KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	**:**	**THERMODYNAMICS**
COURSE CODE	**:**	**DKM 3203**
EXAMINATION	**:**	**NOVEMBER 2020**
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 **8** printed pages including front page
*Kertas soalan ini mengandungi **8** halaman bercetak termasuk muka hadapan*

© **Hak cipta Kolej Yayasan Pelajaran Johor**

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

*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan.*

QUESTION 1/*SOALAN 1*

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

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

(6 marks/*6 markah*)

b. Convert the following units:

(i) 10 g/mm^3 to kg/m^3

(3 marks/*3 markah*)

(ii) 21 N/cm^2 to kN/m^2

(3 marks/*3 markah*)

(iii) 100 MN/m^2 to N/m^2

(3 marks/*3 markah*)

Tukarkan unit berikut:

(i) 10 g/mm^3 kepada kg/m^3

(ii) 21 N/cm^2 kepada kN/m^2

(iii) 100 MN/m^2 kepada N/mm^2

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

(i) dryness fraction.

(3 marks/*3 markah*)

(ii) specific volume.

(3 marks/*3 markah*)

(iii) specific enthalpy.

(3 marks/*3 markah*)

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

(1 marks/*1markah*)

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. 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:

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

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

(iv) the work done.
(2 marks/*2 markah*)

(v) the heat transfer of the gas.
(6 marks/*6 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.

b. According to the steam table, at pressure of 3.25 MN/m^{2,} determine:

(i) saturation temperature.

(3 marks/*3 markah*)

(ii) specific liquid enthalpy.

(3 marks/*3 markah*)

(iii) specific enthalpy of evaporation.

(3 marks/*3 markah*)

(iv) specific enthalpy of dry saturated steam.

(3 marks/*3 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

QUESTION 3/ *SOALAN 3*

a. List **four (4)** devices that use the principle of flow process.

*Senaraikan **empat (4)** peranti yang menggunakan prinsip proses aliran.*

(4 marks/*4 markah*)

b. Differentiate between flow process and non-flow process.

Bezakan antara proses alir dan proses tak-alir.

(6 marks/*6 markah*)

c. Steam flow steadily into a turbine at 6000 kg/h and produce 2400 kW of power output. Properties of steam for inlet and outlet part of the turbine are shown in the **Table 1** below. Assuming that changes in potential energy may be neglected, determine :

(i) heat which is transferred to surrounding in kW.

(11 marks/*11 markah*)

(ii) area of the outlet vessel.

(4 marks/*4 markah*)

Stim mengalir secara mantap memasuki sebuah turbin dengan kadar 6000 kg/jam dan menghasilkan kuasa keluaran sebanyak 2400 kW. Keadaan stim pada bahagian masuk dan keluar dari turbin adalah seperti di ***Jadual 1*** *di bawah. Jika perubahan tenaga keupayaan diabaikan, tentukan :*

(i) Haba yang dipindahkan ke persekitaran dalam kW.

(ii) luas permukaan bahagian keluar vessel.

	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
Specific Volume, υ ***Isipadu Tentu*** **(m^3/kg)**	0.55	1.90

Table 1/ ***Jadual 1***

QUESTION 4/*SOALAN 4*

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

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

(4 marks/*4 markah*)

b. Heat is transferred to heat engine from the furnace at a rate of 255 GJ/hr. If the rate of waste heat rejection to a nearby river is 168 GJ/hr, determine:

(i) the net work done.

(6 marks/*6 markah*)

(ii) the thermal efficiency.

(3 marks/*3 markah*)

Haba dipindahkan ke enjin haba daripada relau pada kadar 255 GJ/jam. Jika kadar pembuangan haba ke sungai yang berhampiran adalah 168 GJ/jam, tentukan:

(i) kerja bersih yang dilakukan

(ii) kecekapan haba

c. A steam generator 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

(7 marks/*7 markah*)

(ii) heat supplied to the boiler

(3 marks/*3 markah*)

(iii) sketch a complete T-s diagram.

(2 marks/*2 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 gambarajah 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 $(PV = C)$

$$U_2 - U_1 = 0 \qquad Q = W \qquad W = P_1V_1 \ln\left(\frac{V_2}{V_1}\right) @ W = P_1V_1 \ln\left(\frac{P_1}{P_2}\right)$$

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

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

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} \qquad \eta_{th,\,rev} = 1 - \frac{T_L}{T_H} \qquad nisbah\,\text{ker}\,ja = \frac{\ln\frac{V_2}{V_1}(T_1 - T_3)}{T_1 \ln\frac{V_2}{V_1} + \frac{T_1 - T_3}{\gamma - 1}}$$

Isobaric Process

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

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

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 $(PV^n = C)$

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

$$P_1V_1^n = P_2V_2^n$$

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

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

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

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

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