SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI II : 2022/2023

DJJ20063: THERMODYNAMICS

TARIKH : 19 JUN 2023
MASA : 8.30 PG - 10.30 PG (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)** questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1 (a) Define the following terms and give **ONE (1)** example for each property.
*Takrifkan istilah-istilah berikut dan berikan **SATU (1)** contoh bagi setiap sifat tersebut.*

(i) Intensive property [2 marks]
Sifat intensif [*2 markah*]

(ii) Extensive property [2 marks]
Sifat ekstensif [*2 markah*]

CLO1 (b) Explain the Zeroth Law of Thermodynamics aided with the suitable diagram.
Terangkan Hukum Sifar Termodinamik dengan bantuan gambarajah yang sesuai.
[4 marks]
[*4 markah*]

CLO2 (c) Interpolate the value of steam at pressure 10 bar and temperature 380°C for the following solution :

Interpolasikan nilai bagi stim pada tekanan 10 bar dan suhu 380°C untuk penyelesaian berikut:

(i) Specific volume [4 marks]
Isipadu tentu [*4 markah*]

(ii) Specific enthalpy [4 marks]
Entalpi tentu [4 *markah*]

CLO2 (d) Given the pressure and the specific entropy of wet steam is 175 bar and 4.832 kJ/kgK. Relate the values given for solution of:

Diberi tekanan dan entropi tentu ialah 175 bar dan 4.832 kJ/kgK.
Hubungkaitkan nilai yang diberi untuk penyelesaian:

(i) Dryness fraction [3 marks]
Pecahan kekeringan [3 *markah*]

(ii) Specific volume [3 marks]
Isipadu tentu [*3 markah*]

(iii) Specific internal energy [3 marks]
Tenaga dalam tentu [3 *markah*]

QUESTION 2

SOALAN 2

CLO2 (a) Based on First Law of Thermodynamics, give **FOUR (4)** characteristics of closed system.

*Berdasarkan Hukum Termodinamik Pertama, berikan **EMPAT (4)** ciri sistem tertutup.*

[4 marks]

[*4 markah*]

CLO2 (b) Explain the following terms.

Terangkan istilah-istilah berikut.

(i) Heat [2 marks]

Haba [*2 markah*]

(ii) Specific heat [2 marks]

Haba tentu [*2 markah*]

CLO2 (c) A certain perfect gas has an initial volume of 0.05 m^3 at pressure of 7 bar and temperature of 131 ºC. The gas is cooled at a constant pressure until its final volume is 0.04 m^3. Calculate:

Sejenis gas sempurna mempunyai isipadu awal sebanyak 0.05 m^3 pada tekanan 7 bar dan suhu 131 ^oC. Gas tersebut disejukkan pada tekanan tetap sehingga isipadu akhir ialah 0.04 m^3. Kirakan:

(i) Final temperature (°C) [3 marks]

Suhu akhir (°C) [*3 markah*]

(ii) Work done [2 marks]

Kerja yang dilakukan [*2 markah*]

CLO2

(d) A Nitrogen (M=28 kg/kmol) expands reversibly in a pneumatic cylinder at a constant pressure of 2 bar. The initial temperature was 35°C with a volume of 0.05 m³. Then the temperature rises to 400°C after the process. Assuming nitrogen to be a perfect gas (Cp = 1.045 kJ/kgK), calculate:

Nitrogen (M = 28kg/kmol) dikembangkan secara boleh balik di dalam silinder pneumatik pada tekanan tetap 2 bar. Suhu awal adalah 35°C dengan isipadu 0.05 m³. Kemudian suhu meningkat kepada 400°C selepas proses tersebut. Andaikan nitrogen sebagai gas sempurna (Cp = 1.045 kJ/kgK), kirakan:

(i) Mass of Nitrogen [6 marks]
Jisim Nitrogen [*6 markah*]

(ii) Work done [3 marks]
Kerja yang dilakukan [*3 markah*]

(iii) Heat transfer [3 marks]
Haba yang dipindahkan [*3 markah*]

QUESTION 3

SOALAN 3

CLO2

(a) Identify **TWO (2)** characteristics of an open system and give **TWO (2)** examples of the equipment involved.

*Kenalpasti **DUA (2)** ciri sistem terbuka dan berikan **DUA (2)** contoh peralatan yang terlibat.* [4 marks]
[*4 markah*]

CLO2

(b) Compare **TWO (2)** differences between steady and unsteady flow process.

