

SULIT



**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 : 2025/2026

DJM20053 : THERMOFLUIDS

TARIKH : 27 NOVEMBER 2025

MASA : 2.30 PETANG - 4.30 PETANG (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Formula dan Jadual Stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1**SOALAN 1**

- CLO1 a) Generally, properties are classified into extensive and intensive. Label those properties, either it is an extensive or intensive process.
- Secara amnya, sifat-sifat dikelaskan kepada ekstensif dan intensif. Labelkan sifat-sifat berikut, sama ada ia adalah proses ekstensif atau intensif.*
- i. Mass
Jisim
 - ii. Temperature
Suhu
 - iii. Volume
Isipadu
 - iv. Pressure
Tekanan
 - v. Density
Ketumpatan

[5 marks]

[5 markah]

CLO1

b) A rigid container with a fixed volume is filled with an ideal gas at atmospheric pressure and temperature.

Sebuah bekas dengan isipadu tetap diisi dengan gas ideal pada tekanan dan suhu atmosfera.

i. Briefly explain about absolute pressure and gauge pressure.

Terangkan secara ringkas tentang tekanan mutlak dan tekanan tolok.

[4 marks]

[4 markah]

ii. If a container is submerged in a lake at depth of h , with the pressure P , choose a formula that can be used to relate the gauge pressure inside the container to the depth and other relevant variables.

Jika bekas ditenggelamkan di tasik dengan kedalaman h , dan tekanan ialah P , pilih formula yang boleh digunakan untuk mengaitkan tekanan tolok di dalam bekas dengan kedalaman dan pembolehubah lain yang berkaitan.

[1 mark]

[1 markah]

iii. Express the gauge pressure experienced by the container in kPa, if the depth of the lake is 10 m and the density of water is γ 1000 kg/m³.

Nyatakan tekanan tolok yang dikenakan oleh bekas dalam kPa, Jika kedalaman tasik ialah 10 m dan ketumpatan air adalah 1000 kg/m³.

[3 marks]

[3 markah]

- CLO1 c) A force of 500 N is applied to the small piston of a simple hydraulic jack. The diameter of larger piston is 18 cm, and the diameter of small piston is 7 cm. Consider that the specific gravity of hydraulic oil is 0.8.
- Daya sebanyak 500 N dikenakan pada omboh yang kecil pada sebuah bicu hidraulik yang asas. Diameter omboh besar adalah 18 cm dan diameter omboh kecil adalah 7 cm. Graviti tentu minyak hidraulik ialah 0.8.*
- i. Calculate an area for both piston in m^2 .
Kirakan luas bagi kedua-dua piston dalam unit m^2 .
- [4 marks]
[4 markah]
- ii. If both piston are at same level, calculate the load that can be lifted by larger piston.
Jika kedua-dua omboh pada aras yang sama, kira beban boleh diangkat oleh omboh yang besar.
- [4 marks]
[4 markah]
- iii. Calculate the load that the large piston can lift if it is 0.75 m below the small piston.
Kirakan beban yang boleh diangkat oleh omboh yang besar jika ia berada 0.75 m di bawah omboh yang kecil.
- [4 marks]
[4 markah]

QUESTION 2**SOALAN 2**

- CLO1 a) Piezometer is a device that uses pressure and depth concept. Describe the working principle of piezometer.
Piezometer ialah alat yang menggunakan konsep tekanan dan kedalaman. Terangkan prinsip kerja piezometer.
- [5 marks]
[5 markah]
- CLO1 b) An empty boat has a volume of 1.5 m^3 immersed in the sea. The boat immersed 4.5 m^3 when load is put on it. The density of the sea is 1020 kg/m^3 . Calculate:
Sebuah bot yang kosong di laut mempunyai isipadu yang tenggelam sebanyak 1.5 m^3 . Isipadu bot yang tenggelam menjadi 4.5 m^3 apabila sejumlah beban dimasukkan ke dalam bot. Ketumpatan air laut adalah 1020 kg/m^3 . Kirakan:
- i. Weight of empty boat.
Berat bot kosong.
- [3 marks]
[3 markah]
- ii. Weight of boat with load.
Berat bot dengan muatan.
- [3 marks]
[3 markah]
- iv. Load that can be carry by the boat.
Beban yang boleh dibawa oleh bot.
- [2 marks]
[2 markah]

CLO1

- c) Figure 2(c) shows an inverted differential manometer. It contains oil with the specific gravity 0.8 and it is connected to two pipes which carry untreated boiler water with specific gravity 1.

Rajah 2(c) menunjukkan sebuah manometer pembezaan songsang. Ia mengandungi minyak dengan graviti tentu 0.8 dan ia disambung dengan paip yang membawa air dandang yang tak dirawat dengan graviti tentu 1.

