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) Define the following items:

Definisikan yang berikut:

i. First law of thermodynamics

Hukum Pertama Termodinamik

[2 marks]

[2 markah]

ii. Intensive properties

Sifat-sifat intensif

[2 marks]

[2 markah]

iii. Surroundings

Persekitaran

[2 marks]

[2 markah]

CLO2
C2

(b) A mass of gas has an initial pressure of 120 kN/m^2, volume 0.014 m^3 and temperature 135°C. It is expanded until its final pressure is 275 kN/m^2 and its volume becomes 0.056 m^3. determine

Jisim udara mempunyai tekanan awal sebanyak 120 kN/m^2, isipadu 0.014 m^3 dan suhu 135°C. Ia berkembang sehingga tekanan akhir 275 kN/m^2 dan isipadu akhir 0.056 m^3. Tentukan

i. the mass of air

jisim udara

[3marks]

[3markah]

ii. the final temperature

suhu akhir Ambil

[3marks]

[3markah]

iii. Specific heat capacity at constant volume

Muatan haba tentu pada isipadu malar

[2marks]

[2markah]

iv. Specific heat capacity ratio

Nisbah muatan haba tentu

[2 marks]

[2 markah]

Take R = 0.24 kJ/kgK and C_p = 1.132 kJ/kg.K

Ambil R = 0.24 kJ/kgK dan C_p = 1.132 kJ/kg.K

CLO2
C3

(c) A perfect gas is contained in a rigid vessel at 3 bar and 315^{o}C. The gas is then cooled until the pressure falls to 1.5 bar. Given M = 26 and γ = 1.26. Calculate the heat rejected per kg of gas.

Suatu gas sempurna terkandung dalam sebuah bekas tegar pada 3 bar dan 315^{o}C. Gas ini kemudiannya disejukkan sehingga tekanan jatuh ke 1.5 bar. Diberi: M = 26 dan γ = 1,26. Hitungkan haba yang disingkirkan per kg gas.

[9 marks]

[9 markah]

QUESTION 2

SOALAN 2

CLO2
C1

(a) i. Indicate **SIX (6)** practical applications of a steady flow energy equation.

*Nyatakan **ENAM (6)** penggunaan praktikal persamaan tenaga aliran mantap.*

[3 marks]
[*3markah*]

ii. Sketch the diagram of condenser.

Lakarkan gambarajah pemeluwap.

[4 marks]
[*4markah*]

iii. Write **THREE (3)** assumptions made in forming steady flow energy equation.

*Tuliskan **TIGA (3)** anggapan yang dibuat dalam membentuk persaman aliran mantap.*

[3 marks]
[*3markah*]

CLO2
C2

(b) Helium at a pressure of 1.2 MPa and a temperature of 20°C is throttled to 100 kPa. The diameter of the outlet pipe is so much larger than the inlet pipe that the inlet and exit velocities are equal. Assuming no changes in the kinetic energy. Calculate:

Helium pada tekanan 1.2 MPa dan suhu 20℃ didikitkan kepada 100 kPa. Garispusat paip keluar adalah lebih besar daripada garispusat paip masuk yang mana halaju masuk dan halaju keluar adalah sama. Anggapkan tiada perubahan tenaga kinetik berlaku. Kirakan:

i. the exit temperature of the helium , T_2
suhu keluar bagi Helium , T_2

ii. the ratio of the pipe diameters, D_2/D_1
nisbah diameter paip, D_2/D_1

[6 marks]
[*6 markah*]

CLO2
C3

(c) Air flows through a nozzle isentropically, at a rate of 600 kg/hr. The pressure at the inlet nozzle is 2 Mpa and temperature is 127^0C. The outlet pressure is 0.5 MPa. If the initial air velocity is 300 m/s and the specific heat ratio is 1.4, calculate the outlet velocity of air.

Given C_p= 1.005kJ/kg.K

Udara mengalir menerusi sebuah muncung secara seentropi , pada kadar 600kg/jam. Tekanan di salur masuk muncung adalah 2 MPa dan suhu 127^0C. Tekanan di salur keluar adalah 0.5 MPa. Jika halaju awal udara adalah 300 m/s dan nisbah haba tentu 1.4, kirakan halaju salur keluar bagi udara.