*Bandingkan **DUA (2)** perbezaan di antara proses aliran mantap dengan proses aliran tidak mantap.*

[4 marks]
[*4 markah*]

CLO2 (c) A fluid enters a nozzle with specific enthalpy 3020 kJ/kg, velocity 50 m/s and specific volume of 0.15 m^3/kg. The fluid exit a nozzle with specific enthalpy 2780 kJ/kg and specific volume of 0.85 m^3/kg. If the inlet area of the nozzle is 0.1 m^2, calculate:

Bendalir memasuki muncung dengan entalpi tentu 3020 kJ/kg, halaju 50 m/s dan isipadu tentunya 0.15 m^3/kg. Bendalir keluar muncung dengan entalpi tentu 2780 kJ/kg dan isipadu tentunya 0.85m^3/kg. Jika luas bahagian masukan muncung adalah 0.1 m^2, kirakan:

(i) Exit velocity of the fluid [3 marks]
Halaju keluaran bendalir [*3 markah*]

(ii) Outlet area of the nozzle [3 marks]
Luas keluaran muncung [*3 markah*]

CLO2 (d) The power output of an adiabatic steam turbine is 5 MW, with the inlet and the outlet values of the steam are as indicated in Figure Q3(d). If the given the value of g = 9.81 m/s^2, calculate:

Kuasa keluaran suatu turbin adiabatik ialah 5MW dengan nilai-nilai pada masukan dan keluaran stim adalah seperti di Rajah Q3(d). Sekiranya diberi nilai g = 9.81 m/s^2, kirakan:

(i) The specific enthalpy of the turbine outlet [4 marks]
Entalpi tentu pada keluaran turbin [*4 markah*]

(ii) The mass flow rate of the steam [7 marks]
Jisim aliran stim [*7 markah*]

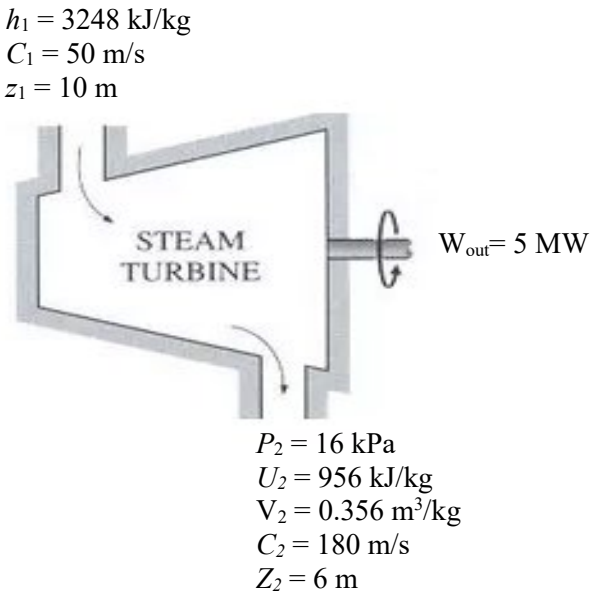

Figure Q3(d)

Rajah Q3(d)

QUESTION 4

SOALAN 4

CLO2 (a) List **FOUR (4)** reversible processes for the Carnot cycle.

*Senaraikan **EMPAT (4)** proses boleh balik Kitar Carnot.*

[4 marks]

[*4 markah*]

CLO2 (b) Aided with a suitable diagram, explain the Principle of Heat Engine.

Dengan bantuan gambarajah yang sesuai, terangkan Prinsip Enjin Haba.

[6 marks]

[6 *markah*]

CLO2 (c) A dry saturated steam is supplied at 50 bar to turbine and the condenser pressure is 0.060 bar. If the plant operates with the Rankine Cycle, aided with T-s diagram, calculate:

Stim tepu kering dibekalkan pada tekanan 50 bar kepada turbin dan tekanan pemeluwap 0.060 bar. Sekiranya loji ini beroperasi dengan Kitar Rankine, dengan bantuan gambarajah T-s, kirakan:

(i) The work for turbine
Kerja turbine [11 marks]
[11 *markah*]

(ii) The pump feed work
Kerja pam suapan [2 marks]
[2 *markah*]

(iii) The specific steam consumption (s.s.c)
Pengunaan 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 ($PV^n = C$)

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

$Q = \frac{\gamma - n}{\gamma - 1}$ 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

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

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

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