SULIT

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI I : 2022 / 2023

DJJ20063: THERMODYNAMICS

TARIKH : 13 DISEMBER 2022
MASA : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Soalan 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)** structure 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 process:

Definisikan proses berikut:

i. Reversible process

Proses boleh balik

[2 marks]

[*2 markah*]

ii. Irreversible process

Proses tidak boleh balik

[2 marks]

[*2 markah*]

CLO1
C2

(b) Explain The Zeroth's Law of Thermodynamics with the aid of suitable diagrams.

Terangkan Hukum Sifar Termodinamik dengan bantuan gambarajah yang sesuai.

[4 marks]

[*4 markah*]

CLO1
C2

(c) Given the pressure and the specific internal energy of wet steam is 20 bar and 2455 kJ/kg. Relate the values given for solution of:
Diberi tekanan dan tenaga dalam tentu bagi stim basah ialah 20 bar dan 2455 kJ/kg. Hubungkaitkan nilai yang diberi untuk penyelesaian:

i. Dryness Fraction
Pecahan Kekeringan

[3 marks]
[*3 markah*]

ii. Specific volume
Isipadu Tentu

[2 markah]
[*2 marks*]

iii. Specific Enthalpy
Entalpi Tentu

[3 marks]
[*3 markah*]

CLO1
C2

(d) Referring to the steam table, interpolate the specific enthalpy for steam at pressure 5.33 bar and temperature of 236 °C.
Dengan merujuk Jadual Stim, interpolasikan entalpi tentu stim pada tekanan 5.33 bar dan suhu 236°C.

[9 marks]
[*9 markah*]

QUESTION 2
SOALAN 2

CLO2
C1

(a) Briefly describe the Non Flow Process
Terangkan secara ringkas Proses Tak Alir

[4 marks]
[*4 markah*]

CLO2
C2

(b) Briefly discuss energy transfer by heat and energy transfer by work
Bincangkan secara ringkas tentang pemindahan tenaga oleh haba dan kerja.

[4 marks]
[*4 markah*]

CLO2
C3

(c) The heat transferred to the system is 500 kJ/kg and the initial internal energy is 250 kJ/kg greater than the final. Calculate the work done by the system.
Haba yang dipindahkan ke sistem sebanyak 500 kJ/kg dan tenaga dalaman tentu awal bernilai 250 kJ/kg lebih besar daripada nilai tenaga dalaman akhir. Kirakan nilai kerja yang dilakukan oleh sistem.

[5 marks]
[*5 markah*]

CLO2
C3

(d) A certain perfect gas has initial pressure of 12 bar and volume 0.024 m^3 is expanded adiabatically to a final pressure of 160 kPa. Given C_p and C_v are 1.046 kJ/kgK and 0.752 kJ/kg K respectively. Calculate:
Sejenis gas sempurna mempunyai tekanan bernilai 12 bar dan isipadunya bernilai 0.024m^3 dikembangkan melalui proses adiabatic sehingga tekanan akhirnya bernilai 160 kPa. Diberi nilai Cp dan Cv masing-masing bernilai 1.046 kJ/kgK dan 0.752 kJ/kgK. Kirakan:

i. Final volume of the gas.
Isipadu akhir gas.

[6 marks]
[*6 markah*]

ii. Work done by the gas.
Kerja yang dilakukan oleh gas.

[3 marks]
[*3 markah*]

iii. Change of internal energy of the gas
Perubahan tenaga dalaman gas.

[3 marks]
[*3 markah*]

QUESTION 3

SOALAN 3

CLO2 C1 (a) List **FOUR (4)** components that known as steady flow devices.
*Senaraikan **EMPAT (4)** komponen yang diketahui sebagai peranti aliran mantap.*

[4 marks]
[*4 markah*]

CLO2 C2 (b) Explain steady flow process.
Terangkan proses aliran mantap.

[4 marks]
[*4 markah*]

CLO2 C3 (c) A rotary pump draws 6000 kg/hour of atmospheric air and delivers it at a higher pressure. The specific enthalpy of the air at the pump inlet is 300 kJ/kg and the outlet is 509 kJ/kg. The heat lost from the pump casing is 5000 W. Neglecting the changes in kinetic and potential energy, calculate the power required to drive the pump.
Pam putar menarik 6000 kg/jam udara dari atmosfera dan menghembuskannya pada tekanan yang lebih tinggi. Entalpi tentu udara di salur masuk pam ialah 300 kJ/kg dan di pintu keluar ialah 509 kJ/kg. Haba yang hilang dari kelongsong pam ialah 5000 W. Dengan mengabaikan perubahan tenaga kinetik dan tenaga keupayaan, kirakan kuasa yang diperlukan untuk memacu pam.

