SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN PETROKIMIA

PEPERIKSAAN AKHIR

SESI DISEMBER 2018

DGP2043: THERMODYNAMICS

TARIKH : 14 APRIL 2019
MASA : 11.15 PAGI – 1.15 TENGAHARI (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Properties Steam Table

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

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 the First Law of Thermodynamics and sketch the appropriate diagram.
Nyatakan Hukum Pertama Termodinamik dan lakarkan rajah yang bersesuaian.

[5 marks]
[5 markah]

CLO2 C2

b) Determine the mass of the gas contained in the storage tank at a pressure of 10 bar, temperature 40°C. Given the width, length and height of the storage tank are 2 m, 5 m and 3 m, respectively. The gas constant is 0.287 kJ / kgK. Assume the gas in the storage is perfect gas.
Tentukan jisim gas yang terkandung dalam tangki penyimpanan pada keadaan tekanan 10 bar, suhu 40°C. Diberi lebar, panjang dan tinggi tangki penyimpanan tersebut masing-masing ialah 2 m, 5 m dan 3 m. Pemalar gas ialah 0.287 kJ/kgK. Anggapkan gas dalam tangi penyimpanan adalah gas sempurna.

[10 marks]
[10 markah]

CLO2 C3

c) Heat energy is added to the gas inside a closed cylinder. Because of this, the volume increased from 0.128 m^3 to 0.96 m^3 at a constant pressure of 800 kN/m^2. If the molecular weight of the gas is 28 and the initial temperature is 35°C, calculate:
Tenaga haba ditambahkan kepada gas di dalam sebuah silinder tertutup. Disebablan ini, isipadunya bertambah dari 0.128 m^3 kepada 0.96 m^3 pada tekanan tetap 800 kN/m^2. Jika berat molekul gas itu ialah 28 dan suhu awalnya 35°C, kirakan:

i. The mass of the gas
Jisim gas itu.

[7 marks]
[7 markah]

ii. The work done

Kerja yang dilakukan

[3 marks]
[3 markah]

Take $R_o = 8.314$ kJ/kgK

Ambil $R_o = 8.314$ *kJ/kgK*

QUESTION 2
SOALAN 2

CLO2 C1

a) State the assumption made when the steady state energy equation is applied on the following equipment:

Nyatakan andaian yang dibuat apabila persamaan tenaga keadaan mantap diaplikasikan terhadap peralatan berikut:

i. Turbine

Turbin

[2 marks]
[*2 markah*]

ii. Nozzle

Muncung

[3 marks]
[*3 markah*]

iii. Condenser

Pemeluwap

[2 marks]
[*2 markah*]

iv. Compressor

Pemampat

[3 marks]
[*3 markah*]

CLO2
C2

b) At the inlet of a nozzle steam, the enthalpy is 3010 kJ/kg and a velocity of 60 m/s. At the nozzle outlet the enthalpy is 2780 kJ/kg. Determine the velocity at the nozzle outlet.

Alur masuk bagi satu muncung stim mengandungi entalpi 3010 kJ/kg dan halaju 60 m/s. Entalpi di alur keluar muncung ialah 2780 kJ/kg. Tentukan halaju pada alur keluar muncung.

[6 marks]
[*6 markah*]

CLO2
C3

c) A boiler operates at a constant pressure of 13 bar and evaporates fluid at the rate of 950 kg/h. At boiler's entry, the fluid has an enthalpy of 175 kJ/kg and on the leaving boiler the enthalpy of the fluid is 2100 kJ/kg. Calculate the heat energy supplied to the boiler in kilowatt (kW).

Dandang beroperasi pada tekanan malar 13 bar dan menyejat bendalir pada kadar 950 kg/jam. Pada kemasukan ke dandang, cecair mempunyai entalpi 175 kJ/kg dan apabila meninggalkan dandang entalpi bendalir adalah 2100 kJ/kg. Kirakan tenaga haba yang dibekalkan kepada dandang dalam kilowatt (kW).

[9 marks]
[*9 markah*]

QUESTION 3
SOALAN 3

CLO1
C1

a) Define the following terms:
Definisikan terma-terma berikut:

i. Enthalpy
Entalpi

[1 marks]
[1 markah]

ii. Solid phase
Fasa pepejal

[2 marks]
[2 markah]

iii. Liquid phase
Fasa cecair

[2 marks]
[2 markah]

CLO2
C2

b) Calculate the enthalpy and internal energy values of wet steam at 15.5 bar pressure with the quality steam of 85%:
Kirakan nilai entalpi dan tenaga dalam bagi stim basah pada tekanan 15.5 bar dengan kualiti stim 85%

[13 marks]
[13 markah]

CLO2
C3

c) A steam plant operates in the Rankine cycle with a pressure of 0.1 bar condenser. This plant has a working ratio of 99.5% and the amount of work generated by the turbine is 880 kJ / kg. Based on the situation, calculate the pressure value at the inlet of the turbine if the steam is in a dry saturated state.

