SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2017

DJJ2073 : THERMODYNAMICS

TARIKH : 31 OKTOBER 2017
MASA : 2.30 PETANG - 4.30 PETANG (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

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) Define:
Takrifkan:

i. Properties
Sifat

[2 marks]
[2 markah]

ii. Intensive properties
Sifat intensif

[2 marks]
[2 markah]

iii. Extensive properties
Sifat ekstensif.

[2 marks]
[2 markah]

CLO1
C2

(b) Convert each of the following units:
Tukarkan setiap unit-unit berikut:

i. 8.64 km/h to m/s [2 marks]
8.64 km/j kepada m/s *[2 markah]*

ii. 1200 kg/m^3 to g/cm^3 [3 marks]
1200 kg/m^3 *kepada* g/cm^3 *[3 markah]*

iii. 25 Watt to kJ/hr [3 marks]
25 Watt kepada kJ/jam *[3 markah]*

CLO1 C2

(c) A mass of 0.23 kg gas is at a temperature of 20 °C, pressure 135 kN/m² and volume 0.22 m³. If the gas has a value of C_V = 720 J/kgK, determine:

Sejumlah gas berjisim 0.23 kg mempunyai suhu 20 °C, tekanan 135 kN/m² dan berisipadu 0.22 m³. Jika gas tersebut mempunyai nilai C_V = 720 J/kgK, tentukan:

i. Gas constant (R)
Pemalar gas (R)

[5 marks]
[5 markah]

ii. Gas molecular weight (M)
Berat molekul gas (M)

[2 marks]
[2 markah]

iii. Specific heat at constant pressure (Cp)
Pekali haba tentu pada keadaan tekanan malar (Cp)

[2 marks]
[2 markah]

iv. Specific heat ratio (γ)
Nisbah haba tentu (γ)

[2 marks]
[2 markah]

QUESTION 2
SOALAN 2

CLO1 C1

(a) Give **THREE (3)** characteristics of an adiabatic process.
*Berikan **TIGA (3)** ciri-ciri proses adiabatik.*

[6 marks]
[6 markah]

CLO1 C2

(b) A quantity of air occupied a pressure of 1.2 bar, volume of 0.334 m³ and temperature of 29 °C. Then the air is compressed at constant pressure until the volume becomes 0.18 m³. Calculate the mass and the final temperature for the air.

Suatu kuantiti udara berada pada tekanan 1.2 bar, isipadu 0.334 m³ dan suhu 29 °C. Udara tersebut kemudiannya dimampatkan pada tekanan malar sehingga isipadu akhir 0.18 m³. Kirakan jisim dan suhu akhir udara tersebut.

[6 marks]
[6 markah]

CLO1 C3

(c) Nitrogen (molar mass 28 kg/kmol) expands reversibly in a perfectly thermally insulated cylinder from 3.5 bar, 200°C to a volume of 0.09 m^3. If the initial volume occupied was 0.03 m^3 and the nitrogen is assumed as a perfect gas with C_V = 0.741 kJ/kg.K, calculate:

Nitrogen (jisim molar 28 kg/kmol) mengembang secara boleh balik di dalam silinder yang ditebat daripada 3.5 bar, 200°C kepada isipadu 0.09 m^3. Jika isipadu awal nitrogen adalah 0.03 m^3 dan nitrogen dianggap sebagai gas sempurna dengan C_V = 0.741 kJ / kg.K, kirakan:

i. The gas constant
Pemalar gas

[4 marks]
[4 markah]

ii. The final gas pressure
Tekanan akhir gas

[6 marks]
[6 markah]

iii. The work input
Kerja masukan gas

[3 marks]
[3 markah]

QUESTION 3
SOALAN 3

CLO1 C1

(a) State **THREE (3)** conditions which must be satisfied by the fluid during the steady flow energy analysis.
*Nyatakan **TIGA (3)** keadaan yang mesti dipenuhi oleh bendalir semasa analisis tenaga aliran mantap.*

[6 marks]
[6 markah]

CLO1 C2

(b) The Steady Flow Energy Equation may be applied to any apparatus. With a sketch, explain the application of the steady flow energy in :

Persamaan Tenaga Aliran Mantap boleh digunakan untuk semua jenis perkakas. Dengan lakaran, terangkan penggunaan tenaga aliran mantap dalam :

i. The boiler [3 marks]
Dandang [3 markah]

ii. The condenser [3 marks]
Pemeluwap [3 markah]

CLO1 C3

Fluid with a specific enthalpy of 4100 kJ/kg enters a horizontal nozzle with negligible velocity at the rate of 79200 kg/h. At the outlet, the specific enthalpy and specific volume of the fluid were 3050 kJ/kg and 1.45 m^3/kg respectively. Assuming the flow is an adiabatic flow process, find the:

Bendalir dengan entalpi tentu 4100 kJ/kg memasuki sebuah muncung mendatar dengan halaju yang boleh diabaikan pada kadar 79200 kg/h. Pada bahagian keluaran, entalpi tentu dan isipadu tentu bendalir adalah 3050 kJ/kg dan 1.45 m³/kg. Andaikan aliran adalah proses adiabatik, tentukan:

i. Velocity outlet
Halaju keluar

[7 marks]
[7 markah]

ii. Required outlet area of the nozzle
Luas bahagian keluar muncung

[6 marks]
[6 markah]

QUESTION 4
SOALAN 4

CLO1 C1

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

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

ii. Heat Engine [2 marks]
Enjin Haba *[2 markah]*

iii. Thermal efficiency [2 marks]
Kecekapan terma / haba *[2 markah]*

CLO1 C2

(b) Heat is transferred to a heat engine from a furnace at a rate of 255 GJ/hr. If the rate of waste heat rejection to a nearby river is 168 GJ/hr, determine the net work done and the thermal efficiency for this heat engine.
Haba dipindahkan ke enjin haba daripada relau pada kadar 255 GJ/jam. Jika kadar pembuangan haba ke sungai yang berhampiran adalah 168 GJ/jam, tentukan kerja bersih yang dilakukan dan kecekapan haba untuk enjin haba ini.

[9 marks]
[9 markah]

CLO1 C3

(c) A steam power plant operates between a boiler pressure of 40 bar and a condenser pressure of 0.04 bar. If steam enters to the turbine at dry saturated state. For a Rankine cycle, determine:

Sebuah penjana kuasa steam bekerja di antara tekanan dandang 40 bar dan tekanan pemeluwap 0.04 bar. Sekiranya stim masuk ke dalam turbin pada keadaan tepu kering, tentukan untuk kitar Rankine:

(i) The feed pump work.

Kerja pam suapan.

[2 marks]
[2 markah]

(ii) The Rankine efficiency.

Kecekapan kitar Rankine.

[6 marks]
[6 markah]

(iii) The specific steam consumption.

Penggunaan stim tepu.

[2 marks]
[2 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

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

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

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

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

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