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) State **THREE (3)** differences between Closed Systems and Open Systems.

*Nyatakan **TIGA (3)** perbezaan antara Sistem Tertutup dan Sistem Terbuka.*

[6 marks]

[6 markah]

CLO2
C2

(b) A perfect gas has a molecular weight of 28 and the specific heat ratios , γ of 1.55. The gas is contained in a rigid cylinder at pressure of 254 bar and temperature of 263°C. The gas is cooled until the final pressure becomes 174 bar. Calculate:

Satu gas sempurn mempunyai berat molekul 28 dan nisbah haba tentu, γ ialah 1.55. Gas terkandung dalam selinder tegar pada tekanan 254 bar dan suhu 263°C. Gas ini disejukkan sehingga tekanan akhir menjadi 174 bar. Kirakan:

i. Universal gas constant

Pemalar gas semesta

[4 marks]

[4 markah]

ii. Specific heat at fixed volume

Haba tentu pada isipadu tetap

[6 marks]

[6 markah]

iii. The final temperature

Suhu akhir

[3 marks]

[3 markah]

CLO2
C3

(c) Calculate the heat value transferred to the cylinder of a given mass of 3.25 kg of gas using the information obtained from question 1(b)
Dengan menggunakan maklumat yang diperolehi daripada soalan 1(b) dan diberi jisim gas 3.25 kg, kirakan nilai haba yang dipindahkan ke silinder.

[6 marks]
[6 markah]

QUESTION 2
SOALAN 2

CLO2
C1

(a) State the assumptions made for the following equipment when the steady state energy equation is applied:
Nyatakan andaian yang dibuat terhadap peralatan berikut a[abila persamaan tenaga keadaan mantap diaplikasikan:

i. Boiler / *Dandang*

[3 marks]
[3markah]

ii. Condenser / *Pemeluwap*

[3 marks]
[3markah]

iii. Compressor / *Pemampat*

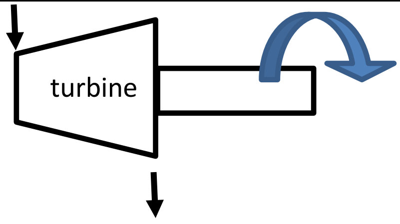
[4 marks]
[4 markah]

CLO2
C2

(b) A steam flow constantly to a turbine at a rate of 11.2 kg/s. Heat transferred to the atmosphere is 44Kj/kg. If the potential energy change is negligible, determine the work output of the turbine in kW
Satu aliran stim tetap melalui turbin pada kadar 11.2 kg/s. Haba dipindahkan ke atmosfera ialah 44Kj/kg. Jika perubahan tenaga keupayaan boleh diabaikan, tentukan kerja keluaran turbin dalam kW.

Steam enter :

Pressure = 7.2 bar,Volume = 250 m/s, Energy = 1500 kJ/kg, Specific volume = 0.52 m3/s



Steam exit :

Pressure = 1.25 bar, Volume = 100 m/s, Energy = 2300 kJ/kg, Specific volume = 1.95 m3/s

[6 marks]
[6 markah]

CLO2
C3

(c) Air expands reversibly and adiabatically in the nozzle. At the nozzle inlet, the pressure is 0.45 bar and the temperature is 443 K. At the nozzle exit, the pressure is 0.15 bar. The flow velocity at the nozzle inlet is small. The expansion process occurs according to steady flow conditions. Given for air; Adiabatic Index [γ] = 1.4 and Cp = 1.005 kJ/kg.K. Calculate:

Udara mengembang secara boleh balik dan adiabatik dalam muncung. Di dalam muncung masukan, tekanan adalah 0.45 bar dan suhu ialah 443 K. Di muncung keluaran, tekanan ialah 0.15 bar. Halaju aliran pada muncung masukan adalah kecil. Proses pembesaran berlaku mengikut keadaan aliran mantap. Diberikan maklumat berkenaan udara; Indeks Adiabatik [γ] = 1.4 dan Cp = 1.005 kJ / kg.K. Kirakan:

i. Final temperature of air in ^oC.
Suhu akhir udara dalam ^oC.

