KOLEJ YAYASAN PELAJARAN JOHOR
ONLINE FINAL EXAMINATION

COURSE NAME	**:**	**THERMODYNAMICS**
COURSE CODE	**:**	**DKM 3203**
EXAMINATION	**:**	**DECEMBER 2021**
DURATION	**:**	**3 HOURS**

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

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

2. Answer ALL questions in the answer sheet which is A4 size paper (or other paper with the consent of the relevant lecturer). /
   Jawab SEMUA soalan di dalam kertas jawapan iaitu kertas bersaiz A4 (atau lain-lain kertas dengan persetujuan pensyarah berkaitan).

3. Write your details as follows in the upper left corner for each answer sheet: /
   Tulis butiran anda sepertimana berikut di penjuru atas kiri bagi setiap kertas jawapan:
   i. Student Full Name / *Nama Penuh Pelajar*
   ii. Identification Card (I/C) No. / *No. Kad Pengenalan*
   iii. Class Section / *Seksyen Kelas*
   iv. Course Code / *Kod Kursus*
   v. Course Name / *Nama Kursus*
   vi. Lecturer Name / *Nama Pensyarah*

4. Each answer sheet must have a page number written at the bottom right corner. /
   Setiap helai kertas jawapan mesti ditulis nombor muka surat di penjuru bawah kanan.

5. Answers should be **neat and clear in handwritten form**. /
   Jawapan hendaklah ditulis tangan, kemas dan jelas.

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 part consists of **FOUR (4)** questions. Answer **ALL** the questions in the answer sheet.
*Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan di dalam kertas jawapan.*

QUESTION 1/*SOALAN 1*

a. Convert the following units:

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

(3 marks / *markah*)

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

(3 marks / *markah*)

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

(3 marks / *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

b. Explain the following terms:

(i) System

(2 marks / *markah*)

(ii) Boundary

(2 marks / *markah*)

(iii) Surrounding

(2 marks / *markah*)

Terangkan istilah-istilah yang berikut:

(i) Sistem

(ii) Sempadan

(iii) Sekeliling

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 marks /*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. Air with mass of 0.65 kg at pressure 15 bar and temperature 230 ºC is expanded until it's is final volume is three times greater than its initial volume. The polytropic expansion process is according to the law $PV^n = C$. Calculate :
(Assume n = 1.37 and R = 0.287 kJ/kg.K)

(ii) the initial volume and final volume.

(4 marks / *markah*)

(iii) the final pressure (bar).

(3 marks / *markah*)

(iv) the final temperature.

(3 marks / *markah*)

(v) the work done.

(3 marks / *markah*)

Udara dengan jisim 0.65 kg pada tekanan 15 bar dan suhu 230 ºC dikembangkan sehingga isipadu akhir adalah tiga kali ganda lebih besar daripada isipadu awal. Proses pengembangan politropik adalah mengikut hukun $PV^n = C$. Kirakan:
(Anggapan n = 1.37 dan R = 0.287 kJ/kg.K)

(i) isipadu awal dan akhir.

(ii) tekanan akhir

(iii) suhu akhir

(iv) kerja yang dilakukan.

b. According to the steam table, at pressure of 1.25 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 1.25 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 in open system.

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

(4 marks / *markah*)

b. List **six (6)** forms of energy.

*Senaraikan **enam (6)** jenis bentuk tenaga.*

(6 marks / *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 / *markah*)

(ii) area of the outlet vessel.

(4 marks / *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. Describe **four (4)** characteristics of heat engine

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

(4 marks / *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.

(5 marks / *markah*)

(ii) the thermal efficiency.

(3 marks / *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 genarator is operated at a boiler pressure of 50 bar and condenser pressure of 0.05 bar. For a Carnot cycle, calculate :

(i) the thermal efficiency of the cycle.

(8 marks / *markah*)

(ii) heat supplied to the boiler.

(3 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 haba kitaran.

(ii) haba bekalan dandang

(iii) lakar gambarajah T-s dengan lengkap.

[100 MARKS / *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 $(PV = C)$

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

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

$U_2 - U_1 = mc_v(T_2 - T_1)$ $\quad Q = 0$ $\qquad$ $W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{mR(T_2 - T_1)}{\gamma - 1}$

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

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

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

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

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

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