

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 II : 2024/2025

DJJ20063 : THERMODYNAMICS

TARIKH : 19 MEI 2025

MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** 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)** structured questions. Answer **ALL** questions.

ARAHAN:

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

QUESTION 1**SOALAN 1**

- CLO1 (a) Define the following terms:
- Takrifkan terma berikut:*
- i. Boundary [2 marks]
Sempadan [2 markah]
 - ii. Energy conversion [2 marks]
Penukaran tenaga [2 markah]
 - iii. Process [2 marks]
Proses [2 markah]
- CLO2 (b) Steam at 32 bar has the specific enthalpy of 2014 kJ/kg. Relate the value from steam table for solution of:
- Stim pada tekanan 32 bar mempunyai entalpi tentu 2014 kJ/kg. Hubungkan nilai yang diberi untuk penyelesaian:*
- i. Dryness fraction [3 marks]
Pecahan kekeringan [3 markah]
 - ii. Specific internal energy [4 marks]
Tenaga dalam tentu [4 markah]

CLO2 (c) The temperature of superheated steam at 125 bar is 570°C. Using the steam table, calculate:

Suhu wap panas lampau pada 125 bar ialah 570°C. Dengan menggunakan jadual stim, kirakan:

i. Degree of Superheat [3 marks]

Darjah Panas lampau [3 markah]

ii. Specific enthalpy [9 marks]

Enthalpy tentu [9 markah]

QUESTION 2**SOALAN 1**

- CLO2 (a) "Non-flow process is a process where no mass transfer across the boundary of a system." Based on the definition of non-flow process, list **FOUR (4)** examples of non-flow process.

*"Proses tidak alir ialah proses di mana tiada jisim merentas sempadan sistem". Berdasarkan takrifan yang dinyatakan, senaraikan **EMPAT (4)** contoh proses tidak alir.*

[4 marks]

[4 markah]

- CLO2 (b) In an industrial process, 0.5 kg of oxygen is compressed isothermally from 1.013 bar and 25°C to 5.5 bar. Assume that oxygen is a perfect gas and take the molecular mass of oxygen to be $M = 32 \text{ kg/kmol}$. Relate the values given for solution of following properties:

Dalam proses perindustrian, 0.5 kg oksigen dimampatkan secara isoterma daripada 1.013 bar dan 25°C kepada 5.5 bar. Andaikan oksigen ialah gas sempurna dan ambil jisim molekul oksigen sebagai $M = 32 \text{ kg/kmol}$. Hubungkan nilai yang diberikan untuk penyelesaian bagi sifat berikut:

- i. Specific gas constant [2 marks]

Pemalar gas tentu [2 markah]

- ii. Work input [4 marks]

Kerja masukan [4 markah]

- iii. Heat transfer during the process [2 marks]

Pemindahan haba semasa proses [2 markah]

Given $R_0 = 8314.5 \text{ J/kmolK}$

Diberi $R_0 = 8314.5 \text{ J/kmolK}$

CLO2

(c) A cylinder contains 0.675 kg of gas at pressure of 17 bar and a temperature of 270°C . The gas is then expanded four times from its initial volume adiabatically with γ value of 1.5. If the gas is assumed to be a perfect gas, and the gas constant is 287 J/kg.K, calculate:

Sebuah silinder mengandung 0.675 kg gas pada tekanan 17 bar dan suhu 270°C . Gas itu kemudiannya dikembangkan empat kali daripada isipadu awal secara adiabatik dengan nilai γ adalah 1.5. Jika gas itu dianggap sebagai gas sempurna, dan pemalar gas ialah 287 J/kg.K, kirakan:

- | | | |
|------|--------------------------------------|------------|
| i. | Initial volume of the gas | [4 marks] |
| | <i>Isipadu awal bagi gas</i> | [4 markah] |
| ii. | Final volume of the gas | [2 marks] |
| | <i>Isipadu akhir bagi gas</i> | [2 markah] |
| iii. | Final pressure of the gas | [3 marks] |
| | <i>Tekanan akhir bagi gas</i> | [3 markah] |
| iv. | Work done of the gas | [4 marks] |
| | <i>Kerja yang dilakukan oleh gas</i> | [4 markah] |

QUESTION 3**SOALAN 3**

- CLO2 (a) The Steady Flow Energy Equation may be applied to any engineering devices. List **FOUR (4)** engineering devices that use the principal of flow process.

