KOLEJ YAYASAN PELAJARAN JOHOR

# KOLEJ YAYASAN PELAJARAN JOHOR
# FINAL EXAMINATION

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|---|---|---|
| **COURSE NAME** | : | **THERMODYNAMICS** |
| **COURSE CODE** | : | **DKM 3203** |
| **EXAMINATION** | : | **DECEMBER 2022** |
| **DURATION** | : | **3 HOURS** |

**INTRUCTION TO CANDIDATES /**
***ARAHAN KEPADA CALON***

1. This examination paper consists of **ONE (1)** part: (100 Marks)
   *Kertas soalan ini mengandungi **SATU (1)** bahagian sahaja.* *(100 Markah)*

2. Candidates are not allowed to bring any material to examination room except with the permission from invigilator. The formula was attached at the back question paper./
   *Calon tidak dibenarkan membawa masuk sebarang bahan/nota ke dalam bilik peperiksaan kecuali dengan kebenaran pengawas peperiksaan. Rumus dilampirkan di belakang kertas soalan peperiksaan.*

3. Please check to make sure that this examination pack consists of:/
   *Sila pastikan kertas soalan peperiksaan ini mengandungi:*

   i. Question Paper.
   *Kertas Soalan.*

   ii. Answer Booklet.
   *Buku Jawapan.*

   iii. Steam Table.
   *Jadual Stim.*

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /**
***JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU***

This examination paper consists of **9** printed pages including front page
*Kertas soalan ini mengandungi **9** halaman bercetak termasuk muka hadapan*

This section consists of **FOUR (4)** questions. Answer **ALL** the questions in the Answering Booklet.

*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan di dalam Buku Jawapan.*

**QUESTION 1/*SOALAN 1***

a. List **six (6)** International System (SI) units with their symbols.

*Senaraikan **enam (6)** unit SI berseta simbol-simbolnya.*

**(6 marks/*markah*)**

b. Convert the following units:

(i) 1 g/mm$^3$ to kg/m$^3$

**(3 marks/*markah*)**

(ii) 10 m/s to km/hr

**(3 marks/*markah*)**

(iii) 20 mg/litre to kg/m$^3$

**(3 marks/*markah*)**

*Tukarkan unit-unit berikut:*

*(i) 1 g/mm$^3$ kepada kg/m$^3$*

*(ii) 10 m/s kepada km/j*

*(iii) 20 mg/liter kepada kg/m$^3$*

c. Steam at 1000 kPa as the specific internal energy 2480 kJ/kg. Calculate the:

(i) dryness fraction.

**(3 marks/*markah*)**

(ii) specific volume.

**(3 marks/*markah*)**

(iii) specific enthalpy.

**(3 marks/*markah*)**

(iv) sketch and locate the dryness fraction on the P-v diagram.

**(1 mark/*markah*)**

*Stim pada tekanan 1000 kPa mempunyai tenaga dalamnya 2480 kJ/kg. Kirakan:*

*(i) pecahan kekeringan.*

*(ii) isi padu tentu.*

*(iii) entalpi tentu.*

*(iv) lakar dan tandakan titik pecahan kekeringan pada rajah P-v.*

**QUESTION 2/*SOALAN 2***

a. List **four (4)** devices for an open system.

*Senaraikan **empat (4)** alat untuk sistem terbuka.*

**(4 marks/*markah*)**

b. The Steady Flow Energy Equation may be applied to any apparatus. With a sketch, explain the application of the steady flow energy in:

(i) the turbine.

**(3 marks/*markah*)**

(ii) the pump.

**(3 marks/*markah*)**

*Persamaan Tenaga Aliran Mantap boleh digunakan untuk semua jenis perkakas. Dengan lakaran, terangkan penggunaan tenaga aliran mantap dalam:*

*(i) turbin.*

*(ii) pam.*

c. A turbine which is operated under steady flow condition is having these properties are shown in **Table 1** below. If heat loss to the atmosphere is at 38 kJ/s and mass flow rate of the steam is 2550 kg/hour, calculate the power produced from the steam.

*Sebuah turbin beroperasi di bawah keadaan aliran tetap mempunyai ciri-ciri yang berikut seperti di dalam **Jadual 1** di bawah. Jika kehilangan haba kepada atmosfera ialah 38 kJ/s dan kadar alir jisim stim ialah 2550 kg/jam, kirakan kuasa yang terhasil daripada stim.*

**(15 marks/*markah*)**

| | **Inlet** ***Masukan*** | **Outlet** ***Keluaran*** |
|---|---|---|
| **Pressure** ***Tekanan*** | 6.5 bar | 1.6 bar |
| **Specific volume** ***Isipadu Tentu*** | 0.45 $m^3$/kg | 1.2 $m^3$/kg |
| **Specific internal energy** ***Tenaga dalam tentu*** | 3250 kJ/kg | 2370 kJ/kg |
| **Velocity** ***Halaju*** | 7.5 m/s | 9.3 m/s |

**Table 1/ *Jadual 1***

QUESTION 3/ *SOALAN 3*

a. According to the steam table, at pressure of 3.25 MN/m$^2$, determine:

