SULIT

POLITEKNIK
Jabatan Pengajian Politeknik

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2013

JJ207: THERMODYNAMICS 1

TARIKH : 22 OKTOBER 2013
TEMPOH : 2 JAM (11.15 AM - 1.15 PM)

Kertas ini mengandungi **ENAM BELAS (16)** halaman bercetak.

Bahagian ini mengandungi ENAM (6) soalan esei. Jawab EMPAT (4) soalan sahaja.
Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:
This paper consists of **SIX (6)** structured questions. Answer **FOUR** questions only.

ARAHAN:
Kertas ini mengandungi ***ENAM (6)*** *soalan berstruktur. Jawab* ***EMPAT (4)*** *soalan sahaja.*

QUESTION 1
SOALAN 1

CLO1 C1

(a) Convert the following units:
Tukarkan unit berikut:

i. 5 MN/cm^2 to GN/m^2
5 MN/cm^2 *kepada* GN/m^2

ii. 2.3 g/mm^3 to kg/m^3
2.3 g/mm^3 *kepada* kg/m^3

iii. 55 mg/liter to kg/m^3
55 mg/liter kepada kg/m^3

[6 marks]
[*6 markah*]

CLO1 C1 (b) Explain the following:
Berikan definisi berikut:

i. System
Sistem

ii. Boundary
Sempadan

iii. Surrounding
Sekeliling

iv. Process
Proses

[8 marks]
[*8 markah*]

CLO1 C2 (c) Explain the Zeroth Law of Thermodynamics
Terangkan Hukum Zeroth Termodinamik.

[4 marks]
[*4 markah*]

CLO1 C3 (d) Sketch the Zeroth Law of Thermodynamics diagram for 1(c)
Lakarkan gambarajah Hukum Sifar Termodinamik untuk 1 (c)

[7 marks]
[*7 markah*]

QUESTION 2
SOALAN 2

CLO1 C1 a) Based on figure 2, name the phases for the H_2O
Berdasarkan rajah 2, label nama fasa bagi H_2O

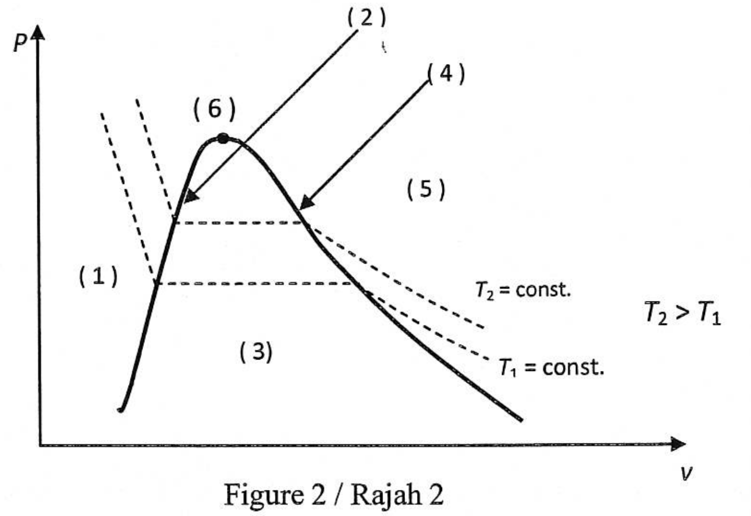


Figure 2 / Rajah 2

[6 marks]
[*6 markah*]

CLO1 C3 b) A wet steam at 42 bar and dryness fraction of 0.82. Calculate:-
i) specific volume
ii) specific enthalpy and
iii) specific internal energy

Diberi stim basah pada 42 bar dan pecahan kekeringan 0.82. Kirakan:-
i) isipadu tentu
ii) entalpi tentu dan
iii) tenaga dalam tentu

[7 marks]
[7 markah]

CLO1 C3

c) Steam at 120 bar has a specific volume of 2.677×10^{-2} m^3/kg. Find the value of :

i) temperature,

ii) degree of superheat,

iii) specific enthalpy and

iv) specific internal energy.

Stim pada 120 bar mempunyai isipadu tentu 2.677×10^{-2} m^3/kg. Cari nilai:

i) suhu,

ii) darjah panas lampau,,

iii) entalpi tentu,

iv) tenaga dalam tentu.

[7 marks]
[7 *markah*]

CLO1 C3

d) Calculate the mass of air in a room with the following dimensions: 4m x 5m x 6m and at 100 kPa and 25°C.

