SULIT

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2019

DJJ2073: THERMODYNAMICS

TARIKH : 07 NOVEMBER 2019
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **LAPAN (8)** 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)

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

CLO1 C1

(a) Define the following terms:

Definisikan istilah berikut:

i. System

Sistem [2 marks] [2 *markah*]

ii. Thermal Equilibrium

Keseimbangan Terma [2 marks] [2 *markah*]

iii. Zeroth Law

Hukum Sifar [2 marks] [2 *markah*]

CLO1 C2

(b) Convert the following units:

Tukarkan unit-unit berikut:

i. 150kg/m³ to g/mm³

150kg/m³ kepada g/mm³ [3 marks] [*3 markah*]

ii. 555m² to km²

555m² kepada km² [3 marks] [*3 markah*]

CLO1
C2

(c) Table Q1(c) indicated the data from steam table. Relate the values given to find (A), (B), (C) and (D).

Jadual Q1(c) menunjukkan data daripada jadual stim. Hubungkaitkan nilai yang diberi untuk mencari (A), (B), (C) *dan* (D).

Table Q1(c)/ *Jadual Q1(c)*

Pressure *Tekanan*	*12 bar*
Specific internal energy *Entropi tentu*	*2578 kJ/kg*
Dryness fraction *Pecahan kekeringan*	(A)
Specific enthalpy *Tenaga dalam tentu*	(B)
Specific entropy *Isipadu tentu*	(C)
Specific volume *Entalpi tentu*	(D)

[4 marks]
[4 *markah*]

[3 marks]
[*3 markah*]

[3 marks]
[*3 markah*]

[3 marks]
[*3 markah*]

QUESTION 2
SOALAN 2

CLO1
C1

(a) Give **TWO (2)** difference between open and close system.
*Beri **DUA (2)** perbezaan antara sistem terbuka dan sistem tertutup.*

[4 marks]
[*4 markah*]

CLO1
C2

(b) An air occupies in the tank with pressure of 6.5 bar and volume 0.7m³ at temperature 50°C. After an isobaric expansion, the volume increased to 0.95m³. Relate the values given to find the value of mass and the final temperature of the air.
Udara memenuhi tangki dengan tekanan 6.5 bar dan isipadu 0.7m³ pada suhu 50°C. Selepas pengembangan isobarik, isipadu meningkat kepada 0.95m³. Hubungkaitkan nilai yang diberi untuk mencari nilai jisim dan suhu akhir bagi udara.

[6 marks]
[*6 markah*]

CLO1
C3

(c) A perfect gas is expanded adiabatically from 6 bar, 0.08m³ at 70°C to 0.82m³. Calculate the mass of the gas, the final pressure, final temperature and work done of the gas. Given C_v= 0.752kJ/kgK and molecular mass 30kg/kmol.
Gas unggul mengembang secara adiabatik dari tekanan 6 bar, isipadu 0.08m³ dan suhu 70°C kepada 0.82m³. Kira jisim gas, tekanan akhir, suhu akhir dan kerja yang dilakukan oleh gas. Diberi C_v= 0.752kJ/kgK dan jisim molekul gas 30kg/kmol.

[15 marks]
[*15 markah*]

QUESTION 3

SOALAN 3

CLO 1
C1

(a) List **FOUR (4)** devices in open system

*Senaraikan **EMPAT (4)** peranti dalam sistem terbuka*

[4 marks]
[4 *markah*]

CLO 1
C2

(b) Relate the properties in Table Q3 (b) below into the continuity equations to identify the value of turbine's velocity.

Kaitkan ciri-ciri pada Jadual Q3 (b) di bawah ke dalam persamaan keterusan untuk mengenalpasti nilai halaju turbin.