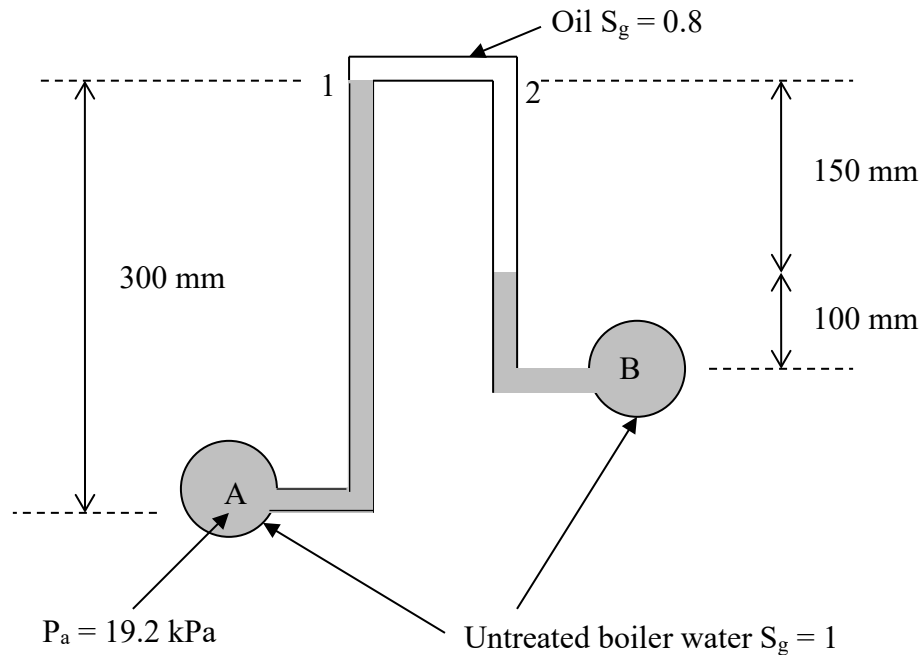


Figure 2(c) / Rajah 2(c)

- i. Compute mass density of oil and untreated boiler water.
Kira ketumpatan jisim minyak dan air dandang yang tidak dirawat.
[2 marks]
[2 markah]
- ii. With concept of “pressure will be the same at the same level”, calculate the different pressure between pipe A and pipe B.
Dengan konsep "tekanan akan sama pada tahap yang sama", hitung perbezaan tekanan antara paip A dan paip B
[8 marks]
[8 markah]

- iii. Calculate pressure in pipe B, if pressure in pipe A is 19.2 kPa,
Kira tekanan di paip B jika tekanan di paip A ialah 19.2 kPa.

[2 marks]

[2 markah]

QUESTION 3

SOALAN 3

CLO1

- a) Venturi meter is an ideal tool to measure flowrate of fluid.
Meter Venturi ialah alat yang sesuai untuk mengukur kadar alir bendalir.
- i. Briefly explain the principle behind the operation of a venturi meter.
Terangkan secara ringkas prinsip di sebalik pengendalian meter venturi.

[5 marks]

[5 markah]

- ii. Using the principle of continuity and Bernoulli's equation, express the flow rate equation for venturi meter.

Dengan menggunakan prinsip keterusan dan persamaan Bernoulli, ungkapkan persamaan kadar alir bagi meter venturi.

[1 mark]

[1 markah]

b) Air flows steadily through a horizontal venturi meter attached in a pipe. The diameter of the pipe is 10 cm at the inlet (point A) and narrows to 5 cm at the throat (point B) before expanding back to 10 cm at the outlet (point C). The measured pressure at point A is 105 kPa, and the pressure at point B is 50 kPa. *Udara mengalir secara mantap melalui meter venturi mendatar yang dipasang di sebatang paip. Diameter paip ialah 10 cm di bahagian masuk (titik A) dan mengecil hingga 5 cm di bahagian tekak (titik B) sebelum mengembang kembali ke 10 cm di alur keluar (titik C). Tekanan yang diukur pada titik A ialah 105 kPa, dan tekanan di titik B ialah 50 kPa.*

- i. Using the continuity equation, derive formula the velocity of the air at the throat (point B).

Dengan menggunakan persamaan keterusan, terbitkan persamaan halaju udara di leher (titik B).

[3 marks]

[3 markah]

- ii. Apply Bernoulli's theorem to calculate the velocity of the air at the inlet (point A).

Gunakan teorem Bernoulli untuk mengira halaju udara di salur masuk (titik A).

[3 marks]

[3 markah]

- iii. Based on your calculations, show how the venturi meter utilizes the principles of Bernoulli's theorem to measure flow rate.

Berdasarkan pengiraan anda, tunjukkan cara meter venturi menggunakan prinsip teorem Bernoulli untuk mengukur kadar aliran.

[3 marks]

[3 markah]

CLO1

- c) A piston-cylinder arrangement contains a fixed mass of an ideal gas initially at a pressure of 100 kPa, a volume of 0.1 m^3 , and a temperature of 300 K. The gas undergoes a combined cycle consisting of two processes:

Process 1-2: Isothermal expansion to a final volume of 0.2 m^3 .

Process 2-3: Adiabatic compression from 80 kPa until the pressure and volume reaches its initial value.

Take into consideration specific heat ratio, $\gamma = 1.4$.