[6 marks]
[6 markah]

ii. Flow velocity at the nozzle exit
Halaju aliran pada muncung keluar

[3 Marks]
[3 markah]

QUESTION 3

SOALAN 3

CLO1
C1

(a) Sketch the Figure T-s for steam and mark the position of the line and the following points:
Lakarkan Rajah T-s bagi stim dan tandakan kedudukan garisan dan titik berikut:

i. Critical point / *Titik genting*

[2 marks]
[2 markah]

ii. Saturated Liquid Line / *Garisan Cecair Tepu*

[2 marks]
[2 markah]

iii. Saturated Steam Line / *Garisan stim tepu*

[2 marks]
[2 markah]

CLO2
C2

(b) Based on the steam table, given pressure 40 bar and the specific enthalpy of 2450 kJ/kg. Determine the following values:
Berpandukan jadual stim, diberi tekanan 40 bar dan nilai entalpi tentunya 2450 kJ/kg. Tentukan nilai-nilai berikut:

i. Quality steam, x / *Kualiti stim, x*

[3 marks]
[3 markah]

ii. Specific volumes, *v* / *Isipadu tentu, v*

[3 marks]
[3 markah]

iii. Specific Internal energy, u / *Tenaga dalaman Tentu, u*

[3 marks]
[3 markah]

iv. Specific Entropy, s / *Entropi Tentu, s*

[3 marks]
[3 markah]

CLO2
C3

(c) A steam power plant for Rankine cycle operates between a boiler and a condenser with cycle efficiency is 35.9%. Meanwhile the calculated feed pump and turbine work are 4 kJ/kg and 961.7 kJ/kg respectively, calculate:
Sebuah penjana kuasa stim untuk kitaran Rankine beroperasi di antara dandang dan pemeluwap dengan kecekapan kitaran ialah 35.9%. Sementara itu, pam suapan dan kerja turbin yang telah dikira ialah 4 kJ/kg dan 961.7 kJ/kg, kirakan:

i. Heat supply to the boiler
Haba yang dibekalkan ke dandang

[4 marks]
[4 markah]

ii. The work ratio
Nisbah kerja

[3 marks]
[3 markah]

QUESTION 4
SOALAN 4

CLO2
C1

(a) Describe the **TWO (2)** process in thermodynamics given bellow
*Terangkan **DUA (2)** proses dalam termodinamik seperti yang diberikan*

i. Flow process
Proses aliran

[3 marks]
[3 markah]

i. Non Flow process
Proses tak alir

[3 marks]
[3 markah]

CLO2
C2

(b) The combustion gases in a petrol engine cylinder is at 30 bar and 800 ^oC before expansion. The gases expand through a volume ratio [V_2 / V_1] of [8.5/1] and occupy 510 cm^3 after expansion. When the engine air is cooled, the polytropic expansion index is n = 1.15. Determine :

Gas pembakaran dalam silinder enjin petrol adalah pada 30 bar dan 800 ^oC sebelum pengembangan. Gas-gas meluaskan nisbah isipadu [V_2 / V_1] *dari [8.5/1] dan menduduki 510 cm^3 selepas pengembangan. Apabila enjin udara di sejukkan, indeks pengembangan polytropic n = 1.15. Tentukan:*

i. The temperature and pressure of the gas after expansion
Suhu dan tekanan gas selepas pengembangan

[6 marks]
[6 markah]

ii. The work output.
Keluaran kerja.

[4 marks]
[4 markah]

CLO2
C3

(c) A wet steam at 10 bar is heated reversibly at a constant volume to a pressure of 20 bar and 250 ^oC. Calculate:

Wap basah pada 10 bar dipanaskan secara berulang pada isipadu malar hingga tekanan 20 bar dan 250 ^oC. Hitung :

i. the heat supply [in kJ/kg] and
bekalan haba [dalam kJ / kg] dan

[7 marks]
[7 markah]

ii. Draw the process on a T-s diagram, indicating the area that represents the heat flow.
Lukiskan proses pada rajah T-s, menunjukkan kawasan yang mewakili aliran haba.

[2 marks]
[2 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

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