SULIT

POLITEKNIK MALAYSIA

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2018

DJJ2073 : THERMODYNAMICS

TARIKH : 28 OKTOBER 2018
MASA : 2.30 PETANG - 4.30 PETANG (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula dan buku Stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

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

ARAHAN:

*Kertas ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO 1
C1

(a) Define the following terms:

Takrifkan istilah-istilah berikut:

i. Process / *Proses.*

[2 marks]
[*2 markah*]

ii. State / *Keadaan.*

[2 marks]
[*2 markah*]

iii. Principal of energy conversion / *Prinsip perubahan tenaga.*

[2 marks]
[*2 markah*]

CLO 1
C2

(b) Convert the following units:

Tukarkan unit-unit berikut:

i. 10 km/h to m/s.
10 km/h kepada m/s.

[2 marks]
[*2 markah*]

ii. 15 g/mm^3 to kg/m^3.
15 g/mm^3 kepada kg/m^3.

[2 marks]
[*2 markah*]

iii. 1 g/cm^3 to kg/m^3.
1 g/cm^3 kepada kg/m.

[2 marks]
[*2 markah*]

CLO 1
C2

(c) Given the pressure of wet steam is 36 bar and the dryness fraction is 0.62. Calculate:

Diberi tekanan stim basah bersamaan dengan 36 bar dan pecahan kekeringan 0.62. Kirakan nilai:

i. Specific volume / *Isipadu tentu.*

[3 marks]
[*3 markah*]

ii. Specific enthalpy / *Enthalpi tentu.*

[3 marks]
[*3 markah*]

iii. Specific entropy / *Entropi tentu.*

[3 marks]
[*3 markah*]

iv. Specific internal energy / *Tenaga Dalam tentu.*

[4 marks]
[*4 markah*]

QUESTION 2

SOALAN 2

(a) Define the following term:

Takrifkan yang berikut:

CLO 1
C1

i. Microscopic energy

Tenaga mikroskopik. [2 marks]

[*2 markah*]

ii. Energy transfer by work.

Pemindahan tenaga kerja. [2 marks]

[*2 markah*]

(b) 0.25 kg of gas is at a temperature of 17 °C, volume 0.19 m^3 and pressure 115 kN/m^2. If the gas has a value of C_v = 720 J/kg K, determine:

0.25 kg gas pada suhu 17 ^0C, berisipadu 0.19 m^3 dan tekanan 115 kN/m^2. Jika gas tersebut mempunyai C_v = 720 J/kg K, tentukan:

CLO 1
C2

i. Gas constant

Pemalar gas [2 marks]

[*2 markah*]

ii. Specific heat at constant pressure

Haba tentu pada tekanan tetap [2 marks]

[*2 markah*]

iii. Specific heat ratio

Nisbah haba tentu [2 marks]

[*2 markah*]

CLO 1
C3

(c) A quantity of air occupies a volume of 0.45 m^3 at the pressure 1.5 bar and 23^0C of temperature. The air is compressed isothermally to a pressure of 6.3 bar and then expanded adiabatically to its initial volume.
Given $\gamma = 1.4$, $R = 0.287$ kJ/kgK and $C_P = 1.006$ kJ/kgK. Calculate:

Sejumlah udara mempunyai tekanan isipadu 0.45 m^3 pada tekanan 1.5 bar dan suhu 23 ^{0}C. Udara ini dimampatkan secara sesuhu sehingga tekanan bernilai 6.3 bar seterusnya dikembangkan secara proses adiabatik sehingga mencapai isipadu asal.
Diberi $= 1.4$, $R = 0.287$ kJ/kgK *dan* $C_P = 1.006$ kJ/kgK. *Kirakan:*

i. Mass of air during the compression
Jisim udara ketika proses mampatan [3 marks]
[3 *markah*]

ii. Heat received or rejected (state which) during the compression
Haba yang dibekalkan atau dikeluarkan semasa proses mampatan dan nyatakan yang mana satu.
[4 marks]
[4 *markah*]

iii. Change of internal energy during the expansion
Perubahan tenaga dalam ketika proses pengembangan
[8 marks]
[8 *markah*]