Di beri Cp= 1.005kJ/kg.K

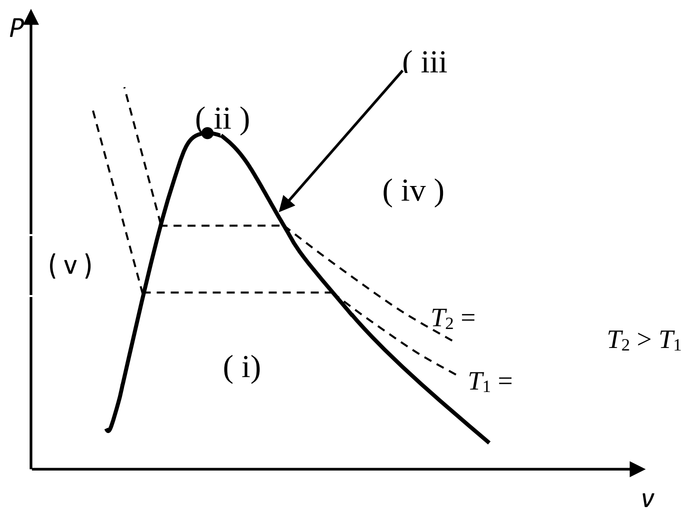
[9 marks]
[*9 markah*]

CLO1
C1

QUESTION 3

SOALAN 3

(a) Write the suitable phases for H_2O in the *P*-*v* diagram below.
Tulis fasa yang sesuai untuk H_2O dalam gambarajah Pv di bawah



[5 marks]
[5 markah]

CLO2
C2

(b) A steam plant operating in a Rankine cycle with condenser pressure 0.1 bars. This plant has a 99.5% work ratio and the amount of work produced by the turbine is 880 kJ/kg. From this condition, calculate the pressure in bar at the inlet to the turbine where the steam entering the turbine is in dry saturated state.

Loji stim beroperasi dalam kitaran Rankine dengan tekanan kondenser 0.1 bar. Loji ini mempunyai nisbah 99.5% daripada kerja dan jumlah kerja yang dihasilkan oleh turbin adalah 880 kJ/kg. Dari keadaan tersebut, kirakan tekanan dalam bar di salur masuk turbin dimana stim memasuki turbin dalam keadaan tepu kering.

[13 marks]

[13 markah]

CLO2
C3

(c) If the superheated steam is at 12.5 MN/m^2 and 650^oC is given. Determine its specific volume with reference to the Steam Table.

Jika stim panas lampau adalah 12.5 MN/m^2 dan 650^oC, tentukan isipadu spesifik dengan merujuk kepada Jadual Stim.

[7 marks]

[7 markah]

QUESTION 4

SOALAN 4

CLO2
C1

(a) A 1.0 L volume of air initially at 4.5 bar of pressure is allowed to expand isothermally until the pressure is 1.0 bar. It is then compressed at a constant pressure to its intial volume and finally is brought back to its original pressure by heating at a constant volume. Draw the process in a P-V diagram, including the numbers and labels for each axis.

Suatu gas berisipadu 1.0 liter bertekanan awal 4.5 bar dibenarkan mengembang secara isothermal sehingga ketekanan 1.0 bar. Gas kemudiannya dimampatkan pada tekanan malar dan akhirnya kembali ke tekanan asal dengan pemanasan ispadu malar. . Lakarkan proses tersebut dalam rajah P-V serta lengkapkan nombor dan label bagi setiap paksi.

[6 marks]
[6 markah]

CLO2
C2

(b) 2 kg of an ideal gas is compressed adiabatically from a pressure of 100 kPa and temperature of 220 K to a final pressure of 400 kPa. Calculate:
2 kg gas sempurna dimampatkan secara adiabatic daripada 100 kPa dan suhu 220 K kepada tekanan akhir 400 kPa. Kirakan:

i. Specific heat ratio, γ / *Nisbah haba tentu, γ*

ii. Initial volume, V_1 / *Isipadu awal , V_1*

iii. Final volume , V_2 / *Isipadu akhir, V_2*

iv. Final temperature, T_2 / *Suhu akhir , T_2*

Given Cp = 1 kJ/kg-K and Cv = 0.707 kJ/kg-K.
Diberi Cp = 1 kJ/kg-K and Cv = 0.707 kJ/kg-K.

[10 marks]
[10 markah]

CLO2
C3

(c) 0.6125 kg of steam at 150 kPa and 0.6 m^3 is heated reversibly at constant pressure until its temperature becomes 200 °C. Calculate the work interaction and the internal energy for this system.

0.6125 kg stim pada 150 kPa and 0.6 m^3 dipanaskan secara boleh balik pada tekanan malar sehingga mencapai suhu 200°C. Kirakan tindakbalas kerja dan tenaga dalam untuk sistem tersebut.

