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 : 2023/2024

DJJ20063 : THERMODYNAMICS

TARIKH : 08 JUN 2024
MASA : 2.30 PETANG - 4.30 PETANG (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)

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) Identify **(i), (ii), (iii), (iv), (v)** and **(vi)** for the following characteristics based on Table 1(a) below either it is extensive properties or intensive properties.

*Kenalpasti **(i), (ii), (iii), (iv), (v)** dan **(vi)** untuk ciri berikut berdasarkan Jadual 1(a) di bawah sama ada ianya bersifat ekstensif atau bersifat intensif.*

Table 1(a)/ *Jadual 1(a)*

Characteristic *Ciri*	Extensive properties/ Intensive properties *Sifat ektensif/Sifat intensif*
15 m^3 of water. *15 m^3 air.*	**(i)**
33 kJ of kinetic energy. *33 kJ tenaga kinetik.*	**(ii)**
90 N/m^2 of air pressure. *90 N/m^2 tekanan udara.*	**(iii)**
60 kg of sugar. *60 kg gula.*	**(iv)**
27^0C room temperature. *27^0C suhu bilik.*	**(v)**
120 kg/m^3 of gases. *120 kg/m^3 gas.*	**(vi)**

[6 marks]

[*6 markah*]

CLO2 (b) The percentage of steam quality is 80% at 40 bar. Relate the values given for solution of:

Peratus kualiti stim adalah 80% pada 40 bar. Hubungkaitkan nilai yang diberi untuk penyelesaian :

i. Specific volume

Isipadu tentu

[4 marks]

[*4 markah*]

ii. Specific enthalpy

Entalpi tentu

[3 marks]

[*3 markah*]

CLO2 (c) Calculate the specific enthalpy for superheated steam at pressure of 35 bar at the following temperature:

Kira nilai enthalpi tentu bagi stim panas lampau pada tekanan 35 bar pada suhu berikut:

i. Temperature of 450^0C.

Suhu 450^0C

[4 marks]

[*4markah*]

ii. Temperature of 500^0C

Suhu *500^0C*

[4 marks]

[*4 markah*]

iii. Temperature of 470^0C

Suhu 470^0C

[4 marks]

[*4 markah*]

QUESTION 2

SOALAN 2

CLO2 (a) Name the system X in Figure 2(a) below and state **THREE (3)** characteristics of System X.

*Namakan Sistem X pada Rajah 2(a) di bawah dan nyatakan **TIGA (3)** ciri Sistem X.*

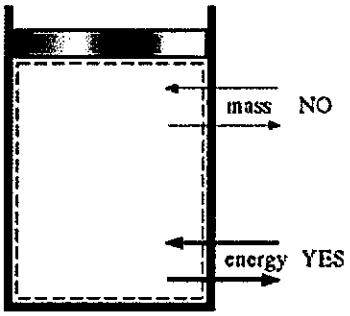

Figure 2(a): System X / *Rajah 2(a): Sistem X*

[4 marks]

[*4 markah*]

CLO2 (b) Air at 1.02 bar with temperature 22^0C, initially occupying a cylinder of $0.015m^3$, is compressed reversibly and adiabatically by piston to a pressure 6.8 bar. Assuming the gas is a perfect gas with specific heat ratio 1.4, relate the values given for solution of following properties:

Udara pada 1.02 bar dengan suhu 22^0C pada awalnya dimampatkan secara boleh balik dan adiabatik di dalam silinder berisipadu $0.015m^3$ oleh piston kepada tekanan 6.8 bar. Dengan menganggap gas adalah gas sempurna dengan nisbah kepada haba tentu 1.4, hubungkaitkan nilai yang diberi untuk penyelesaian bagi ciri- ciri berikut:

i. The final temperature.

Suhu akhir.

[4 marks]

[*4 markah*]

ii. The final volume.

Isipadu akhir.

[4 marks]

[*4 markah*]

CLO2

(c) 1 kg of an ideal gas has an initial pressure of 5.2 bar and temperature of 120^0C. Given C_p = 1.005 kJ/kgK and C_v = 0.718 kJ/kgK.

1 kg gas unggul mempunyai tekanan awal 5.2 bar dan suhu 120^0C. Diberi C_p = 1.005 kJ/kgK, C_v = 0.718 kJ/kgK

i. If the gas undergoes an isometric process until its temperature increases to 210^0C, calculate the change of internal energy and the final pressure of the gas.

Jika gas menjalani proses isometrik sehingga suhunya meningkat kepada 210^0C, kirakan perubahan tenaga dalam dan tekanan akhir gas.

[7 marks]

[*7 markah*]

ii. If the gas undergoes an isobaric process with an initial volume of 0.219 m^3 and the final volume of 0.42 m^3, calculate the final temperature and work done of the gas.

