SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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

JABATAN KEJURUTERAAN PETROKIMIA

PEPERIKSAAN AKHIR

SESI II : 2023/2024

DGP20053 : THERMODYNAMICS

TARIKH : 29 MEI 2024
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **TUJUH (7)** 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)

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 (a) Describe

Terangkan

i. process

proses

[2 marks]

[2 markah]

ii. close system

sistem tertutup

[2marks]

[2 markah]

CLO1 (b) A gas with weight molecule of 30.02 is at a temperature of 28 °C, pressure 100 kN/m² and volume 0.22 m³. If the gas has a value of C_v = 0.720 kJ/kg K, discuss:

Gas dengan molekul berat 30.07 berada pada suhu 28 °C, tekanan 100 kN/m² dan isipadu 0.22 m³. Jika gas mempunyai nilai C_v = 0.720 J/kg K, bincangkan:

i. gas constant

pemalar gas dan

[4 marks]

[4 markah]

ii. mass of the gas

jisim gas

[5 marks]

[5 markah]

CLO1 (c) Use steam tables to determine the specific volume, the specific enthalpy and the specific entropy when given superheated steam at 25 bar and 350°C.

Gunakan jadual stim untuk menentukan isipadu tentu, entalpi tentu dan entropi tentu apabila diberi keadaan stim panas lampau pada 25 bar dan 350°C.

[12 marks]

[*12 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Explain the terms below with example:

Jelaskan terma dibawah bersama dengan contoh:

i. Steady flow

Aliran sekata

[3 marks]

[*3 markah*]

ii. Unsteady flow

Aliran tak sekata

[3 marks]

[*3 markah*]

CLO1 (b) An adiabatic gas turbine expands air from 1300 kPa and 500°C to 100 kPa and 127°C. Air enters the turbine through a 0.2 m^2 opening with an average velocity of 40 m/s, and exhausts through a 1 m^2 opening. Calculate.

Given: R = 0.287kJ/k K Cp= 1.048 kJ/k K

Suatu turbin gas adiabatik mengembang udara pada 1300 kPa dan 500°C kepada 100 kPa dan 127°C. Udara memasuki turbin melalui bukaan 0.2 m^2 dengan kelajuan purata 40 m/s, dan ekzos melalui bukaan 1 m^2. Kirakan;

Diberi: R = 0.287kJ/k K Cp = 1.048 kJ/k K

i. Specific volume and mass flow rate
Isipadu tentu dan kadar alir jisim

[12 marks]
[*12 markah*]

ii. Work output by the turbine in kW
Kerja keluaran oleh turbin di dalam kW

[7 marks]
[*7 markah*]

QUESTION 3
SOALAN 3

CLO1 (a) State **THREE (3)** assumptions of Steady Flow Energy equation for:
*Nyatakan **TIGA(3)** anggapan Persamaan Tenaga Aliran Mantap untuk:*

i. condenser
pemeluwap

[3 marks]
[*3 markah*]

ii. throttle
pendikit

[3 marks]
[*3 markah*]

CLO1

(b) A certain perfect gas at temperature 18°C and pressure 225 kN/m^2, occupying a volume of 0.63 m^3 at initial state. The gas is heated at constant pressure until the temperature is 47°C. Given C_p for gas as 0.34 kJ/kg K, detail the final volume of the gas, the work done during the process and the heat transferred during the process.

Gas sempurna pada suhu 18°C dan tekanan 225 kN/m^2, menduduki isipadu 0.63 m^3 pada keadaan awal. Gas dipanaskan pada tekanan malar sehingga suhu adalah 47°C. Diberi C_p untuk gas sebagai 0.34 kJ/kg K, perincikan jumlah isipadu gas akhir, kerja yang dilakukan semasa proses dan haba dipindahkan semasa proses.

[10 marks]

[*10 markah*]

CLO1

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

Given C_p= 1.005kJ/k K

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

Di beri C_p= 1.005kJ/kg.K

[9 marks]

[*9 markah*]

QUESTION 4
SOALAN 4

CLO1

(a) A steam power plant operates between a boiler pressure of 46 bar and a condenser pressure of 0.03 bar. If steam enters the turbine at a dry saturated state, discuss the feed pump work and the Rankine efficiency.
Sebuah penjana kuasa steam bekerja di antara tekanan dandang 46 bar dan tekanan pemeluwap 0.03 bar. Sekiranya stim masuk ke dalam turbin pada keadaan tepu kering, bincangkan kerja pam suapan dan kecekapan kitar Rankine.

[15 marks]
[15 markah]

CLO1

(b) Given the reaction of gas N_2 and H_2 with the equilibrium constant Kc 1.2 atm and temperature 375°C.
Diberi tidak balas di antara gas N_2 dan H_2 dengan pemalar keseimbangan Kc 1.2 atm dan suhu 375°C.

$$N_2(g) + 3\,H_2(g) \rightarrow 2NH_3\,(g)$$

i. Write the equation of Kc for the reaction above.
Tuliskan persamaan Kc bagi tindak balas ini atas.

[2 marks]
[2 markah]

ii. Calculate the value of K_p for this reaction.
Kirakan nilai kp bagi tindak balas ini.

[6 marks]
[6 markah]

iii. Share the equilibrium constant for the reverse reaction at the same temperature.
Kongsikan pemalar keseimbangan bagi tindak balas berbalik pada suhu yang sama.