(i) saturation temperature. **(3 marks/*markah*)**

(ii) specific liquid enthalpy. **(3 marks/*markah*)**

(iii) specific enthalpy of evaporation. **(3 marks/*markah*)**

(iv) specific enthalpy of dry saturated steam. **(3 marks/*markah*)**

*Berpandukan jadual stim, pada tekanan 3.25 MN/m$^2$, tentukan:*

*(i) suhu tepu.*

*(ii) entalpi cair tentu.*

*(iii) entalpi tentu penyejatan.*

*(iv) entalpi tentu stim tepu kering.*

b. 2.3 kg of gas at 15 °C is heated using isobaric process from 0.52 m$^3$ to 0.127 m$^3$. Given R = 0.263 kJ/kg.K and $C_v$ = 655 J/kg.K. Determine:

(i) the initial pressure. **(3 marks/*markah*)**

(i) the final temperature. **(2 marks/*markah*)**

(ii) the work done.

**(2 marks/*markah*)**

(iii) the heat transfer of the gas.

**(6 marks/*markah*)**

*2.3 kg gas pada suhu 15 °C telah dipanaskan menggunakan proses isobarik dari 0.52 $m^3$ kepada 0.127 $m^3$. Diberi R = 0.263 kJ/kg.K dan $C_v$ = 655 J/kg.K. Tentukan:*

*(i) tekanan awal.*

*(ii) suhu akhir.*

*(iii) kerja terlaku.*

*(iv) haba yang terpindah oleh gas.*

**QUESTION 4/*SOALAN 4***

a. List **four (4)** characteristics of heat engine

*Senaraikan **empat (4)** ciri sebuah enjin haba.*

**(4 marks/*markah*)**

b. A steam genarator is operated at a boiler pressure of 50 bar and condenser pressure of 0.05 bar. For a Carnot cycle, calculate :

(i) the efficiency of the cycle

**(15 marks/*markah*)**

(ii) heat supplied to the boiler

**(4 marks/*markah*)**

(iii) sketch a complete T-s diagram.

**(2 marks/*markah*)**

*Sebuah penjana stim yang bekerja antara tekanan dandang 50 bar dan tekanan pemeluwap 0.05 bar. Untuk kitar Carnot, kirakan :*

*(i) kecekapan kitar.*

*(ii) haba bekalan dandang.*

*(iii) lakar gambar rajah T-s dengan lengkap.*

**[100 MARKS/*100 MARKAH*]**

**END OF THE QUESTION PAPER / *KERTAS SOALAN TAMAT***

# FORMULA

## 1. FIRST LAW OF THERMODYNAMICS

$$\Sigma Q = \Sigma W \qquad Q - W = U_2 - U_1$$

## 2. FLOW PROCESS

$$\dot{m} = \rho V A = \frac{CA}{V}$$

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

## 3. PROPERTIES OF PURE SUBSTANCE

### Steam

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

### Ideal Gas

$$PV = mRT \qquad R = \frac{R_o}{M} \qquad R = c_p - c_v \qquad \gamma = \frac{c_p}{c_v}$$

## 4. NON FLOW PROCESS

### Isothermal Process $(PV = C)$

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

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

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

### Adiabatic Process $(PV^\gamma = C)$

$$U_2 - U_1 = mc_v(T_2 - T_1) \quad Q = 0 \qquad W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{mR(T_2 - T_1)}{\gamma - 1}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} \qquad \eta_{th,rev} = 1 - \frac{T_L}{T_H}$$

$$nisbah\,\text{ker}\,ja = \frac{\ln\frac{V_2}{V_1}(T_1 - T_3)}{T_1 \ln\frac{V_2}{V_1} + \frac{T_1 - T_3}{\gamma - 1}}$$

### Isobaric Process

$$Q = mC_P(T_2 - T_1) \qquad W = P(V_2 - V_1) \qquad \Delta U = Q - W \qquad PV = mRT \qquad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

### Isometric Process

$$Q = mC_v(T_2 - T_1) \qquad PV = mRT \qquad \frac{P_1}{T_1} = \frac{P_2}{T_2} \qquad \Delta U = Q$$

### Polytropic Process ($PV^n = C$)

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1} \qquad U_2 - U_1 = mC_v(T_2 - T_1) \qquad Q = \frac{\gamma - n}{\gamma - 1} \times W \qquad W = \frac{P_1V_1 - P_2V_2}{n-1} = \frac{mR(T_1 - T_2)}{n-1}$$

$$P_1V_1^n = P_2V_2^n$$

## 5. SECOND LAW OF THERMODYNAMICS

### Heat Engine

$$\eta_{th} = \frac{W_{net,out}}{Q_H} = 1 - \frac{Q_L}{Q_H}$$

### Heat Pump

$$COP_{HP,rev} = \frac{T_H}{T_H - T_L} = \frac{1}{1 - \frac{T_L}{T_H}}$$

### Power Cycle

$$\eta_{rankine} = \frac{w_T - w_p}{q_{in}} = \frac{(h_1 - h_2) - v_f(p_4 - p_3)}{(h_1 - h_4)}$$

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

$$s.s.c_{rankine} = \frac{3600}{(h_1 - h_2) - v_f(p_4 - p_3)}$$

$$r_{w(rankine)} = \frac{(h_1 - h_2) - v_f(p_4 - p_3)}{(h_1 - h_2)}$$