QUESTION 3

SOALAN 3

CLO 1
C1

(a) State **FOUR (4)** devices that use the principal of flow process.
*Nyatakan **EMPAT (4)** peranti yang menggunakan prinsip proses aliran.*

[4 marks]
[*4 markah*]

CLO 1
C2

(b) A steam enters a boiler with specific enthalpy of 175 kJ/kg and exit with specific enthalpy of 2100 kJ/kg. If the mass flow rate is 950 kg/h, determine the heat transfer in kW.
Stim memasuki dandang dengan entalpi tentu 175 kJ/kg dan keluar dengan entalpi tentu 2100 kJ/kg. Jika kadar alir jisim adalah 950 kg/jam, tentukan tenaga haba yang dibekalkan kepada dandang dalam kilowatt (kW).

[6 marks]
[*6 markah*]

CLO 1
C3

(c) Steam flows steadily into a turbine at 6000 kg/h and produce 2400 kW of power. Properties of steam for inlet and outlet part of the turbine are shown in the **Table 3** below. Assuming that changes in potential energy may be neglected, determine:
*Stim mengalir secara mantap memasuki sebuah turbin dengan kadar 6000 kg/jam dan menghasilkan kuasa keluaran sebanyak 2400 kW. Keadaan stim pada bahagian masuk dan keluar dari turbin adalah seperti di **Jadual 3** di bawah. Jika perubahan tenaga keupayaan diabaikan, tentukan:*

	Inlet ***Masukan***	**Outlet** ***Keluaran***
Pressure, P ***Tekanan*** **(bar)**	9	1.5
Internal energy, u ***Tenaga Dalam*** **(kJ/kg)**	3770	2550
Velocity, C ***Halaju Aliran*** **(m/s)**	320	110
Spesific Volume, υ ***Isipadu Tentu*** **(m^3/kg)**	0.55	1.90

Table 3: Properties of Steam

i. Heat which is transferred to surrounding in kW.
Haba yang dipindahkan ke persekitaran dalam kW.

[12 marks]
[*12 markah*]

ii. Area of the outlet vessel.
Luas permukaan bahagian keluar vessel.

[3 marks]
[*3 markah*]

QUESTION 4

SOALAN 4

CLO 1
C1

(a) Define the following terms:
Takrifkan istilah-istilah berikut:

i. Second Law of Thermodynamics
Hukum Kedua Termodinamik [2 marks]
[*2 markah*]

ii. Heat Engine / *Enjin Haba*

[2 marks]
[*2 markah*]

CLO 1
C2

(b) A heat pump absorbed 190 kJ/s of heat at temperature of 7°C and heat rejected at 30000 kJ/min. Determine power input, coefficient of performance and sink temperature.
Sebuah pam haba menyerap 190 kJ/s haba pada suhu 7°C serta haba disingkirkan sebanyak 30000 kJ/min. Tentukan kuasa masukan, pekali pengembangan prestasi dan suhu keluaran.

[9 marks]
[*9 markah*]

CLO 1
C3

(c) A steam power plants operates between a boiler pressure of 40 bar and a condenser pressure of 0.04 bar. If steam entry to the turbine with dry saturated, calculate for a Rankine cycle :
Sebuah penjana kuasa stim beroperasi diantara tekanan dandang 40 bar dan tekanan pemeluwap 0.04 bar. Sekiranya stim masuk ke dalam turbin pada tekanan.

i. Feed pump work / *Kerja pam suapan.*

[2 marks]
[*2 markah*]

ii. Rankine efficiency / *Kecekapan kitar Rankine.*

[8 marks]
[*8 markah*]

iii. Specific steam consumption / *Penggunaan stim tepu.*

[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

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

$h = u + pv$

$h = Cp\,\Delta T$

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

Non-Flow Process

1. Isothermal Process ($PV = C$)

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

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

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

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

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

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

3. Politropic 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 = $mC_v(T_2 - T_1)$
$W = P(V_2 - V_1) = mR\ (T_2 - T_1)$
$Q = mC_p(T_2 - T_1)$

5. Isometric Process

$U_2 - U_1 = mC_v(T_2 - T_1)$
$W = 0$
$Q = U_2 - U_1 = mC_v(T_2 - T_1)$

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

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

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

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