Kira jisim bagi udara di dalam sebuah bilik yang berukuran 4m x 5m x 6m pada 100 kPa dan 25°C

[5 marks]
[5 *markah*]

QUESTION 3

SOALAN 3

CLO1 C1

(a) Define the following terms:

Terangkan istilah-istilah berikut

i. heat

Haba

[2 marks]
[2 *markah*]

ii. specific heat

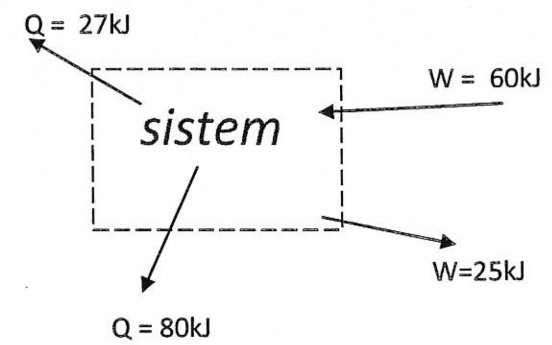
haba tentu

[2 marks]
[2 *markah*]

CLO1 C3

(b) Calculate the energy differences for the system below.

Kirakan perubahan tenaga dalam bagi sistem dibawah.



[4 marks]
[4 *markah*]

CLO1 C3 (c) A quantity of gas has a pressure of 3.5 bar when the volume and the temperature is $0.03m^3$ and 35°C respectively. Specific gas constant is 0.29 kJ/kgK. Calculate the mass of gas.

Satu Kuantiti gas mempunyai tekanan 3.5bar apabila isipadu dan suhunya masing-masing $0.03m^3$ dan 3 °C. Pemalar gas adalah 0.29kJ/kgK. Kirakan jisim gas tersebut.

[5 marks]
[5 *markah*]

CLO1 C4 (d) A closed system containing 2kg of air undergoes an isothermal process from 600kPa at 200°C to 80kPa. Determine the initial volume of this system, the work done, and the heat transfer during this process.

Satu sistem tertutup mengandungi 2kg udara melalui proses suhu malar dari 600kPa pada suhu 200°C kepada 80kPa. Kirakan isipadu awal gas, kerja terlaku dan haba yang berpindah semasa proses berlaku.

[12 marks]
[12 *markah*]

QUESTION 4
SOALAN 4

CLO1 C1 (a) State **THREE (3)** devices that use the principal of flow process
*Nyatakan **TIGA (3)** alat yang menggunakan prinsip proses alir*

[3 marks]
[3 *markah*]

CLO1 C2 (b) Differentiate between flow process and non-flow process
Bezakan di antara proses alir dan proses tak alir

[4 marks]
[4 *markah*]

CLO2 C4 (c) Steam flows steadily into a turbine at 5400 kg/h and produces 2500 kW of power. Properties of steam for inlet and outlet part of the turbine are shown in the table below. If the potential energy can be neglected, determine:

i. The heat which is transferred to surrounding
ii. the area for the outlet vessel

Stim mengalir secara mantap memasuki sebuah turbin dengan kadar 5400 kg/jam dan menghasilkan kuasa keluaran sebanyak 2500 kW. Keadaan stim pada bahagian masuk dan keluar dari turbin adalah seperti di jadual 4 Jika tenaga keupayaan diabaikan :

i. Kira nilai haba yang dipindahkan ke persekitaran
ii. Tentukan luas bahagian keluaran

	Inlet *masukan*	Outlet *keluaran*
Velocity, C_1 *Halaju aliran, C_1*	330 m/s	119 m/s
Pressure, P_1 *Tekanan, P_1*	10 bar	1.4 bar
Internal Energy, U_1 *Tenaga dalaman, U_1*	3770 kJ/kg	2550 kJ/kg
Specific volume, υ_1 *Isipadu tentu, υ_1*	0.65 m^3/kg	1.82 m^3/kg

Table 4 / Jadual 4

[18 marks]
[*18 markah*]

QUESTION 5
SOALAN 5

CLO1 C2 (a) Give **TWO (2)** differences between the First law of Thermodynamics and the Second Law of Thermodynamics.
*Berikan **DUA (2)** perbezaaan di antara Hukum Termodinamik Pertama dan Hukum Termodinamik Kedua.*

[8 marks]
[*8 markah*]

CLO2 C3 (b) A steam boiler receives 2460 kJ/min of heat and produces 25 kW of power. Determine the heat that is absorbed by the river and the thermal efficiency.
Dandang stim menerima sebanyak 2460 kJ/min tenaga haba dan menghasilkan kuasa sebanyak 25 kW. Tentukan tenaga haba yang diserap oleh sungai dan kecekapan terma.

