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 II : 2025/2026

DJJ30293: THERMODYNAMICS

TARIKH : 13 MEI 2026
MASA : 02.30 PETANG – 04.30 PETANG (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. Answers **ALL** questions.

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) The fundamental thermodynamic concepts are the basic ideas used to describe and analyze energy interactions in a system. Define the fundamental thermodynamic concepts of system, boundary, and surroundings.

Konsep termodinamik asas ialah idea asas yang digunakan untuk menerangkan dan menganalisis interaksi tenaga dalam sesuatu sistem. Takrifkan konsep termodinamik asas bagi sistem, sempadan dan persekitaran.

[6 marks]

[6 *markah*]

CLO1 (b) Water is heated in a boiler at constant pressure until it changes phase from liquid to steam. With the aid of P–V diagram, locate the following terms:

Air dipanaskan di dalam dandang pada tekanan malar sehingga ia berubah fasa daripada cecair kepada wap. Dengan bantuan rajah P–V, letakkan terma-terma berikut:

i. The critical point

Titik kritikal

[3 marks]

[*3 markah*]

ii. The saturated liquid line and saturated steam line

Garisan cecair tepu dan garisan wap tepu

[2 marks]

[*2 markah*]

iii. The wet steam region compressed liquid region and superheated steam region.
Kawasan wap basah, kawasan cecair termampat dan kawasan wap panas lampau.

[3 marks]
[*3 markah*]

CLO1 (c) Given the pressure and specific internal energy of the wet steam are 25 bar and 2765 kJ/kg. Calculate:
Diberi tekanan dan tenaga dalam tentu wap basah 25 bar dan 2765 kJ/kg. Kirakan:

i. Dryness Fraction. Locate point of dryness fraction in P-V diagram.
Pecahan kekeringan. Tandakan titik pecahan kekeringan pada gambarajah P-V .

[5 marks]
[*5 markah*]

ii. Spesific Volume.
Isipadu tentu

[3 marks]
[*3 markah*]

iii. Specific Enthalpy.
Entalpi tentu.

[3 marks]
[*3 markah*]

TERBUKA

QUESTION 2

SOALAN 2

CLO2

(a) An amount of gas inside an insulated vessel contained 45kJ of internal energy. The gas expands until its internal energy decreases to 23kJ. Relate the values given for the solution of the work (W) produced by the gas.

Sejumlah gas yang berada di dalam bekas berpenebat mengandungi 45kJ tenaga dalaman. Gas tersebut mengembang sehingga tenaga dalamannya berkurang kepada 23 kJ. Hubungkaitkan nilai yang diberi untuk penyelesaian kerja (W) yang dihasilkan oleh gas tersebut.

[6 marks]

[6 *markah*]

CLO2

(b) Air has initial pressure of 10.5 bar and a volume of 30 litre. It expands adiabatically until the final pressure reaches 300 kPa. Given the index adiabatic, γ is 1.4. Calculate the following:

Udara pada tekanan 10.5 bar dan isipadu 30 liter berkembang secara adiabatik hingga mencapai tekanan akhir 300 kPa. Diberi nilai indeks adiabatic, γ ialah 1.4. Kirakan yang berikut:

i. Final volume

Isipadu akhir

[9 marks]

[9 *markah*]

ii. Work done

Kerja yang dilakukan

[6 marks]

[6 *markah*]

TERBUKA

CLO2 (c) Determine the change in internal energy for question 2(b) and state whether it is increase or decreases.

Tentukan perubahan tenaga dalam untuk soalan 2(b) dan tentukan sama ada ianya meningkat atau menurun.

[4 marks]

[*4 markah*]

TERBUKA

QUESTION 3

SOALAN 3

CLO2 (a) Explain an open system in thermodynamics with **THREE (3)** example of devices for the system.