[9 marks]
[9 markah]

SOALAN TAMAT

BASIC THERMODYNAMICS

- $Pv = mRT$
- $R = C_p - C_v$
- $U_2 - U_1 = Q - W$
- $\gamma = \frac{C_p}{C_v}$
- $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
- $R = \frac{R_o}{M}$

NON FLOW PROCESS

1. **Isothermal Process ($T_1 = T_2$)**
   - $U_2 - U_1 = 0$
   - $Q = W$
   - $W = P_1V_1 \ln\left(\frac{V_2}{V_1}\right)$ @ $W = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$
2. **Adiabatic Process (Seentropi)**
   - $U_2 - U_1 = mC_V(T_2 - T_1)$
   - $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$
   - $Q = 0$
   - $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$
3. **Polytropic Process**
   - $U_2 - U_1 = mC_V(T_2 - T_1)$
   - $W = \frac{P_1V_1 - P_2V_2}{n - 1} = \frac{mR(T_1 - T_2)}{n - 1}$
   - $Q = \frac{\gamma - n}{\gamma - 1} \times W$
   - $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}$
4. **Constant Pressure Process ($P_1 = P_2$)**
   - $Q = mC_P(T_2 - T_1)$
   - $U_2 - U_1 = Q - W = mC_V(T_2 - T_1)$
   - $W = P(V_2 - V_1) = mR(T_2 - T_1)$
5. **Constant Volume Process ($V_1 = V_2$)**
   - $Q = U_2 - U_1 = mC_V(T_2 - T_1)$
   - $W = 0$

FLOW PROCESS

- $Q - W = \dot{m}\left[(h_2 - h_1) + \left(\frac{C_2^2 - C_1^2}{2000}\right) + \left(\frac{Z_2 - Z_1}{1000}\right)g\right]$
- $h_2 - h_1 = (U_2 - U_1) + (P_2v_2 - P_1v_1) = C_p(T_2 - T_1)$
- $\dot{m} = \frac{CA}{v}$

PROPERTIES OF STEAM

- $V = x(V_g)$
- $h = h_f + x(h_{fg})$
- $h = U + Pv$
- $U = U_f + x(U_g - U_f)$
- $S = S_f + x(S_{fg})$

2nd LAW THERMODYNAMICS

1. **STEAM**
   a. **Constant Pressure Process ($P_1 = P_2$)**
      $W = P(V_2 - V_1) = Q - (u_2 - u_1)$
      $Q = h_2 - h_1$
   b. **Constant Volume Process ($V_1 = V_2$)**
      $W = 0$ $Q = u_2 - u_1$
   c. **Isothermal Process ($T_1 = T_2$)**
      $Q = T(s_2 - s_1)$ $W = Q - (u_2 - u_1)$
   d. **Adiabatic Process (Seentropi)**
      $s_1 = s_2$ $Q = 0$ $W = u_1 - u_2$
   e. **Polytropic Process**
      $W = \frac{P_1V_1 - P_2V_2}{n - 1}$ $Q = (u_2 - u_1) + W$

2. **PERFECT GAS**
   a. **Constant Pressure Process ($P_1 = P_2$)**
      - $s_2 - s_1 = mC_p \ln\left(\frac{T_2}{T_1}\right)$
   b. **Constant Volume Process ($V_1 = V_2$)**
      - $s_2 - s_1 = mC_V \ln\left(\frac{T_2}{T_1}\right)$
   c. **Isothermal Process ($T_1 = T_2$)**
      - $s_2 - s_1 = mR\ln\left(\frac{v_2}{v_1}\right) = mR\ln\left(\frac{P_1}{P_2}\right)$
   d. **Polytropic Process**
      - $s_2 - s_1 = mR\ln\left(\frac{v_2}{v_1}\right) - mC_V \ln\left(\frac{T_1}{T_2}\right)$

      Or

      - $s_2 - s_1 = mR\ln\left(\frac{P_1}{P_2}\right) - mC_p \ln\left(\frac{T_1}{T_2}\right)$

POWER CYCLES STEAM

- $\eta_c = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)}$
- $r_w = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$
- $S.S.C. = \frac{3600}{(h_1 - h_2) - (h_4 - h_3)}$

CHEMICAL EQUILIBRIUM

- $\Delta S = Q_p (S_P - S_A)$
- $\Delta G = \Delta G^O + RT \ln K$
- $\frac{d(\ln K)}{dT} = \frac{\Delta H}{RT^2}$