SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2015

DJJ2073 : THERMODYNAMICS

TARIKH : 22 OCTOBER 2015
TEMPOH : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.
Soalan Struktur (4 soalan). Jawab semua soalan
Dokumen sokongan yang disertakan : Rumus & Jadual 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 :
*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab semua soalan*

QUESTION 1

SOALAN 1

CLO1
C1

a) List **SIX (6)** of International System (SI) derived quantities and its unit.

*Senaraikan **ENAM (6)** kuantiti terbitan bagi Sistem Antarabangsa (SI) dan unitnya.*

[6 marks]
[*6 markah*]

CLO1
C2

b) Convert the following units :
Tukarkan unit-unit berikut :

i. 60 kg/cm^2 to g/m^2.
60 kg/cm^2 kepada g/m^2.

ii. 79 MN/hr to N/s.
79 MN/jam kepada N/s.

iii. 15 liter/g to m^3/kg.
15 liter/g kepada m^3/kg.

iv. 45 kJ/hr to Watt.
45 kJ/hr kepada Watt.

[12 marks]
[*12 markah*]

c) Based on dimensional homogeneity:
Berdasarkan dimensi homogeny;

CLO1
C1

i. Define the dimensional homogeneity.
Takrifkan dimensi homogen.

[3 marks]
[*3markah*]

ii. Give **ONE (1)** example of the dimension which is homogen and **ONE (1)** example which is **NOT** homogen,
*Berikan **SATU (1)** contoh dimensi yang homogen dan **SATU (1)** contoh dimensi yang tidak homogen.*

[4 marks]
[*4 markah*]

QUESTION 2
SOALAN 2

CLO1
C1

a) Sketch a P-v diagram and T-v diagram to show the difference in the phase changing processes

Lakarkan gambarajah P-v dan gambarajah T-v bagi menunjukkan perbezaan proses-proses perubahan fasa.

[6 marks]
[*6 markah*]

CLO1
C2

b) Given pressure for wet steam is 10 bar and specific internal energy is 2480 kJ/kg.
Diberi tekanan pada stim basah adalah 10 bar dan tenaga dalam tentu adalah 2480 kJ/kg.

i. Determine the dryness fraction, specific volume and specific enthalpy.
Tentukan pecahan kekeringan, isipadu tentu dan entalpi tentu.

[7 marks]
[*7 markah*]

ii. Sketch and locate the point on P-v diagram.
Lakar dan tentukan titik pada gambarajah P-v.

[3 marks]
[*3 markah*]

CLO1
C3

c) 0.01 kg of an ideal gas is contained in a pressure vessel that has a volume of 0.003 m^3. In this condition, the absolute pressure is 5 bar and the gas temperature 120°C. Then, the gas is expanded until the pressure dropped to 1 bar and volume is 0.02 m^3. Calculate the molecular mass and final temperature of the gas.

0.01 kg suatu gas unggul terkandung di dalam sebuah pengandung tekanan yang berisipadu 0.003 m^3. Pada keadaan ini tekanan mutlak ialah 5 bar dan suhu gas 120 ℃. Kemudian, gas dikembangkan sehingga tekanan menurun kepada 1 bar dan isipadu 0.02 m^3. Kirakan jisim molekul dan suhu keadaan akhir gas.

[9 marks]
[*9 markah*]

QUESTION 3
SOALAN 3

CLO1
C1

a) Based on First Law of Thermodynamics, state **FOUR (4)** characteristics of an open system.
*Berdasarkan Hukum Termodinamik Pertama, nyatakan **EMPAT (4)** ciri-ciri utama sistem terbuka.*

[4 marks]
[*4 markah*]

CLO1
C1

b) Based on Steady Flow Energy Equation:
Berdasarkan Persamaan Tenaga Airan Mantap:

i. Write down the equation.
Tuliskan persamaannya.

ii. State **TWO (2)** related engineering devices.
*Nyatakan **DUA (2)** peralatan kejuruteraan yang berkaitan.*

[4 marks]
[*4 markah*]

CLO1
C2

c) 1.02 kg of Ethane (molecular mass of 30 kg/kmol, C_v = 1.823kJ/kgK, W = −161.31 kJ/kg) is compressed from pressure 1.11 bar at 37 °C according to the Law $PV^{1.3}$= C to a pressure of 7.7 bar. Determine the final temperature, gas constant and the heat flow to or from the cylinder walls.