*Jelaskan sistem terbuka dalam termodinamik dengan **TIGA (3)** contoh peranti bagi sistem tersebut.*

[6 marks]

[*6 markah*]

CLO2 (b) A steam turbine in a thermal power plant operates under steady-flow conditions to generate mechanical power. The turbine receives steam at 10 MPa and 470°C with a velocity of 80 m/s and discharges steam at a pressure of 0.1 bar, specific internal energy of 2257 kJ/kg and specific volume of 13.5 m³/kg leaving the turbine at a velocity of 120 m/s. The mass flow rate of the steam is 57,600 kg/h, and the system experiences a heat loss of 30 kJ/kg to the surroundings. Calculate:

Sebuah turbin loji janakuasa stim beroperasi di bawah keadaan aliran malar untuk menjana kuasa mekanikal. Turbin menerima stim pada 10 MPa dan 470°C dengan halaju 80 m/s dan melepaskan stim pada tekanan 0.1 bar, tenaga dalaman tentu 2257 kJ/kg dan isipadu tentu 13.5 m³/kg meninggalkan turbin dengan halaju 120 m/s. Kadar aliran jisim stim ialah 57,600 kg/j, dan sistem mengalami kehilangan haba sebanyak 30 kJ/kg ke persekitaran. Kirakan:

i. The change in specific enthalpy of the steam between the inlet and outlet.

Perubahan entalpi tentu stim antara bahagian masukan dan bahagian keluaran

[10 marks]

[*10 markah*]

ii. The power output of the turbine in kilowatts (kW).

Keluaran kuasa turbin dalan kilowatt (kW)

[5 marks]

[*5 markah*]

TERBUKA

CLO2 (c) Referring to Question 3(b), if the turbine undergoes an adiabatic process, determine the turbine's output power.

Merujuk kepada soalan 3(b), jika turbin itu mengalami proses adiabatik, tentukan kuasa keluaran turbin.

[4 marks]

[4 *markah*]

TERBUKA

QUESTION 4
SOALAN 4

CLO2 (a) In thermodynamics, not all energy conversion processes can occur spontaneously, and some processes are irreversible in nature. Define the Second Law of Thermodynamics.
Dalam termodinamik, tidak semua proses penukaran tenaga boleh berlaku secara spontan, dan sesetengah proses adalah bersifat tidak boleh balik (irreversible). Takrifkan Hukum Kedua Termodinamik.

[4 Marks]
[4 *Markah*]

CLO2 (b) A Carnot heat engine operates between two thermal energy reservoirs with temperatures of 730 ^{0}C and 288 ^{0}C respectively. It receives 835 kJ/s of heat from the hot reservoir. Calculate:
Enjin haba Carnor beroperasi do antara dua takungan haba dengan suhu masing-masing 730 ^{0}C dan 288 ^{0}C. Ia menerima kadar haba 835 kJ/s daripada takungan panas. Kirakan :

i. Thermal efficiency
Kecekapan terma

[4 Marks]
[4 *Markah*]

ii. The rate of heat rejected to the cold reservoir
Kadar haba yang disingkirkan ke takungan sejuk

[4 Marks]
[4 *Markah*]

TERBUKA

CLO2 (c) A steam power plant operates on an ideal Rankine cycle between a boiler pressure of $3MN/m^2$ and a condenser pressure of 0.04 bar. The steam enters the turbine in a dry saturated condition, and all processes are assumed to be ideal. Calculate:

Sebuah loji janakuasa stim beroperasi mengikut kitaran Rankine ideal antara tekanan dandang sebanyak $3MN/m^2$ dan tekanan kondenser sebanyak 0.04 bar. Stim memasuki turbin dalam keadaan tepu kering, dan semua proses dianggap ideal. Kirakan :

i. The thermal efficiency of the cycle.
Kecekapan kitar

[11 Marks]
[11 *Markah*]

ii. The specific steam consumption
Penggunaan steam tentu

[2 Marks]
[2 *Markah*]

TERBUKA

SOALAN TAMAT

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

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

$\dot{m} = \rho CA$

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

Non-Flow process

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

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

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

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

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**

$U_2 - U_1 = Q$

$W = 0$

$Q = mC_v(T_2 - T_1)$

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

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

Refrigerator

$$COP_R = \frac{Q_L}{W_{net}} = \frac{Q_L}{Q_H - Q_L} \qquad COP_{R,rev} = \frac{T_L}{T_H - T_L}$$

Heat Pump

$$COP_{HP} = \frac{Q_H}{W_{net}} = \frac{Q_H}{Q_H - Q_L} \qquad COP_{HP,rev} = \frac{T_H}{T_H - T_L}$$

Power Cycle

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

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

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

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