SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI II : 2021/2022

DJJ20063 / DJJ2073: THERMODYNAMICS

TARIKH : 01 JULAI 2022
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **TUJUH (7)** halaman bercetak.
Struktur (4 soalan)
Dokumen sokongan yang disertakan : Formula

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 struktur. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C1

(a) Define the following concepts of thermodynamics:

Definasikan konsep termodinamik di bawah:

i. System

Sistem

ii. Energy conversion

Penukaran tenaga

[4 marks]

[*4 markah*]

CLO1
C2

(b) Figure 1(b) shows aluminum and copper is placed in the insulated container. Describe this situation according to the thermal equilibrium concept.

Rajah 1(b) menunjukkan aluminium dan kuprum diletakkan dalam bekas yang ditebat. Huraikan situasi ini berdasarkan kepada konsep keseimbangan terma.

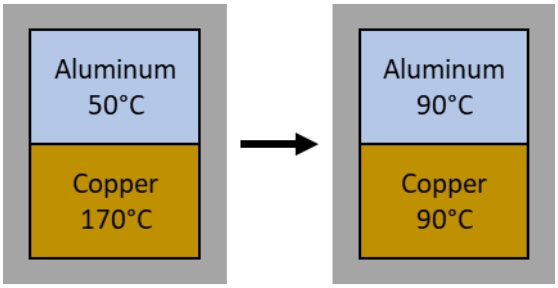

Figure 1(b): Aluminum and copper in insulated container

Rajah 1(b): Aluminium dan kuprum di dalam bekas yang ditebat

[4 marks]

[*4 markah*]

CLO1
C2

Relate the data from steam table for solution of the specific volume, specific internal energy and specific entropy for a wet steam at 32 bar with specific enthalpy of 2014 kJ/kg.

Hubungkaitkan data dari jadual stim bagi penyelesaian isipadu tentu, tenaga dalam tentu dan entropi tentu bagi stim basah pada 32 bar dengan tenaga dalam tentu berjumlah 2014 kJ/kg.

[8 marks]
[*8 markah*]

CLO1
C2

(c) Interpolate the specific volume for steam at 108 bar and 472°C. Plot the point on T-v diagram.

Interpolasikan isipadu tentu bagi stim pada 108 bar dan 472°C. Plotkan titik tersebut pada gambarajah T-v.

[9 marks]
[*9 markah*]

QUESTION 2
SOALAN 2

CLO2
C1

(a) Identify **FOUR (4)** characteristics of closed system.

*Kenal pasti **EMPAT (4)** ciri-ciri sistem tertutup.*

[4 marks]
[*4 markah*]

CLO2
C2

(b) A system extracted 750 kJ of heat energy from the surrounding to produce work amounting 530 kJ. Categorize the change of internal energy for this system whether it is an increase or decrease with correct solution.

Suatu sistem menarik 750 kJ tenaga haba dari persekitaran untuk menghasilkan kerja sebanyak 530 kJ. Kategorikan perubahan tenaga dalam bagi sistem ini sama ada ia bertambah atau berkurang dengan penyelesaian yang betul.

[4 marks]
[*4 markah*]

CLO2
C3

(c) A perfect gas is contained in a cylinder at 150 kN/m^2, 27°C and 0.2 m^3. The gas is compressed slowly at constant temperature until the pressure reaches 800 kN/m^2. Calculate the work for this process and state whether it is the input or output.

Suatu gas sempurna terkandung dalam sebuah silinder pada 150 kN/m^2, 27°C dan 0.2 m^3. Gas ini dimampatkan dengan perlahan pada suhu malar sehingga tekanannya menjadi 800 kN/m^2. Kirakan kerja bagi proses ini dan nyatakan sama ada ianya kerja masukkan atau keluaran.

[5 marks]
[*5 markah*]

CLO2
C3

(d) Nitrogen is expanded polytropically according $PV^{1.24}$=constant from pressure 1.3 bar, volume 0.07 m^3 and temperature 120°C to pressure 1.0 bar. If the gas constant for nitrogen is 0.2968 kJ/kgK, calculate:
Nitrogen dikembangkan secara politropik mengikut $PV^{1.24}$=pemalar daripada tekanan 1.3 bar, isipadu 0.07 m^3 dan suhu 120°C kepada tekanan 1.0 bar. Jika pemalar gas nitrogen adalah 0.2968 kJ/kgK, kirakan:

i. Mass of the nitrogen
Jisim nitrogen

ii. Final volume
Isipadu akhir

iii. Final temperature
Suhu akhir

iv. Work done
Kerja yang dilakukan

[12 marks]
[*12 markah*]

QUESTION 3

SOALAN 3

CLO2 C1 (a) List **FOUR (4)** characteristics of steady flow process.
*Senaraikan **EMPAT (4)** ciri-ciri proses aliran sekata.*

[4 marks]
[*4 markah*]

CLO2 C2 (b) Nozzle and Diffuser are part of the open system apparatus. Compare between both apparatus.
Nozel dan Peresap adalah sebahagian daripada radas sistem terbuka. Bandingkan antara radas tersebut.

