KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI I : 2026/2027

DJJ30293: THERMODYNAMICS

TARIKH : 24 OKTOBER 2026
MASA : 08.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula dan Jadual Steam

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

TERBUKA

INSTRUCTION:

This section consists of **FOUR (4)** structured questions. Answer all questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan struktur. Jawab semua soalan.*

QUESTION 1

SOALAN 1

CLO1 (a) State **TWO (2)** differences between a closed system and open system in thermodynamics.

*Nyatakan **DUA (2)** perbezaan antara sistem tertutup dan sistem terbuka dalam termodinamik.*

[4 marks]

[*4 markah*]

CLO1 (b) In thermodynamics, physical properties are classified based on how they respond to changes in the size or amount of matter in a system. Explain the following:

Dalam termodinamik, sifat fizikal dikelaskan berdasarkan bagaimana ia bertindak balas terhadap perubahan saiz atau jumlah jirim dalam sesuatu sistem. Terangkan perkara berikut:

(i) The extensive properties with **TWO (2)** examples.

*Ciri-ciri ekstensif dengan **DUA (2)** contoh.*

[3 marks]

[*3 markah*]

(ii) The intensive properties with **TWO (2)** examples.

*Ciri-ciri intensif dengan **DUA (2)** contoh.*

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[3 marks]

[*3 markah*]

CLO1

(c) A steam power plant operates with superheated steam entering the turbine at a pressure of 120 bar and a temperature of 470°C. Before analysing the turbine performance, an engineer needs to determine the thermodynamic properties of the steam using the superheated steam table. Calculate the following properties:
Sebuah loji jana kuasa stim menggunakan stim panas lampau (superheated steam) untuk menggerakkan turbin. Stim memasuki turbin pada tekanan 120 bar dan suhu 470°C. Sebelum menganalisis prestasi turbin, seorang jurutera perlu menentukan sifat-sifat termodinamik stim menggunakan Jadual Stim Panas Lampau (Superheated Steam Table). Hitungkan:

(i) Degree of superheated steam
Darjah panas lampau stim

[4 marks]
[*4 markah*]

(ii) Specific volume
Isipadu tentu

[4 marks]
[*4 markah*]

(iii) Specific internal energy
Tenaga dalaman tentu

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[7 marks]
[*7 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Steam tables are commonly used in thermodynamics to determine the properties of water during heating and cooling processes. State **FOUR (4)** properties of pure substances that can be obtained from the steam table.

*Jadual stim lazimnya digunakan dalam termodinamik untuk menentukan sifat-sifat air semasa proses pemanasan dan penyejukan. Nyatakan **EMPAT (4)** sifat bahan tulen yang boleh diperoleh daripada jadual stim.*

[4 marks]

[*4 markah*]

CLO1 (b) A gas occupies a volume of 2.5 m^3 at a temperature of 300 K. The gas is heated at constant pressure until its temperature reaches 450 K.

Gas mempunyai isipadu 2.5 m^3 pada suhu 300 K. Gas tersebut dipanaskan pada tekanan malar sehingga suhunya mencapai 450 K.

(i) Express the final volume

Nyatakan isipadu akhir

[3 marks]

[3 *markah*]

(ii) Explain the relationship between the temperature and volume of the gas.

Terangkan hubungan antara suhu dan isipadu gas.

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[3 marks]

[3 *markah*]

CLO2

(c) A cylinder contains 0.25 kg of a perfect gas at a constant pressure of 500 kPa. The initial volume of the gas is 0.030 m^3. During an isobaric expansion, the volume increases to 0.075 m^3. The specific heat at constant pressure, C_p, and the specific heat at constant volume, C_v, are 1.005 kJ/kg·K and 0.718 kJ/kg·K, respectively.

Sebuah silinder mengandungi 0.25 kg gas sempurna pada tekanan malar 500 kPa. Isipadu awal gas ialah 0.030 m^3. Semasa proses pengembangan isobarik, isipadu gas meningkat kepada 0.075 m^3. Haba tentu pada tekanan malar, $\boldsymbol{C_p}$, dan haba tentu pada isipadu malar, $\boldsymbol{C_v}$, masing-masing ialah 1.005 kJ/kg·K dan 0.718 kJ/kg·K.

(i) Sketch the P–V diagram for the isobaric expansion process. Label the initial state (State 1), final state (State 2), and indicate the direction of the process.

Lakarkan rajah P–V bagi proses pengembangan isobarik. Labelkan keadaan awal (Keadaan 1), keadaan akhir (Keadaan 2), dan tunjukkan arah proses.

