- (a) Define the following process:

Definisikan proses berikut:

- i. Reversible process

Proses boleh balik

[3 marks]

[3 markah]

- ii. Irreversible process

Proses tidak boleh balik

[3 marks]

[3 markah]

CLO1

- (b) Based on the Zeroth Law of Thermodynamics:

Berdasarkan Zeroth Law of Thermodynamics:

- i. Explain the Zeroth Law of Thermodynamics

Terangkan Zeroth Law of Thermodynamics

[3 marks]

[3 markah]

- ii. Visualize the Zeroth Law of Thermodynamics with the aid of a suitable diagram.

Gambarkan Zeroth Law of Thermodynamics dengan bantuan rajah yang sesuai.

[5 marks]

[5 markah]

CLO2

- (c) Given the specific energy of wet steam is 2245 kJ/kg and the pressure is 20 bar, calculate the given values for the solution:

Diberi tenaga tentu wap basah ialah 2245 kJ/kg dan tekanan ialah 20 bar, kirakan nilai yang diberikan bagi penyelesaian:

- i. Specific volume

Isipadu tentu

[4 marks]

[4 markah]

- ii. Specific enthalpy

Entalpi tentu

[2 marks]

[2 markah]

- iii. the specific enthalpy for steam at a pressure of 5 bar and a temperature of 236 °C by referring to the steam table:

nilai entalpi tentu stim pada tekanan 5 bar dan suhu 236°C dengan merujuk kepada jadual stim:

[5 marks]

[5 markah]

QUESTION 2

SOALAN 2

- CLO2 (a) Describe briefly the Non-Flow Process.
Terangkan secara ringkas Proses Tak Alir.
[4 marks]
[4 markah]
- CLO2 (b) The heat transfer to the system is 500 kJ/kg, and the initial internal energy is 250 kJ/kg greater than the final.
Haba yang dipindahkan ke sistem sebanyak 500 kJ/kg dan tenaga dalaman awal bernilai 250 kJ/kg lebih besar daripada nilai tenaga dalaman akhir.
- i. Express by calculating the value of work done by the system.
Nyatakan dengan mengira nilai kerja yang dilakukan oleh system
[6 marks]
[6markah]
- ii. Based on answer b (i), interpret whether the work is done by the system or on the system.
Berdasarkan jawapan di b(i), terjemahkan sama ada kerja dilakukan oleh sistem atau ke atas sistem.
[2 marks]
[2 markah]
- CLO2 (c) A certain perfect gas has an initial pressure of 12 bar and a volume of 0.024 m³ is expanded adiabatically to a final pressure of 160 kPa. Given that C_p and C_v are 1.046 kJ/kgK and 0.752 kJ/kgK. Calculate:
Sejenis gas sempurna mempunyai tekanan bernilai 12 bar and isipadunya bernilai 0.024 m³ dikembangkan melalui proses adiabatic sehingga tekanan akhirnya bernilai 160 kPa. Diberi nilai C_p and C_v masing-masing bernilai 1.046 kJ/kgK dan 0.752 kJ/kgK. Kirakan:

- i. Final volume of the gas

Isipadu akhir gas

[6 marks]

[6 markah]

- ii. Work done by the gas

Kerja yang dilakukan oleh gas

[3 marks]

[3 markah]

- iii. Change of internal energy of the gas

Perubahan tenaga dalaman gas

[4 marks]

[4 markah]

QUESTION 3

SOALAN 3

- CLO2 (a) Identify **TWO (2)** characteristics of an open system including **ONE (1)** example of the equipment involved for each.
*Kenalpasti **DUA (2)** ciri sistem terbuka termasuk **SATU (1)** contoh peralatan bagi setiap sistem*
- [4 marks]
[4 markah]
- CLO2 (b) A fluid enters a nozzle with a specific enthalpy of 3020 kJ/kg, a velocity of 50 m/s, and a specific volume of 0.15 m³/kg. The fluid exits a nozzle with a specific enthalpy of 2780 kJ/kg and a specific volume of 0.85 m³/kg. If the inlet area of the nozzle is 0.1 m². Express the following value by calculating:
Bendalir memasuki muncung dengan entalpi tentu 3020 kJ/kg, halaju 50 m/s dan isipadu tentu 0.15 m³/kg. Bendalir keluar muncung dengan entakpi tentu 2780 kJ/kg dan isipadu tentu 0.85 m³/kg. Jika luas bahagian masukan muncung adalah 0.1 m², nyatakan nilai berikut dengan mengira:
- i. Exit velocity of the fluid
Halaju keluaran bendalir
- [4 marks]
[4 markah]
- ii. Outlet area of the nozzle
Luas keluaran muncung
- [4 marks]
[4 markah]

CLO2

- (c) A nozzle is supplied with steam having a specific enthalpy of 2780 kJ/kg at the rate of 9.1 kg/min. At the nozzle outlet, the steam velocity is 1070 m/s. Assuming that the inlet velocity of the system is negligible and that the process is adiabatic, calculate:

Sebuah muncung dibekalkan dengan stim yang mempunyai entalpi tertentu 2780 kJ/kg pada kadar 9.1 kg/min. Pada salur keluar dari muncung halaju stim ialah 1070 m/s. Dengan mengandaikan bahawa halaju masuk sistem boleh diabaikan dan prosesnya adalah adiabatik, kirakan:

- i. The specific enthalpy of the steam at the nozzle exit

Entalpi tentu stim pada keluar muncung

[7 marks]

[7 markah]

- ii. The nozzle outlet area (mm^2) required if the final specific volume of the steam is $18.75 \text{ m}^3/\text{kg}$

Luas salur keluar muncung yang diperlukan jika isipadu tentu akhir stim ialah $18.75 \text{ m}^3/\text{kg}$

[6 marks]

[6 markah]

QUESTION 4**SOALAN 4**

- CLO2 (a) List **FOUR (4)** reversible processes for the Carnot cycle.
Senaraikan EMPAT (4) proses boleh balik kitar Karnot.
- [4 marks]
[4 markah]
- CLO2 (b) Based on the heat engine principles:
- i. Explain **ONE (1)** characteristic of the heat engine
Terangkan prinsip operasi enjin haba.
- [2 marks]
[2 markah]
- ii. Visualize heat engine with the aid of a suitable diagram.
Gambarkan enjin haba dengan bantuan rajah yang sesuai.
- [4 marks]
[4 markah]
- CLO2 (c) A steam power plant operates between a boiler pressure of 40 bar and a condenser pressure of 0.045 bar. Calculate these limits for the Rankine Cycle with dry saturated steam at entry to the turbine:
Sebuah penjana kuasa stim bekerja diantara tekanan dandang 40 bar dan tekanan pemeluap 0.045 bar. Kirakan had bagi Kitar Rankine dengan wap kering tepu Ketika memasuki turbin:
- i. Cycle efficiency
Kecekapan kitar
- [11 marks]
[11 markah]

ii. Work Ratio

Nisbah Kerja

[2 marks]

[2 markah]

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

Penggunaan 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

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

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

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