[4 marks]
[*4 markah*]

CLO2 C3 (c) Steam enters a nozzle with specific volume of 0.38 m^3/kg, velocity of 10 m/s and leaves the nozzle with specific volume of 1.32 m^3/kg. For inlet and exit area of 0.08 m^2 and 0.005 m^2 respectively, calculate the mass flow rate and the exit velocity of the nozzle.

Stim memasuki muncung dengan isipadu tentu 0.38 m^3/kg, halaju 10 m/s. dan meninggalkan muncung dengan isipadu tentu 1.32 m^3/kg. Dengan luas bahagian masuk dan keluar masing-masing adalah 0.08 m^2 dan 0.005 m^2, kirakan kadar alir jisim dan halaju keluaran muncung.

[6 marks]
[*6 markah*]

CLO2
C3

(d) In a steady flow system, steam flows through a turbine at the rate of 12 kg/s. It enters the system at a pressure of 100 bar, a velocity of 80 m/s, internal energy 3238 kJ/kg and specific volume of 0.03 m^3/kg. It leaves the system at a pressure of 0.1 bar, a velocity of 50 m/s, internal energy 2257 kJ/kg and specific volume of 13.5 m^3/kg. Calculate the power of the system in kilowatts.

Dalam suatu sistem aliran sekata, stim mengalir melalui turbin pada kadar 12 kg/s. Ia memasuki sistem pada tekanan 100 bar, berkelajuan 80 m/s, tenaga dalam 3238 kJ/kg dan isipadu tentu sebanyak 0.03 m^3/kg. Ia keluar dari sistem pada tekanan 0.1 bar, berkelajuan 50 m/s, tenaga dalam 2257 kJ/kg dan isipadu tentu sebanyak 13.5 m^3/kg. Kirakan perubahan entalpi dan kuasa bagi system dalam kilowatt.

[11 marks]

[*11 markah*]

QUESTION 4

SOALAN 4

CLO2
C1

(a) State **FOUR (4)** characteristics of reversed heat engine.

*Nyatakan **EMPAT (4)** ciri enjin haba balikkan.*

[4 marks]

[*4 markah*]

CLO2
C2

(b) A Carnot refrigerator operates in a kitchen in which the temperature is 21°C. The refrigerator has a COP of 4.5 and consumes 550 W of power while operating. Relate the values given for solution of the rate of heat removal from the refrigerated space and the temperature of the refrigerated space for this refrigerator.

Sebuah peti sejuk Carnot beroperasi di sebuah dapur yang bersuhu 21°C. Peti sejuk ini mempunyai COP bernilai 4.5 dan menggunakan 550 W kuasa semasa beroperasi. Hubungkaitkan nilai yang diberi untuk penyelesaian bagi kadar haba yang dibuang dari ruangan penyejukkan dan suhu ruangan penyejukkan bagi peti sejuk ini.

[6 marks]

[*6 markah*]

CLO2
C3

(c) A dry saturated steam with a pressure of 44 bar is supplied to a turbine and the condenser pressure is 0.03 bar. If the plant operates with Rankine cycle, calculate:
Stim tepu kering yang bertekanan 44 bar dibekalkan kepada turbin dan pemeluwap yang bertekanan 0.03 bar. Jika loji itu beroperasi dengan menggunakan kitaran Rankine, kirakan:

i. The cycle efficiency
Kecekapan kitar

ii. The work ratio
Nisbah kerja

iii. The specific steam consumption
Penggunaan stim tentu

[15 marks]
[*15 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

$$\dot{m} = \rho CA = \frac{CA}{V}$$

$$h = u + pv$$

$$h = Cp\,\Delta T$$

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

Non-Flow Process

1. Isothermal Process ($PV = C$)

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

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

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

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

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

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

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

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

$Q = \frac{\gamma - n}{\gamma - 1}$ x 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 = Q - W
$W = P(V_2 - V_1) = mR\,(T_2 - T_1)$
$Q = mC_p\,(T_2$-$T_1)$

5. Isometric Process

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

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

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

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

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