[6 marks]
[*6 markah*]

CLO2
C3

(d) A nozzle is supplied with steam that has a specific enthalpy of 2780 kJ/kg at the rate of 9.1 kg/min. At outlet from the nozzle the velocity of the steam is 1070 m/s. Assuming that the inlet velocity of the steam is negligible and that the process is adiabatic, calculate:

Muncung dibekalkan dengan stim yang mempunyai entalpi tertentu 2780 kJ/kg pada kadar 9.1 kg/min. Di bahagian keluaran muncung halaju stim ialah 1070 m/s. Dengan mengabaikan halaju masuk stim dan proses adalah adiabatik, kirakan:

i. The specific enthalpy of the steam at the nozzle exit
Entalpi tentu stim pada keluar muncung

[6 marks]
[*6 markah*]

ii. The nozzle outlet area if the final specific volume of the steam is 18.75 m^3/kg. (in mm^2 unit)
Luas saluran keluar muncung jika isipadu tentu akhir stim ialah 18.75 m^3/kg. (dalam unit mm^2)

[5 marks]
[*5 markah*]

QUESTION 4

SOALAN 4

CLO2 C1 (a) Identify **ONE (1)** characteristic of heat Engine and give **TWO (2)** examples of heat engine.

*Kenalpasti **SATU (1)** ciri Enjin haba dan berikan **DUA (2)** contoh Enjin haba.*

[4 marks]

[*4 markah*]

CLO2 C2 (b) Explain the function of components (A), (B) and (C) in a simple close cycle steam plant as illustrated in the Figure Q4 (b).

Terangkan fungsi komponen (A), (B) dan (C) bagi kitar tertutup loji kuasa stim seperti yang digambarkan dalam Rajah Q4 (b).

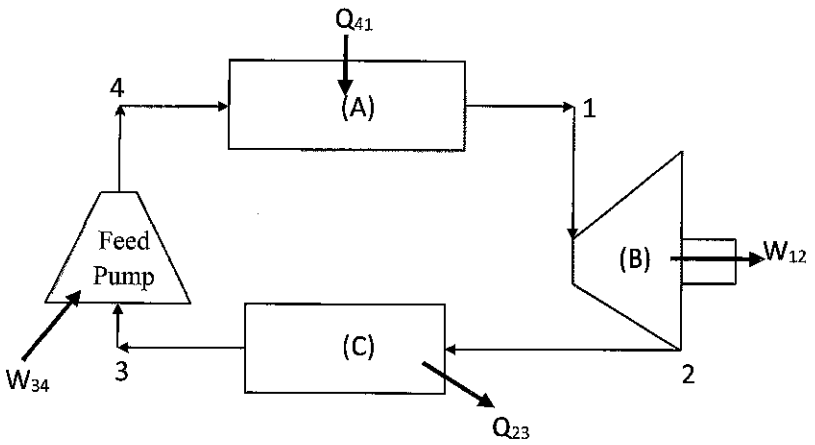

Figure Q4 (b)

[6 marks]

[*6 markah*]

CLO2
C3

(c) A steam power plant operates between a boiler pressure of 40 bar and a condenser pressure of 0.045 bar. Calculate for these limits for Rankine Cycle with dry saturated steam at entry to the turbine:

Sebuah penjana kuasa stim berkerja di antara tekanan dandang 40 bar dan tekanan pemeluap 0.045 bar. Kirakan had bagi Kitar Rankine dengan wap tepu kering ketika masuk ke turbin

i. Cycle efficiency.
Kecekapan kitar.

[11 marks]
[*11 markah*]

ii. Work Ratio.
Nisbah Kerja .

[2 marks]
[*2 markah*]

iii. The specific steam consumption (s.s.c)
Penggunaan Stim Tentu

[2 marks]
[*2 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 ($PV^n = C$)

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

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

4. Isobaric Process

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

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

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

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

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