INSTRUCTION:

This section consists of **FOUR (4)** questions. Answers **ALL** questions.

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO 1
C1

(a) State **TWO (2)** differences between Reversible Process and Irreversible Process in thermodynamics.

*Nyatakan **DUA (2)** perbezaan antara Proses Boleh Balik dan Proses Tidak Boleh Balik dalam termodinamik.*

[4 marks]

[*4 markah*]

CLO 1
C2

(b) Explain the following terms with **ONE (1)** examples for each terms.

*Terangkan istilah berikut berserta **SATU (1)** contoh bagi setiap terma tersebut.*

i. Extensive property

Sifat ekstensif

ii. Intensive property

Sifat intensif

[4 marks]

[*4 markah*]

CLO 1
C2

(c) Table 1(c) shows certain properties of pure substance at point A, B, C and D. Based on the table given:
Jadual 1(c) menunjukkan beberapa ciri bahan tulin pada titik A, B, C dan D. Berpandukan pada jadual yang diberi:

Table 1(c) / *Jadual 1(c)*

Point / *Titik A*	P = 40 bar	T = 350 ^{0}C
Point / *Titik B*	T = 250 ^{0}C	v = 0.0498 m^3/kg
Point / *Titik C*	P = 15 bar	h = 2650 kJ/kg
Point / *Titik D*	P = 7 bar	h = 3164 kJ/kg

i. Locate point A, B, C and D on the P-v diagram based on Table 1(c).
Tempatkan titik-titik A, B, C dan D pada rajah P-v berdasarkan Jadual 1(c) yang di beri.

[4 marks]
[*4 markah*]

ii. Categorize the phase region for point A, B, C and D.
Kategorikan kawasan fasa bagi titik A, B, C dan D.

[4 marks]
[*4 markah*]

CLO 1
C2

(d) Given wet steam at pressure 30 bar and the dryness fraction is 0.4. Using the steam table, relate the values given for the following solution:
Diberi stim basah pada tekanan 30 bar dan pecahan kekeringan 0.4. Dengan menggunakan jadual stim, hubungkaitkan nilai yang diberi bagi penyelesaian berikut:

i. Specific volume
Isipadu tentu

[3 marks]
[*3 markah*]

CLO 2
C3

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

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

[3 marks]
[*3 markah*]

ii. Specific heat at constant pressure (Cp)
Haba tentu pada tekanan tetap (Cp)

[2 marks]
[*2 markah*]

CLO 2
C3

(d) 1.02 kg of gas is compressed from 1 bar, 20°C according to the law $pV^{1.3}$ = constant, until the pressure is 5.5 bar and temperature 161°C. If the gas is Argon with molar mass 40 kg/kmol which has Cp = 0.520 kJ/kgK, calculate:
1.02 kg gas dimampatkan daripada 1 bar, 20°C mengikut hukum $pV^{1.3}$ =pemalar, sehingga tekanannya menjadi 5.5 bar dan suhunya 161°C. Jika gas adalah gas Argon dengan jisim molar 40 kg/kmol dengan Cp= 0.520 kJ/kgK, kirakan:

i. Work done
Kerja yang dilakukan

[5 marks]
[*5 markah*]

ii. Heat flow of the gas
Aliran haba gas

[7 marks]
[*7 markah*]

ii. Specific enthalpy

Entalpi tentu

[3 marks]

[*3 markah*]

iii. Specific internal energy

Tenaga dalam tentu

[3 marks]

[*3 markah*]

QUESTION 2

SOALAN 2

CLO 2
C1

(a) Based on First Law of Thermodynamics, state **THREE (3)** characteristics of the closed system and give **ONE (1)** example the equipment involved.
*Berdasarkan kepada Hukum Pertama Termodinamik, nyatakan **TIGA (3)** ciri-ciri sistem tertutup dan berikan **SATU (1)** contoh peralatan yang terlibat.*

[4 marks]

[*4 markah*]

CLO 2
C2

(b) Table 2(b) shows information about a process of a closed system. Fill in the blanks in the table with the correct answers.
Jadual 2(b) menunjukkan maklumat tentang proses sistem tertutup. Isikan ruang kosong dalam jadual dengan jawapan yang betul.