[3 marks]
[*3 markah*]

(ii) Calculate the work done by the gas.

Hitungkan kerja yang dilakukan oleh gas.

[4 marks]
[4 *markah*]

(iii) Calculate the internal energy changes of the gas.

Hitungkan perubahan tenaga dalaman gas.

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[8 marks]
[*8 markah*]

QUESTION 3

SOALAN 3

CLO2 (a) State **FOUR (4)** devices that uses the principal of flow process.

*Nyatakan **EMPAT (4)** alat yang menggunakan prinsip proses alir.*

[4 marks]

[*4 markah*]

CLO2 (b) A steady-flow air compressor operates continuously. Air enters the compressor with the following properties in **Table 1:**

*Sebuah pemampat udara beroperasi secara proses aliran mantap. Udara memasuki pemampat dengan data berikut dalam **Jadual 1**:*

Table 1 / *Jadual 1*

Inlet Enthalpy *Enthalpi masukan*	280 kJ/kg
Outlet Enthalpy *Entalpi keluaran*	330 kJ/kg
Heat loss from the compressor *Kehilangan haba daripada pemampat*	12 kJ/kg
Changes in kinetic energy and potential energy are negligible *Perubahan tenaga kinetik dan tenaga keupayaan boleh diabaikan.*	

Calculate:

(i) The specific work input to the compressor by applying the Steady Flow Energy Equation.

Hitung kerja tentu masuk ke pemampat dengan menggunakan Persamaan Tenaga Aliran Mantap.

[5 marks]

[*5 markah*]

TERBUKA

(ii) The power required to operate the compressor if the mass flow rate of air is 9000 kg/h.
Kuasa yang diperlukan untuk mengoperasikan pemampat jika kadar aliran jisim udara ialah 9000 kg/h.

[6 marks]
[6 *markah*]

CLO2

(c) In a steady flow system, a substance flows at the rate of 4kg/s. It enters at a pressure of 620 kN/m^2, a velocity of 300 m/s, internal energy of 2100 kJ/kg and specific volume of 0.37 m^3/kg. It leaves the system at a pressure of 130 kN/m^2, a velocity of 150 m/s, internal energy 1500 kJ/kg and specific volume 1.2 m^3/kg. During its passage through the system, 30 kJ/kg of heat is lost to the surroundings. Neglect any changes in potential energy.
Dalam sebuah sistem aliran mantap, suatu bahan mengalir pada kadar 4 kg/s. Bahan tersebut memasuki sistem pada tekanan 620 kN/m², halaju 300 m/s, tenaga dalaman 2100 kJ/kg, dan isipadu tentu 0.37 m³/kg. Bahan tersebut meninggalkan sistem pada tekanan 130 kN/m², halaju 150 m/s, tenaga dalaman 1500 kJ/kg, dan isipadu tentu 1.2 m³/kg. Semasa melalui sistem tersebut, sebanyak 30 kJ/kg haba hilang ke persekitaran. Abaikan sebarang perubahan tenaga keupayaan.

(i) Calculate the power produce by the system in kilowatts.
Hitungkan kuasa keluaran sistem dalam kilowatt (kW).

[8 marks]
[8 *markah*]

(ii) Based on the result obtained in (i) determine whether the work is done by the system or on system.
Berdasarkan keputusan yang diperolehi dalam (i), tentukan samada kerja dilakukan oleh system atau kerja dilakukan ke atas system.

TERBUKA

[2 marks]
[2 *markah*]

QUESTION 4

SOALAN 4

CLO2 (a) State **THREE (3)** characteristics of heat engine with **ONE (1)** example of a commonly used heat engine.

*Nyatakan **TIGA (3)** ciri enjin haba dengan **SATU (1)** contoh enjin haba yang lazim digunakan.*

[4 marks]

[*4 markah*]

CLO2 (b) A Carnot Cycle operates between 200°C and 1200°C. Calculate:

Satu Kitar Carnot beroperasi di antara suhu 200°C dan 1200°C. Hitungkan:

(i) The thermal efficiency if it operates as a power cycle.

Kecekapan terma sekiranya ia beroperasi sebagai sebuah kitaran kuasa.

[5 marks]

[*5 markah*]

(ii) The Coefficient of Performance (COP) if it operates as a refrigerator.

Nilai Pekali Prestasi (COP) sekiranya ia beroperasi sebagai sebuah peti sejuk.