1.02 kg Etana (jisim molekul 30 kg/kmol, C_v = 1.823 kJ/kgK, W = − 161.31 kJ/kg) dimampatkan daripada tekanan 1.11 bar pada 37°C menurut Hukum $PV^{1.3}$= pemalar kepada tekanan 7.7 bar. Tentukan suhu akhir, pemalar gas dan haba yang mengalir kepada atau daripada dinding silinder.

[9 marks]
[*9 markah*]

CLO1
C3

d) A rotary air pump is required to deliver 950 kg of air per hour. The specific enthalpy at the inlet and exit of the pump are 350 kJ/kg and 700 kJ/kg respectively. The air velocity at the entrance and exit are 13 m/s and 24 m/s respectively. The rate of heat loss from the pump is 6500 W. Calculate the power required to drive the pump.

Pam udara berputar diperlukan untuk menghantar 950 kg udara dalam tempoh sejam. Entalpi tentu pada kawasan masukan dan keluaran masing - masing ialah 350 kJ/kg dan 700 kJ/kg. Halaju udara pada bahagian masukkan dan keluaran masing - masing ialah 13 m/s dan 24 m/s. Kadar kehilangan haba daripada pump ialah 6500 W. Kirakan kuasa yang diperlukan untuk memacu pam tersebut.

[8 marks]
[*8 markah*]

QUESTION 4

SOALAN 4

CLO1
C1

a) Define the Second Law of Thermodynamics.
Takrifkan Hukum Termodinamik Kedua.

[4 marks]
[*4 markah*]

CLO1
C1

b) List **FOUR (4)** characteristics of a heat engine.
*Senaraikan **EMPAT (4)** ciri-ciri sebuah enjin haba*

[4 marks]
[*4 markah*]

CLO1
C2

c) A Carnot heat engine receives heat from a reservoir at 900°C at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27°C. The entire work output of the heat engine is used to drive a Carnot refrigerator that removes heat from the refrigerated space at 5°C and transfer it to the same ambient air at 27°C. Determine:

Sebuah enjin haba Carnot menerima haba daripada punca bekalan pada suhu 900°C dengan kadar 800 kJ/min dan menyingkirkan haba ke persekitaran pada suhu 27°C. Keseluruhan kerja keluaran enjin haba digunakan untuk memacu sebuah peti sejuk Carnot yang membuang haba daripada peti sejuk pada suhu 5°C dan dipindah kepada udara persekitaran yang sama pada suhu 27°C. Tentukan:

i. The heat engine efficiency.
Kecekapan engine haba.

[2 marks]
[*2 markah*]

ii. The maximum rate of heat removal from the refrigerated space (in kW),
Kadar maksimum keluaran haba dari ruang peti sejuk (dalam kW),

[7 marks]
[*7 markah*]

iii. The total rate of heat rejection to the ambient air (in kW),
Jumlah kadar haba yang disingkirkan ke udara persekitaran (dalam kW).

[2 marks]
[*2 markah*]

CLO1
C3

d) A power plant operates with an efficiency of 44%. If the power plant rejects heat to the atmosphere at 38°C, calculate the temperature of the heat reservoir in °C unit.
Loji jana kuasa beroperasi dengan kecekapan sebanyak 44%. Jika loji jana kuasa ini menyingkirkan haba kepada atmosfera pada 38℃, kirakan suhu bagi takungan panas dalam unit ℃.

[6 marks]
[*6 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

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

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

Non-Flow Process

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

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

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

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

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

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

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

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

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

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

4. Isobaric Process

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

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

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

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

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