SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI DISEMBER 2015

DJJ2073 : THERMODYNAMICS

TARIKH : 07 APRIL 2016
MASA : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.
Struktur (4 soalan)
Dokumen sokongan yang disertakan : Formula & Jadual Stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 C1

(a) List **SIX (6)** International System (SI) units and their symbols.

*Senaraikan **ENAM (6)** unit SI dan simbol-simbolnya.*

[6 marks]

[*6 markah*]

CLO1 C2

(b) Convert the following units:

Tukarkan unit berikut:

i. 73 km/h to m/s

73 km/h kepada m/s

ii. 5.9 MN/mm^2 to N/m^2

5.9 MN/mm^2 kepada N/m^2

iii. 12 g/mm^3 to kg/m^3

12 g/mm^3 kepada kg/m^3

[9 marks]

[*9 markah*]

CLO1 C2 (c) A superheated steam at 160 bar has a specific enthalpy of 3139 kJ/kg. Determine the:

Stim panas lampau pada 160 bar mempunyai entalpi tentu 3139 kJ/kg. Tentukan:

i. Temperature.
Suhu.

ii. Degree of superheat.
Darjah panas lampau.

iii. Specific volume.
Isipadu tentu.

iv. Specific internal energy.
Tenaga dalam tentu.

[10 marks]
[*10 markah*]

QUESTION 2
SOALAN 2

CLO 1 C1 (a) List **FOUR (4)** characteristics of non-flow process.

*Senaraikan **EMPAT (4)** ciri – ciri proses tidak alir.*

[4 marks]
[*4 markah*]

CLO 1 C2 (b) A mass of 0.5 kg of air, initially at 130^0C is heated at a constant pressure of 2 bar until the volume occupied is 0.0658 m^3. Calculate the heat supplied and the work done.

Jisim 0.5 kg udara, suhu awalnya 130^0C dipanaskan pada tekanan tetap 2 bar sehingga mencapai isipadu 0.0658m^3. Kirakan haba yang dibekalkan dan kerja yang dilakukan.

[6 marks]
[*6 markah*]

CLO 1 C3 (c) 0.055 kg of carbon dioxide (CO_2) gas at a pressure of 1.03 bar occupying a volume of 0.035 m^3. The gas is compressed reversibly according to the law of $PV^{1.4}$ = constant until the pressure is 6.5 bar. Assuming carbon dioxide to be a perfect gas and takes:

0.055 kg gas karbon dioksida (CO_2) pada tekanan 1.03 bar memenuhi ruang isipadu 0.035 m^3. Gas tersebut dimampatkan secara boleh balik mengikut hukum $PV^{1.4}$ = pemalar sehingga tekanan meningkat kepada 6.5 bar. Dengan menganggapkan gas CO_2 sebagai gas sempurna dan mempunyai nilai-nilai berikut:

Specific heat at constant pressure, C_P = 0.846 kJ/kg.K
Haba tentu pada tekanan tetap, C_P = 0.846 kJ/kg.K
Specific heat at constant volume, C_V = 0.657 kJ/kg.K
Haba tentu pada isipadu tetap, C_V = 0.657 kJ/kg.K
Molecular mass, M = 44 kg/kmol
Jisim molekul = 44 kg/kmol

Calculate the following:
Kirakan yang berikut:

i. Final temperature of gas.
Suhu akhir gas.

[9 marks]
[*9 markah*]

ii. Work done on the gas.
Kerja yang dilakukan ke atas gas.

[3 marks]
[*3 markah*]

iii. Heat flow to or from the walls.
Pengaliran haba yang berlaku semasa proses.