Sebuah loji stim beroperasi dalam kitar Rankine dengan tekanan pemeluwap 0.1 bar. Loji ini mempunyai nisbah kerja sebanyak 99.5% dan jumlah kerja yang terhasil oleh turbin ialah 880 kJ/kg. Dari keadaan tersebut, kirakan nilai tekanan pada bahagian kemasukan turbin jika stim adalah dalam keadaan tepu kering.

[7 marks]
[7 markah]

QUESTION 4
SOALAN 4

CLO2
C1

a) Draw P-V diagram for the following non-flow process:
Lukiskan rajah P-V bagi proses tak alir berikut:

i. Constant pressure process
Proses tekanan malar

[2 marks]
[*2 markah*]

ii. Adiabatic process
Proses adiabatic

[2 marks]
[*2 markah*]

iii. Polytropic process
Proses politropik

[2 marks]
[*2 markah*]

CLO2
C2

b) In a cylinder, the pressure and temperature are 2 bars and 60 ^{0}C, respectively. The volume of air is 1.5 m^3. Air is then compressed in an adiabatic process by following the equation of $PV^{1.4} = C$ until the pressure becomes 8 bars. Determine:
Di dalam suatu silinder, tekanan dan suhu adalah 2 bar dan 60 ^{0}C. Isipadu udara adalah 1.5 m^3. Udara ini kemudiannya dimampatkan dalam proses adiabatic mengikut hukum $PV^{1.4} = C$ sehingga tekanan menjadi 8 bar. Tentukan:

i. Temperature at the end of compression process.
Suhu di akhir proses mampatan.

[3 marks]
[*3 markah*]

ii. Mass of air in cylinder.
Jisim udara dalam silinder.

[5 marks]
[*5 markah*]

iii. Work done on air during compression process.
Kerja yang dilakukan ke atas udara semasa proses mampatan.

[2 marks]
[*2 markah*]

Given, $R = 287$ J/kg.K and $\gamma = 1.4$.

Diberi, $R = 287$ *J/kg.K dan* $\gamma = 1.4$.

CLO2
C3

c) 0.47 kg of Nitrogen gas at a constant pressure of 1.2 bar and volume of 0.35 m^3 expand reversibly in a cylinder behind a piston. The initial temperature is 28 ^{0}C. It then rises to 450 ^{0}C. Assuming the nitrogen gas is in perfect gas condition, calculate:

0.47 kg gas nirogen pada tekanan 1.2 bar dan isipadu 0.35 m^3 berkembang secara boleh balik di dalam silinder di belakang omboh. Suhu awal adalah pada 28 ^{0}C. Suhu kemudian naik kpadae 450 ^{0}C. Dengan menganggap gas nitrogen sebagai gas sempurna, kirakan:

i. Work done
Kerja dilakukan

[5 marks]
[*5 markah*]

ii. Heat flow during the expansion
Pemindahan haba

[2 marks]
[*2 markah*]

iii. Change of entropy
Perubahan entropi

[2 marks]
[*2 markah*]

Given, C_p = 1.045 kJ/kg.K.
Diberi, C_p = 1.045 kJ/kg.K.

SOALAN TAMAT

BASIC THERMODYNAMICS

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

NON FLOW PROCESS

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

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

PROPERTIES OF STEAM

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

2^{nd} 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 ($V_1 = V_2$)
      $W = 0$ $\quad Q = u_2 - u_1$
   c. Isothermal Process ($T_1 = T_2$)
      $Q = T(s_2 - s_1)$ $\quad W = Q - (u_2 - u_1)$
   d. Adiabatic Process (Seentropi)
      $s_1 = s_2$ $\quad Q = 0$ $\quad W = u_1 - u_2$
   e. Polytropic Process
      $W = \dfrac{P_1V_1 - P_2V_2}{n-1}$ $\quad Q = (u_2 - u_1) + W$

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

      Or

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

POWER CYCLES STEAM

- $\eta_c = \dfrac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_4)}$
- $r_w = \dfrac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$
- $s.s.c. = \dfrac{3600}{(h_1 - h_2) - (h_4 - h_3)}$

CHEMICAL EQUILIBRIUM

- $\Delta S = Q_p\ (S_P - S_A)$
- $\Delta G = \Delta G^0 + RT \ln K$
- $\dfrac{d(\ln K)}{dT} = \dfrac{\Delta H}{RT^2}$