Jika gas menjalani proses isobarik dengan isipadu awal 0.219m^3 dan isipadu akhirnya 0.42m^3, kirakan suhu akhir dan kerja yang dilakukan oleh gas.

[6 marks]

[*6 markah*]

QUESTION 3
SOALAN 3

CLO2 (a) List **FOUR (4)** energies that are included in Steady Flow Energy Equation.
*Senaraikan **EMPAT (4)** tenaga yang terlibat dalam persamaan tenaga aliran mantap.*

[4 marks]
[*4 markah*]

CLO2 (b) Air flows steadily through an air compressor as shown on Table 3(b) below:
Udara mengalir secara mantap melalui pemampat udara seperti ditunjukkan di dalam Jadual 3(b) di bawah:

Table 3(b)/ *Jadual 3(b)*

	Entrance *Masukan*	**Exit** *Keluaran*
Pressure (bar) *Tekanan (bar)*	2.5	6.7
Specific volume (m^3/kg) *Isipadu tentu (m^3/kg)*	1.042	0.321
Velocity (m/s) *Halaju (m/s)*	35	16

The air flows at the rate of 0.4 kg/s with specific internal energy of the air leaving is 999 kJ/kg greater than the entrance. If the heat transfer to the cooling water is 65 kJ/s, express the value of power required to drive the compressor.
Udara mengalir pada kadar 0.4 kg/s dengan tenaga dalam tentu udara pada keluaran adalah 999 kJ/kg lebih besar dari masukan. Jika haba yang dipindahkan pada air penyejuk adalah sebanyak 65 kJ/s, zahirkan nilai kuasa yang diperlukan untuk memacu pemampat.

[8 marks]
[*8 markah*]

CLO2 (c) A steam turbine receives a steam flow of 75 kg/min and the power output is 450 kW. The heat loss from the casing is negligible. Calculate:
Turbin stim menerima aliran stim sebanyak 75 kg/min dan kuasa keluaran sebanyak 450 kW. Kehilangan haba daripada selongsong diabaikan. Kirakan:

i. The change of specific enthalpy across the turbine when the velocities at entrance and the exit and the difference in elevation are negligible.
Perubahan entalpi tentu merentasi turbin apabila halaju pada bahagian masuk dan keluar serta perbezaan ketinggian diabaikan.

[5 marks]
[*5 markah*]

ii. The change of specific enthalpy across the turbine when the velocity at entrance is 65 m/s, the velocity at exit is 350 m/s and the inlet pipe is 3m above the exhaust pipe.
Perubahan entalpi tentu merentasi turbin apabila halaju di bahagian masukan adalah 65 m/s, halaju dibahagian keluaran adalah 350 m/s, dan paip masuk adalah 3m di atas paip keluar.

[5 marks]
[*5 markah*]

iii. The area of the inlet pipe if the velocity and specific volume of the steam at inlet is 65 m/s and 4.68 m^3/kg respectively.
Luas salur masuk paip jika halaju dan isipadu tentu stim pada bahagian masukan masing-masing ialah 65 m/s dan 4.68 m^3/kg.

[3 marks]
[*3 markah*]

QUESTION 4
SOALAN 4

CLO2 (a) Describe **TWO (2)** characteristics for heat engine and **TWO (2)** characteristics for reverse heat engine.
*Huraikan **DUA (2)** ciri enjin haba dan **DUA (2)** ciri enjin haba balikan.*

[4 marks]
[*4 markah*]

CLO2 (b) Heat is transferred to a heat engine from a furnace at a rate of 70000 kW. If the rate of waste heat rejection to a nearby river is 35 MW, express the value of nett work done and the thermal efficiency for this heat engine.
Haba dipindahkan kepada enjin haba dari relau pada kadar 70000 kW. Sekiranya sisa buangan haba tersebut ke sungai berdekatan adalah sebanyak 35MW, zahirkan nilai kerja bersih yang dilakukan dan kecekapan enjin haba tersebut.

[6 marks]
[*6 markah*]

CLO2 (c) A Rankine steam power plant operates between a boiler pressure of 4400 kPa and a condenser pressure of 0.03 bar. If steam entry to the turbine with dry saturated, calculate:
Sebuah penjana kuasa stim Rankine bekerja di antara tekanan dandang 4400 kPa dan tekanan pemeluwap 0.03 bar. Sekiranya stim masuk ke dalam turbin pada keadaan tepu kering kirakan:

i. Turbine work
Kerja turbin

[8 marks]
[*8 markah*]

ii. Feed pump work.
Kerja pam suapan.

[3 marks]
[*3 markah*]

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

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

$h = u + pv$

$h = Cp\,\Delta T$

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

Non-Flow Process

1. Isothermal Process ($PV = C$)

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

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

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

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

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

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

iii. Rankine cycle efficiency.
Kecekapan kitar Rankine

[4 marks]
[*4 markah*]

SOALAN TAMAT

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

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

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

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

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

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

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