[7 marks]
[*7 markah*]

CLO2 C4 (c) The reversed Carnot heat engine receives heat at temperature of 10°C and rejects the heat at temperature of 32°C with heat transfer of 100 kW. Determine the power required in kJ/hr.
Enjin haba Carnot yang bertentangan menerima haba pada suhu 10 °C dan memindahkan haba sebanyak 100 kW pada suhu 32 °C. Tentukan kuasa yang diperlukan dalam kJ/hr.

[10 marks]
[*10 markah*]

QUESTION 6
SOALAN 6

CLO1 C1 (a) Define **ONE (1)** characteristic of heat engines and give **ONE (1)** example of heat engine.
*Nyatakan **SATU (1)** ciri-ciri enjin haba dan berikan **SATU (1)** contoh enjin haba.*

[3 marks]
[3 *markah*]

CLO1 C2 (b) Differentiate the function of the heat pump and refrigerator.
Bezakan fungsi di antara pam haba dan peti sejuk.

[4 marks]
[4 *markah*]

CLO2 C3 (c) A steam at pressure of 13 bar and enthalpy of 815 kJ/kg is expanded isobarically to temperature 200°C. Determine the entropy change.
Stim pada tekanan 13 bar dan entalpi sebanyak 815 kJ/kg dikembangkan secara setekanan kepada suhu 200°C. Tentukan perubahan entropi.

[6 marks]
[6 *markah*]

CLO2 C4 (d) A house air conditioner maintained heat at 200 kJ/s and temperature of 7°C and rejected the heat at 555 kJ/s. Determine the power input and coefficient of performance.
If the house air conditioner temperature is reduced to 2°C while maintaining the temperature at the sink, determine the new coefficient of performance.

Penyaman udara rumah mengekalkan haba sebanyak 200 kJ/s pada suhu °C dan mengeluarkan haba sebanyak 555 kJ/s. tentukan kuasa yang dibekalkan dan pekali kecekapan.Jika penyaman udara rumah menurunkan suhu kepada 2°C sementara mengekalkan suhu pada sinki, tentukan pekali kecekapan yang baru.

[12 marks]
[12 *markah*]

SOALAN TAMAT

Rumus JJ207

1. FIRST LAW OF THERMODYNAMICS

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

2. FLOW PROCESS

$$m = \rho VA = \rho V \text{ (kg/s)} = \dot{m} = \frac{CA}{V}$$

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

$$q - w = \left[(h_2 - h_1) + \left(\frac{C_2^2 - C_1^2}{2}\right) + (Z_2 - Z_1)g\right]$$

3. 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

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

Non-Flow Process

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

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

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

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

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

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

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

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

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

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

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**

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

4. SECOND LAW OF THERMODYNAMICS

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

$$COP_{HP,rev} = \frac{T_H}{T_H - T_L} = \frac{1}{1 - T_L / T_H}$$

Entropy

$$S_{gen} = \Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding} = 0$$

$$\left(\frac{P_2}{P_1}\right)_{isentropic} = \left(\frac{P_{r2}}{P_{r1}}\right)$$

$$\left(\frac{v_2}{v_1}\right)_{isentropic} = \left(\frac{v_{r2}}{v_{r1}}\right)$$

5. GAS POWER CYCLES

$$r = \frac{V_{max}}{V_{min}} = \frac{V_{BDC}}{V_{TDC}} = \frac{V_1}{V_2} = \frac{v_1}{v_2}$$

$$MEP = \frac{W_{net}}{V_{disp}}$$

$$\eta_{th} = \frac{W_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$$

Otto Cycle

$$\eta_{th} = 1 - \frac{1}{r^{k-1}}, \quad \text{where } k = c_p / c_v$$

Diesel Cycle

$$\eta_{th} = 1 - \frac{1}{r^{k-1}}\left[\frac{r_c^k - 1}{k(r_c - 1)}\right],$$

where $r_c = \frac{v_3}{v_2}$ (cutoff ratio)

Brayton Cycle

$$\eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{\dot{W}_t - \dot{W}_c}{\dot{Q}_{in}} = \frac{h_3 - h_4 - h_2 + h_1}{h_3 - h_2}$$

$$r_{bw} = \frac{\dot{W}_{comp}}{\dot{W}_{turb}} = \frac{h_2 - h_1}{h_3 - h_4}$$

$$\eta_{th} = 1 - \frac{1}{r_p^{(k-1)/k}}$$