Table Q3 (b) / *Jadual Q3 (b)*

Mass flow rate *Kadar alir jisim*	4.59 kg/s
Area *Luas*	0.2 m^2
Specific volume *Isipadu tentu*	0.22 m^3/kg

[6 marks]
[*6 markah*]

CLO 1
C3

(c) 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 Q3 (c) below. Assuming that changes in potential energy may be neglected, calculate:

Stim mengalir secara mantap memasuki sebuah turbin dengan kadar 6000 kg/jam dan menghasilkan kuasa keluaran sebanyak 3000 kW. Sifat bagi stim pada bahagian masuk dan keluar dari turbin adalah seperti di Jadual Q3 (c) di bawah. Jika perubahan tenaga keupayaan diabaikan, kirakan:

Table Q3(c)/ Jadual Q3(c)

Properties of steam **Sifat-sifat stim**	**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 which is transferred to surroundings in kW

Haba yang dipindahkan ke persekitaran dalam kW

[10 marks]
[*10 markah*]

ii. Area of the outlet vessel

Luas permukaan bahagian keluar vessel

[5 marks]
[*5 markah*]

QUESTION 4

SOALAN 4

CLO 1
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 1
C2

(b) Based on schematic diagram as shown in Figure Q4 (b), relate the values given to find the power input, coefficient of performance and sink temperature.

Berdasarkan gambarajah skematik seperti ditunjukkan dalam Rajah Q4 (b) di bawah, hubungkaitkan nilai yang diberi untuk mendapatkan kuasa masukan, pekali prestasi dan suhu sinki.

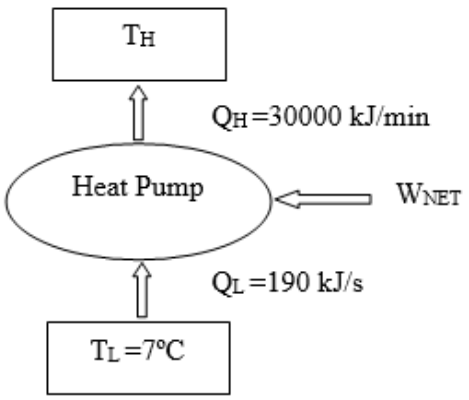

Figure Q4 (b) /*Rajah Q4 (b)*

[9 marks]
[*9 markah*]

CLO 1
C3

(c) A steam power plants operates between a boiler pressure of 40 bar and a condenser pressure of 0.04 bar. If steam entry to the turbine with dry saturated, calculate for a Rankine cycle:

Sebuah penjana kuasa stim beroperasi diantara tekanan dandang 40 bar dan tekanan pemeluwap 0.04 bar. Sekiranya stim masuk ke dalam turbin pada tekanan tepu kering, kirakan untuk kitar Rankine :

i. Feed pump work

Kerja pam suapan

[2 marks]
[*2 markah*]

ii. Rankine efficiency

Kecekapan kitar Rankine

[7 marks]
[7 *markah*]

ii. 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

$$\dot{m} = \rho CA = \frac{CA}{V} \qquad h = u + pv$$

$$h = Cp\,\Delta T$$

$$Q - W = \dot{m}\left[(h_2 - h_1) + \left(\frac{C_2^{\,2} - C_1^{\,2}}{2}\right) + (Z_2 - Z_1)g\right]$$

Non-Flow Process

1. Isothermal Process ($PV = C$)

$U_2 - U_1 = 0$ $\quad Q = W$

$$W = P_1V_1 \ln\left(\frac{V_2}{V_1}\right) \quad @ \quad W = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$$

$$Q = P_1V_1 \ln\left(\frac{V_2}{V_1}\right) \quad @ \quad Q = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$$

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. Politropic Process ($PV^n = C$)

$U_2 - U_1 = mC_v(T_2 - T_1)$ $\qquad W = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{mR(T_1 - T_2)}{n-1}$

$Q = \frac{\gamma - n}{\gamma - 1}$ x 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 = $mC_v(T_2 - T_1)$
$W = P(V_2 - V_1) = mR\,(T_2 - T_1)$
$Q = mC_p(T_2 - T_1)$

5. Isometric Process

$U_2 - U_1 = mC_v(T_2 - T_1)$
$W = 0$
$Q = U_2 - U_1 = mC_v(T_2 - T_1)$

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

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

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

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