Table 2(b) / *Jadual 2(b)*

PROCESS	Q_{12} **(kJ)**	W_{12} **(kJ)**	$(U_2 - U_1)$ **(kJ)**
a.	+50	-20	i. _____
b.	+100	ii. _____	-30
c.	iii. _____	-70	+130
d.	-50	+20	iv. _____

[4 marks]

[*4 markah*]

QUESTION 3

SOALAN 3

CLO 2
C1

(a) State **FOUR (4)** devices that use the principal of flow process.
*Nyatakan **EMPAT (4)** peralatan yang menggunakan prinsip proses alir.*

[4 marks]
[*4 markah*]

CLO 2
C2

(b) Explain **TWO (2)** differences between steady and unsteady flow processes.
*Terangkan **DUA (2)** perbezaan antara proses aliran mantap dan aliran tidak mantap.*

[4 marks]
[*4 markah*]

CLO 2
C3

(c) A steam enters a diffuser with pressure of 1.05 bar and specific volume of 0.55 m^3/kg and exit with pressure of 2.23 kN/m^2 and specific volume of 0.18 m^3/kg. If the steam exit a diffuser at velocity of 159 m/s with specific enthalpy change of 433 kJ/kg, calculate:
Stim memasuki peresap dengan tekanan 1.05 bar dan isipadu tentu 0.55 m^3/kg dan keluar dengan tekanan 2.23 kN/m^2 dan isipadu tentu 0.18 m^3/kg. Jika stim keluar pada peresap dengan halaju 159 m/s dengan perubahan entalpi tentunya 433 kJ/kg, kirakan:

i. initial velocity
isipadu awal

ii. specific internal energy change
perubahan tenaga dalam tentu

[6 marks]
[*6 markah*]

CLO 2
C3

(d) Steam flows steadily into a turbine at 6000 kg/h and produce 3000 kW of power. Properties of steam for inlet and outlet part of the turbine are shown in the Table 3(d) below. Assuming that changes in potential energy may be neglected, calculate:

Stim mengalir masuk di dalam sebuah turbin dengan aliran sekata pada 6000 kg/j dan menghasilkan kuasa sebanyak 3000kW. Sifat-sifat stim pada bahagian masukan dan keluaran turbin ditunjukkan seperti jadual 3(d) di bawah. Dengan anggapan perubahan tenaga keupayaan diabaikan, hitungkan:

Table 3(d) / *Jadual 3(d)*

	Inlet ***Masukan***	**Outlet** ***Keluaran***
Pressure, P ***Tekanan*** **(bar)**	9	1.5
Internal energy, u ***Tenaga Dalam*** **(kJ/kg)**	3770	2550
Velocity, C ***Halaju Aliran*** **(m/s)**	320	110
Spesific Volume, υ ***Isipadu Tentu*** **(m^3/kg)**	0.55	1.90

i. Heat transfer in kW.
Haba yang dipindahkan dalam unit kW.

[8 marks]
[*8 markah*]

ii. Outlet area of the turbine.
Luas bahagian keluaran turbin.

[3 marks]
[*3 markah*]

QUESTION 4

SOALAN 4

CLO 2
C1

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

i. Second Law of Thermodynamics
Hukum Kedua Termodinamik

[2 marks]
[2 markah]

ii. Heat Engine
Enjin Haba

[2 marks]
[2 markah]

CLO 2
C2

(b) Explain **TWO (2)** characteristics of heat pump with schematic diagram of the heat pump principles.
*Terangkan **DUA (2)** ciri-ciri pam haba berserta rajah skematik bagi prinsip pam haba.*

[6 marks]
[6 markah]

CLO 2
C3

(c) A steam power plants operates between a boiler pressure of 40 bar and a condenser pressure of 0.035 bar. If steam entry to the turbine with dry saturated, calculate for a Rankine cycle:

Sebuah loji kuasa stim beroperasi di antara tekanan dandang 40 bar dan tekanan pemeluwap 0.035 bar. Sekiranya stim masuk ke dalam turbin pada keadaan tepu kering, kirakan untuk kitar Rankine:

i. Rankine efficiency
Kecekapan kitar Rankine

[9 marks]
[9 markah]

ii. Work ratio
Nisbah kerja

[3 marks]
[3 markah]

iii. Specific steam consumption
Penggunaan stim tepu

[3 marks]
[3 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

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

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

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