*Persamaan Tenaga Aliran Mantap boleh digunakan pada mana-mana peralatan kejuruteraan. Senaraikan **EMPAT (4)** peralatan kejuruteraan yang menggunakan prinsip proses aliran.*

[4 marks]

[4 markah]

- CLO2 (b) In a steady flow system, an air flow through a compressor at the rate of 30 kg/s and having properties as in Table 3(b).

Dalam sistem aliran mantap, aliran udara melalui pemampat pada kadar 30 kg/s mempunyai ciri-ciri seperti Jadual 3(b).

Table 3(b)/ Jadual 3(b)

Property <i>Ciri-ciri</i>	Inlet <i>Bahagian Masukan</i>	Outlet <i>Bahagian Keluaran</i>
Specific enthalpy <i>Entalpi tentu</i>	1744.4 kJ/kg	3556 kJ/kg
Velocity <i>Halaju</i>	15 m/s	35 m/s

During its passage through the system, the air has a loss of heat of 30 kJ/s to the surrounding. Assuming the change in potential energy are negligible, relate the value given for the solution of the following:

Semasa merentasi sistem, udara kehilangan haba sebanyak 30 kJ/s ke persekitaran. Dengan mengabaikan perubahan tenaga keupayaan, hubungkan nilai yang diberi untuk penyelesaian bagi yang berikut:

- i. Power required in kW.

Kuasa yang diperlukan dalam kW.

[5 marks]

[5 markah]

- ii. Compressor's inlet area if the specific volume is $0.34 \text{ m}^3/\text{kg}$.

Luas masukan bagi pemampat sekiranya isipadu tentu adalah $0.34 \text{ m}^3/\text{kg}$.

[3 marks]

[3 markah]

CLO2

- (c) In a steady flow system, steam flows through a turbine at the rate of 12 kg/s . It enters the system at a pressure of 100 bar , a velocity of 80 m/s , specific internal energy 3238 kJ/kg and specific volume of $0.03 \text{ m}^3/\text{kg}$. It leaves the system at a pressure of 0.1 bar , a velocity of 50 m/s , specific internal energy 2257 kJ/kg and specific volume of $13.5 \text{ m}^3/\text{kg}$. Calculate:

Dalam suatu sistem aliran sekata, stim mengalir melalui turbin pada kadar 12 kg/s . Ia memasuki sistem pada tekanan 100 bar , berkelajuan 80 m/s , tenaga dalam tentu 3238 kJ/kg dan isipadu tentu sebanyak $0.03 \text{ m}^3/\text{kg}$. Stim keluar dari sistem pada tekanan 0.1 bar , berkelajuan 50 m/s , tenaga dalam tentu 2257 kJ/kg dan isipadu tentu sebanyak $13.5 \text{ m}^3/\text{kg}$. Kirakan:

- i. Change of specific enthalpy

Perubahan entalpi tentu

[6 marks]

[6 markah]

- ii. Power of the system in kilowatts.

Kuasa bagi sistem dalam kilowatt.

[7 marks]

[7 markah]

QUESTION 4**SOALAN 4**

- CLO2 (a) Define Second Law of Thermodynamics.
Takrifkan Hukum Kedua Termodinamik.
[4 marks]
[4 markah]
- CLO2 (b) A Carnot heat engine operates between two thermal energy reservoirs with temperatures of 999 K and 376 K, respectively. It receives 810 kJ/s of heat rate from the hot reservoir. Relate the given data to the solution of:
Enjin haba Carnot beroperasi di antara dua takungan haba dengan suhu masing-masing 999K dan 376K. Ia menerima kadar haba 810 kJ/s daripada takungan panas. Hubungkaitkan data yang diberi untuk penyelesaian:
- i. Thermal efficiency [3 marks]
Kecekapan terma [3 markah]
- ii. The rate of heat rejected to the cold reservoir
Kadar haba yang disingkirkan ke takungan sejuk
[3 marks]
[3 markah]
- CLO2 (c) A Rankine steam power plant operates between a boiler pressure of 48 bar and a condenser pressure of 0.060 bar. If the plants operate with the Rankine cycle, calculate:
Sebuah penjana kuasa stim beroperasi di antara tekanan dandang 48 bar dan tekanan pemeluwap 0.060 bar. Jika loji itu beroperasi dengan menggunakan kitaran Rankine, kirakan:
- i. The cycle efficiency [11 marks]
Kecekapan kitar [11 markah]

- ii. The work ratio [2 marks]
Nisbah kerja [2 markah]
- iii. The specific steam consumption [2 marks]
Penggunaan stim tentu [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

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

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

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