[3 marks]
[*3 markah*]

QUESTION 3
SOALAN 3

CLO 1
C1

(a) List **SIX (6)** forms of energy.
*Senaraikan **ENAM (6)** jenis bentuk-bentuk tenaga.*

[6 marks]
[6 markah]

CLO 1
C2

(b) Fluid enters a condenser at the rate of 35 kg/min with a specific enthalpy of 2200 kJ/kg, and leaves with a specific enthalpy of 255 kJ/kg. Determine the rate of heat energy loss from the system.
Cecair memasuki pemeluwap pada kadar alir 35 kg/min dengan entalpi tentu 2200 kJ/kg, dan meninggalkan pemeluwap dengan entalpi tentu 255 kJ/kg. Tentukan kadar kehilangan tenaga haba dari sistem.

[6 marks]
[6 markah]

CLO 1
C3

(c) Steam enters a nozzle at 400°C and 800 kPa with a velocity of 10 m/s, and leaves the system at 300°C and 200 kPa while losing heat at a rate of 25 kW to the surrounding. For an inlet area of 0.08 m^2, determine:
Stim memasuki muncung pada keadaan 400°C dan 800 kPa dengan kelajuan 10 m/s, dan meninggalkan sistem tersebut pada 300°C dan 200 kPa manakala kehilangan haba pada kadar 2 5kW ke persekitaran. Luas kawasan aliran masuk ialah 0.08 m^2, tentukan;-

i. Mass flow rate (kg/s).
Kadar alir jisim (kg/s).

ii. Outlet area (m^2).
Luas keluaran (m^2).

iii. Volume flow rate (m^3/s).
Volume flow rate (m^3/s).

iv. Exit velocity (m/s).
Exit velocity (m/s).

[13 marks]
[13 markah]

QUESTION 4
SOALAN 4

CLO1
C1

(a) State **FOUR (4)** processes in the Carnot cycle.
*Nyatakan **EMPAT (4)** proses-proses di dalam Kitar Carnot.*

[4 marks]
[4 markah]

CLO1
C3

(b) A household refrigerator with a COP of 1.1 removes heat from the refrigerated space at rate of 105 kJ/h. Calculate:
Sebuah peti sejuk kegunaan rumah dengan COP 1.1 menyingkir haba dari ruang penyejukkannya pada kadar 105kJ/h. Kirakan:

i. The electric power consumed by the refrigerator (in kW).
Kuasa elektrik yang digunakan oleh peti sejuk ini (dalam kW).

ii. The rate of heat transferred to the kitchen air.
Kadar pemindahan haba ke udara di ruang dapur.

[9 marks]
[9 markah]

CLO1 C3 (c) A steam power plant for Rankine cycle operates between a boiler and a condenser with cycle efficiency is 35.9%. Meanwhile the calculated feed pump and turbine work are 4 kJ/kg and 961.7 kJ/kg respectively, calculate:

Sebuah penjana kuasa stim bekerja mengikut kitar Rankine antara dandang dan pemeluwap dengan kecekapan kitar ialah 35.9%, kerja pam suapan dan kerja turbin yang telah dikira ialah 4 kJ/kg dan 961.7 kJ/kg, kirakan:

i. Heat supplied to the boiler.
Haba yang dibekalkan ke dandang.

[4 marks]
[*4 markah*]

ii. The work ratio.
Nisbah kerja.

[4 marks]
[*4 markah*]

iii. The specific steam consumption (s.s.c).
Penggunaan stim tentu (p.s.t).

[4 marks]
[*4 markah*]

SOALAN TAMAT

POLITEKNIK MALAYSIA
DJJ2073 - THERMODYNAMICS

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

$\dot{m} = \rho CA(kg/s) = \frac{CA}{V}$ $h = u + pv = Cp\,\Delta T$

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

Non-Flow Process

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

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

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

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

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 ($PV^n = C$)**

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

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

$$Q = \frac{\gamma - n}{\gamma - 1} \times W$$

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

4. **Isobaric Process**

$U_2 - U_1 = mC_v(T_2 - T_1)$
$W = P(V_2 - V_1) = mR(T_2 - T_1)$
$Q = (h_2 - h_1) = mC_p(T_2 - T_1)$

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

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

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

$$\text{Work Ratio} = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$$

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