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 berstuktur. 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. Hubungkaitkan 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 25^0C to 5.5 bar. Assume that oxygen is a perfect gas and take the molecular mass of oxygen to be M = 32kg/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 25^0C kepada 5.5 bar. Andaikan oksigen ialah gas sempurna dan ambil jisim molekul oksigen sebagai M = 32kg/kmol. Hubungkaitkan 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 J/kmolK

Diberi R_0 = 8314.5 J/kmolK

CLO2 (c) A cylinder contains 0.675 kg of gas at pressure of 17 bar and a temperature of 270^{0}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 mengandungi 0.675 kg gas pada tekanan 17 bar dan suhu 270^{0}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]
Isipadu awal bagi gas [4 *markah*]

ii. Final volume of the gas [2 marks]
Isipadu akhir bagi gas [2 *markah*]

iii. Final pressure of the gas [3 marks]
Tekanan akhir bagi gas [*3 markah*]

iv. Work done of the gas [4 marks]
Kerja yang dilakukan oleh gas [*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 *Ciri-ciri*	Inlet *Bahagian Masukan*	Outlet *Bahagian Keluaran*
Specific enthalpy *Entalpi tentu*	1744.4 kJ/kg	3556 kJ/kg
Velocity *Halaju*	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, hubungkaitkan 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 m^3/kg.
Luas masukan bagi pemampat sekiranya isipadu tentu adalah 0.34 m^3/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 m^3/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 m^3/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 m^3/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 m^3/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

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

Ideal Gas

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

2. FIRST LAW OF THERMODYNAMICS

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

Flow Process

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

$$h = u + pv$$

$$h = Cp\,\Delta T$$

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

Non-Flow Process

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

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

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

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

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

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

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

$Q = 0$

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

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

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

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

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

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

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

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