TERBUKA

[3 marks]

[*3 markah*]

CLO2 (c) A simple steam power plant operates on an ideal Rankine cycle, as shown in **Figure 1.** The boiler pressure is 40 bar and the condenser pressure is 0.045 bar. Steam enters the turbine as dry saturated steam.

Sebuah loji janakuasa stim ringkas beroperasi menggunakan Kitaran Rankine unggul (Ideal Rankine Cycle) seperti yang ditunjukkan dalam ***Rajah 1****. Tekanan dandang ialah 40 bar manakala tekanan pemeluwap ialah 0.045 bar. Stim memasuki turbin dalam keadaan stim tepu kering.*

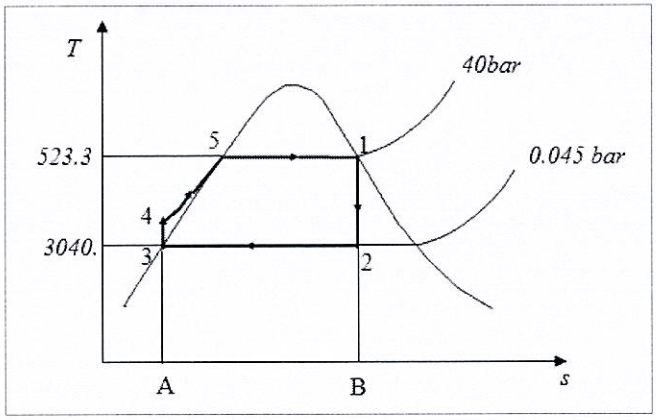

Figure 1 / ***Rajah 1***

Calculate the following:

Hitungkan yang berikut:

(i) Pump work

Kerja pam

[5 marks]

[*5 markah*]

(ii) The specific steam consumption (s.s.c)

Penggunaan Stim Tentu

[8 marks]

[*8 markah*]

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SOALAN TAMAT

POLITEKNIK MALAYSIA

DJJ30293– THERMODYNAMICS

1.0 PROPERTIES OF PURE SUBSTANCES

Wet Steam

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

Superheat Steam

$Degree\ Of Superheat = T_{superheat} - T_{saturated}$

Ideal Gas

$PV = mRT$ $\quad R = \frac{R_o}{M}$ $\quad R = C_p - C_v$ $\quad \gamma = \frac{C_p}{C_v}$

$C_v = \frac{R}{(\gamma - 1)}$ $\quad C_p = \frac{\gamma R}{(\gamma - 1)}$

2.0 FIRST LAW OF THERMODYNAMICS

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

Flow process

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

$\dot{m} = \rho CA$ $\quad h = u + pv$ $\quad h = C_p(T_2 - T_1)$

$\dot{m} = \frac{CA}{v}$

Non-Flow process

1. **Isothermal Process (PV=C)**

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

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

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

2. **Isobaric Process**

$U_2 - U_1 = Q - W$

$W = P(V_2 - V_1) = mR(T_2 - T_1)$

$Q = mC_p(T_2 - T_1)$

3. **Isometric Process**

$U_2 - U_1 = Q$

$W = 0$

$Q = mC_v(T_2 - T_1)$

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4. Adiabatic Process

$$U_2 - U_1 = -W$$

$$U_2 - U_1 = mC_v(T_2 - T_1)$$

$$Q = 0$$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

5. Polytropic Process

$$U_2 - U_1 = mC_v(T_2 - T_1)$$

$$Q = \frac{\gamma - n}{\gamma - 1} \times W$$

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

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{V_1}{V_2}\right)^{n-1}$$

3.0 SECOND LAW OF THERMODYNAMICs

Heat Engine

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

$$\eta_{th,rev} = 1 - \frac{T_L}{T_H}$$

Refrigerator

$$COP_R = \frac{Q_L}{W_{net}} = \frac{Q_L}{Q_H - Q_L}$$

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

Heat Pump

$$COP_{HP} = \frac{Q_H}{W_{net}} = \frac{Q_H}{Q_H - Q_L}$$

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

Power Cycle

$$Cycle\ efficiency, \eta = \frac{W_{net}}{Q_{in}} = \frac{W_T - W_p}{Q_B}$$

$$specific\ steam\ consumption = \frac{3600}{W_{net}} = \frac{3600}{W_T - W_p}$$

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$$work\ ratio, r_w = \frac{W_{net}}{W_{gross}}$$

$$r_w = \frac{W_T - W_p}{W_T}$$