SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI DISEMBER 2017

DJJ2073 : THERMODYNAMICS

TARIKH : 01 APRIL 2018
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

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

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula / Buku Stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:
This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.
ARAHAN:
*Bahagian ini mengandungi **EMPAT(4)** soalan berstruktur. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1
C1

(a) List **SIX (6)** fundamental physical quantities and its International System (SI) units.
*Senaraikan **ENAM (6)** kuantiti fizikal asas dan unit-unit SI.*

[6 marks]
[*6 markah*]

CLO1
C2

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

i. 40 N/cm^2 to kN/m^2 [2 marks]
40 N/cm^2 kepada kN/m^2 [*2 markah*]

ii. 0.005 kg/liter to g/cm^3 [2 marks]
0.005 kg/liter kepada g/cm^3 [*2 markah*]

iii. 75 m/s to km/h [2 marks]
75 m/s kepada km/h [*2 markah*]

CLO1
C2

c) For steam at 22 bar with dryness fraction of 0.9, calculate the;
Bagi stim pada 22 bar dengan pecahan kekeringan 0.9, hitungkan;

i. specific volume [2 marks]
isipadu tentu [*2 markah*]

ii. specific enthalpy [3 marks]
entalpi tentu [*3 markah*]

iii. specific internal energy [3 marks]
tenaga dalam tentu [*3 markah*]

iv. specific entropy and locate on P-v diagram. [5 marks]
entropi tentu dan tandakan titik tersebut pada rajah P-v. [*5 markah*]

QUESTION 2
SOALAN 2

CLO1
C1

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

i. Heat transfer / *Haba dipindahkan*

ii. Specific heat / *Haba tentu*

[4 marks]
[4 markah]

CLO2
C3

(b) An amount of gas inside an insulated vessel contain 45kJ of internal energy. The gas expands until the internal energy is reduced to 23kJ. Calculate the work produced by the gas.
Sejumlah gas yang berada di dalam bekas berpenebat mengandungi 45kJ tenaga dalaman. Gas tersebut mengembang sehingga tenaga dalamannya berkurang kepada 23 kJ. Hitungkan kerja yang dihasilkan oleh gas tersebut.

[6 marks]
[6 markah]

CLO1
C3

(c) (i) A quantity of gas has a pressure of 3.5 bar when the volume and the temperature are $0.03m^3$ and 35°C respectively. Specific gas constant is 0.29 kJ/kgK. Calculate the mass of gas.
Satu kuantiti gas mempunyai tekanan 3.5 bar apabila isipadu dan suhunya masing-masing $0.03m^3$ dan 35°C. Pemalar gas adalah 0.29kJ/kgK. Kirakan jisim gas tersebut.

[5 marks]
[5 markah]

CLO1
C3

(ii) A closed system containing 2 kg of air undergoes an isothermal process from 600 kN/m^2 at 200°C to 80 kN/m^2. Determine the initial volume of this system, the work done, and the heat transferrred during this process.
Satu sistem tertutup mengandungi 2 kg udara melalui proses suhu malar dari 600 kN/m^2 *pada suhu 200°C kepada 80* kN/m^2 *. Kirakan isipadu awal gas, kerja terlaku dan haba yang dipindah semasa proses berlaku.*

[10 marks]
[10 markah]

QUESTION 3

SOALAN 3

CLO1
C1

(a) Define an open system in thermodynamics and state **TWO (2)** devices for the system.

*Berikan definisi sistem terbuka dalam termodinamik dan nyatakan **DUA (2)** peranti untuk sistem tersebut.*

[4 marks]

[*4 markah*]

CLO1
C2

(b) A fluid enters a horizontal nozzle with specific enthalpy 2500 kJ/kg, the mass flow rate is 10.25 kg/s and the velocity is small and neglected. At the end of the nozzle, the specific enthalpy is 1950 kJ/kg and specific volume is 0.75 m^3/kg. Assume that the process is adiabatic , calculate;

Bendalir memasuki sebuah muncung mendatar dengan entalpi tentu 2500 kJ/kg, kadar alir jisim ialah 10.25 kg/s dan halaju adalah kecil yang boleh diabaikan. Pada bahagian akhir muncung, entalpi tentu adalah 1950 kJ/kg dan isipadu tentu adalah 0.75 m^3/kg. Andaikan proses adalah adiabatik, kirakan nilai;

i. the exit velocity
halaju keluaran

ii. the exit cross sectional area of the nozzle.
luas bahagian keluaran muncung.

[6 marks]

[*6 markah*]

CLO1
C3

(c) A turbine which is operated under steady flow condition is having these properties:

Sebuah turbin beroperasi di bawah keadaan aliran tetap mempunyai ciri-ciri yang berikut:

	Inlet *Masukan*	Outlet *Keluaran*
Pressure *Tekanan*	6.5 bar	1.6 bar
Specific volume *Isipadu Tentu*	0.45 m^3/kg	1.2 m^3/kg
Specific internal energy *Tenaga dalam tentu*	3250 kJ/kg	2370 kJ/kg
Velocity *Halaju*	7.5 m/s	9.3 m/s

If heat loss to the atmosphere is at 38 kJ/s and mass flow rate of the steam is 2550 kg/hour, calculate the power produced from the steam.

Jika kehilangan haba kepada atmosfera ialah 38 kJ/s dan kadar alir jisim stim ialah 2550 kg/jam, kirakan kuasa yang terhasil daripada stim.

[15 marks]

[15 *markah*]

QUESTION 4

SOALAN 4

CLO1 C1

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

[4 marks]
[*4 markah*]

CLO1 C2

b) A heat engine operates between two thermal energy reservoirs with a temperature of 1020K and 320K respectively. It receives 700kJ/s of heat rate from the hot reservoir. Determine the :
Satu enjin haba beroperasi antara dua tangki dengan suhu 1020K dan 320K. Ia menerima haba dari tangki panas dengan kadar 700kJ/s, tentukan:

i. Thermal efficiency / *Kecekapan thermal*

ii. Rate of heat released to the cold reservoir / *Kadar alir haba dilepaskan ke tangki sejuk*

iii. Power produced / *Kuasa terhasil.*

[9 marks]
[*9 markah*]

CLO1 C3

c) A steam generator is operated at a boiler pressure of 50 bar and condenser pressure of 0.05 bar. For a Carnot cycle, calculate:
Sebuah penjana stim yang bekerja antara tekanan dandang 50 bar dan tekanan pemeluwap 0.05 bar. Untuk kitar Carnot, kirakan:

i. The efficiency of the cycle / *Kecekapan kitar*

ii. Heat supplied to the boiler / *Haba bekalan dandang*

iii. Sketch a complete T-s diagram / *Lakar gambarajah T-s dengan lengkap*

[12 marks]
[*12 markah*]

SOALAN TAMAT

1. PROPERTIES OF PURE SUBSTANCE

Steam

$v = xv_g \qquad h = h_f + xh_{fg} \qquad u = u_f + x(u_g - u_f) \qquad s = s_f + xs_{fg}$

Ideal Gas

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

2. FIRST LAW OF THERMODYNAMICS

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

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 ($PV = C$)

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

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

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

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

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

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

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

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

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

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

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

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