[2 marks]
[*2 markah*]

SOALAN TAMAT

LIST OF FORMULAS DGP20053 THERMODYNAMICS

PROPERTIES OF SUBSTANCES

1. **STEAM**

$v = xv_g$	$u = u_f + x(u_g - u_f)$
$h = h_f + xh_{fg}$	$s = s_f + xs_{fg}$
$h = u + Pv$	

2. **IDEAL GAS**

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	$R = \frac{R_o}{M}$	$\gamma = \frac{C_P}{C_V}$
$PV = mRT$	$R = C_p - C_v$	$m = nM$
$C_v = \frac{R}{(\gamma - 1)}$	$C_p = \frac{\gamma R}{(\gamma - 1)}$	

1ST LAW OF THERMODYNAMICS

1. NON-FLOW PROCESS : REVERSIBLE PROCESS FOR STEAM

CONSTANT ISOTHERMAL PROCESS ($T_1 = T_2$)	$Q = T(s_2 - s_1)$ $W = Q - (u_2 - u_1)$
CONSTANT VOLUME PROCESS ($V_1 = V_2$)	$Q = (u_2 - u_1)$ $W = 0$
CONSTANT PRESSURE PROCESS ($P_1 = P_2$)	$Q = (u_2 - u_1) + P(v_2 - v_1)$ $Q = h_2 - h_1$ $Q = (u_2 + Pv_2) - (u_1 + Pv_1)$ $W = P(v_2 - v_1)$
ADIABATIC (ISENTROPIC) PROCESS	$S_1 = S_2$ $Q = 0$ $W = u_1 - u_2$
POLYTROPIC PROCESS	$W = \frac{p_1v_1 - p_2v_2}{n - 1}$ $Q = (u_2 - u_1) + W$ $\frac{p_1}{p_2} = \left(\frac{v_2}{v_1}\right)^n$; $\frac{v_2}{v_1} = \left(\frac{p_1}{p_2}\right)^{\frac{1}{n}}$ $\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}$; $\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{n-1}$

2. NON-FLOW PROCESS: REVERSIBLE PROCESS FOR IDEAL GAS

CONSTANT ISOTHERMAL PROCESS ($T_1 = T_2$)	$W = p_1V_1 \ln\frac{V_2}{V_1}$ $W = p_1V_1 \ln\frac{p_1}{p_2}$ $W = mRT_1 \ln\frac{V_2}{V_1}$ $W = mRT_1 \ln\frac{P_1}{P_2}$ $Q = W$ $U_1 = U_2$ $S_2 - S_1 = mR\ln\left(\frac{v_2}{v_1}\right) = mR\ln\left(\frac{p_1}{p_2}\right)$
CONSTANT VOLUME PROCESS ($V_1 = V$)	$W = 0$ $Q = mC_v(T_2 - T_1)$ $Q = U_2 - U_1$ $S_2 - S_1 = mC_v \ln\left(\frac{T_2}{T_1}\right)$

LAMPIRAN : FORMULA DGP20053 THERMODYNAMICS

CONSTANT PRESSURE PROCESS ($P_1 = P_2$)	$W = p(V_2 - V_1)$ $Q = mC_p(T_2 - T_1)$ $U_2 - U_1 = mC_v(T_2 - T_1)$	$W = mR(T_2 - T_1)$ $U_2 - U_1 = Q - W$ $S_2 - S_1 = mC_p \ln\left(\frac{T_2}{T_1}\right)$
ADIABATIC (ISENTROPIC)PROCESS	$W = \frac{p_1V_1 - p_2V_2}{\gamma - 1}$ $W = mC_v(T_1 - T_2)$ $U_2 - U_1 = mC_v(T_2 - T_1)$ $\frac{T_2}{T_1} = \left[\frac{p_2}{p_1}\right]^{\frac{\gamma-1}{\gamma}} = \left[\frac{V_1}{V_2}\right]^{\gamma-1}$	$W = \frac{mR(T_1 - T_2)}{\gamma - 1}$ $Q = 0$ $S_2 - S_1 = 0$
POLYTROPIC PROCESS	$S_2 - S_1 = R\ln\left(\frac{v_2}{v_1}\right) - C_v \ln\left(\frac{T_1}{T_2}\right)$ $S_2 - S_1 = mR\ln\left(\frac{p_1}{p_2}\right) - mC_p \ln\left(\frac{T_1}{T_2}\right)$ $\frac{T_2}{T_1} = \left[\frac{p_2}{p_1}\right]^{\frac{n-1}{n}} = \left[\frac{V_1}{V_2}\right]^{n-1}$	$W = \frac{P_1V_1 - P_2V_2}{n - 1}$ $W = \frac{mR(T_1 - T_2)}{n - 1}$ $U_2 - U_1 = mC_v(T_2 - T_1)$ $Q = W + U_2 - U_1$

3. FLOW PROCESS

STEADY FLOW ENERGY EQUATION

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

LAMPIRAN : FORMULA DGP20053 THERMODYNAMICS

2ND LAW OF THERMODYNAMICS

HEAT ENGINE / PUMP ENGINE

$$W = Q_1 - Q_2 \qquad \eta = \frac{W}{Q_1}$$

CARNOT CYCLE ENGINE

$$\eta = 1 - \frac{Q_2}{Q_1} \qquad \eta_{carnot} = 1 - \frac{T_2}{T_1}$$

$$\eta_{Carnot} = \frac{(h_1 - h_2) - (h_4 - h_3)}{h_1 - h_4}$$

$$r_w = \frac{(h_1 - h_2) - (h_4 - h_3)}{(h_1 - h_2)}$$

$$s.s.c. = \frac{3600}{(h_1 - h_2) - (h_4 - h_3)} \text{ kg/kwh}$$

CHEMICAL EQUILLIBRIUM

$$\Delta S = Q_p (S_P - S_A)$$

$$\Delta G = \Delta G^O + RT \ln K$$

$$\frac{d(\ln K)}{dT} = \frac{\Delta H}{RT^2}$$