Sebuah omboh-silinder sebaris yang mengandungi jisim tetap gas bermula pada tekanan 100 kPa, isipadu 0.1 m^3 , dan suhu 300 K. Gas tersebut mengalami kitaran gabungan yang terdiri daripada dua proses:

Proses 1-2: Pengembangan sesuhu kepada isipadu akhir 0.2 m^3 .

Proses 2-3: Mampatan adiabatik dari 80 kPa sehingga tekanan dan isipadu kembali mencapai nilai awal.

Ambil kira nisbah haba tentu, $\gamma = 1.4$.

- i. Calculate the work done by the gas during each process.

Kira kerja yang dilakukan oleh gas semasa setiap proses.

[6 marks]

[6 markah]

- ii. Calculate the heat transferred during each process.

Kira haba yang dipindahkan bagi setiap proses.

[2 marks]

[2 markah]

- iii. Sketch the complete cycle on a P-V diagram.

Lakarkan kitaran lengkap pada gambar rajah P-V.

[2 marks]

[2 markah]

QUESTION 4**SOALAN 4**

- CLO1 a) List **FIVE (5)** limitations of steady flow energy equation.
Senaraikan LIMA (5) had dalam persamaan aliran tenaga mantap.
- [5 marks]
[5 markah]
- CLO1 b) A fluid flows through a turbine at a rate \bar{m} kg/s. Across the turbine, specific enthalpy drop by h_2 kJ/kg and heat energy loss is Q kJ/s.
Bendalir mengalir melalui turbin pada kadar \bar{m} kg/s. Merentasi turbin, penurunan entalpi tentu sebanyak h_2 kJ/kg dan kehilangan tenaga haba ialah Q kJ/s.
- i. Using steady flow energy equation and neglecting the kinetic energy and potential energy, simplify steady flow energy equation to get power produce by the turbine.
Menggunakan persamaan tenaga aliran mantap dan mengabaikan tenaga kinetik dan tenaga keupayaan, mudahkan persamaan tenaga aliran mantap untuk mendapatkan kuasa yang dihasilkan oleh turbin.
- [2 marks]
[2 markah]
- ii. Explain the meaning of each term in the simplified equation.
Terangkan maksud bagi setiap istilah dalam persamaan yang dipermudahkan.
- [4 marks]
[4 markah]
- iii. Visualize the situation with rough draft.
Visualisasikan keadaan dengan lakaran kasar.
- [2 marks]
[2 markah]

CLO1

- c) A steam power plant operates in the Rankine cycle with boiler pressure 36 bar and a condenser pressure of 0.045 bar. The dry saturated steam entering the turbine produce the turbine work of 888 kJ/kg and feed pump work of 4.2 kJ/kg, calculate:

Loji kuasa wap beroperasi dalam kitar Rankine dengan tekanan dandang 36 bar dan tekanan pemeluwap 0.045 bar. Wap tepu kering yang masuk ke turbin menghasilkan kerja turbin sebanyak 888 kJ/kg dan kerja pam suapan sebanyak 4.2 kJ/kg, hitung:

- i. Heat requires by the turbine.

Haba yang diperlukan oleh turbin.

[6 marks]

[6 markah]

- ii. Rankine cycle efficiency.

Kecekapan kitar Rankine

[3 marks]

[3 markah]

- iii. Work ratio.

Nisbah kerja.

[3 marks]

[3 markah]

SOALAN TAMAT

1. FLUID PROPERTIES

$$\rho = \frac{m}{V} \quad \omega = \rho g \quad S = \frac{\omega_{\text{substance}}}{\omega_{\text{water}}} \quad v = \frac{1}{\rho}$$

2. FLUID APPLICATIONS

$$P = \rho gh \quad \frac{F_1}{A_1} = \frac{W}{A_2} \quad F_b = \rho gV \quad Q = Av \quad Q_1 = Q_2 \quad \dot{m} = \rho Av$$

$$z_1 + \frac{p_1}{\omega} + \frac{v_1^2}{2g} = z_2 + \frac{p_2}{\omega} + \frac{v_2^2}{2g}$$

$$Q_{\text{Actual}} = C_d (Q_{\text{Theory}}) \quad Q_{\text{Theory}} = A_1 \sqrt{\frac{2gH}{(m^2 - 1)}} \quad m = \frac{A_1}{A_2} = \frac{d_1^2}{d_2^2}$$

$$H = \frac{P_1 - P_2}{\omega_{\text{sub}}} = x \left[\frac{\omega_{Hg}}{\omega_{\text{sub}}} - 1 \right]$$

3. PROPERTIES OF PURE SUBSTANCE

Wet Steam

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

Superheated Steam

$$D.O.S = T_{\text{superheated}} - T_{\text{sat}} \quad u = h - pv$$

Ideal Gas

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

5. FIRST LAW OF THERMODYNAMICS

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

Flow Process

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

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

Process	Formula	Heat (Q)	Work (W)	ΔU	$S_2 - S_1$
➤ Isothermal ➤ Constant Temperature $T_1 = T_2$	$PV = mRT$ $P_1V_1 = P_2V_2$	$Q = W$	$W = P_1V_1 \ln \left[\frac{V_2}{V_1} \right]$ $W = P_1V_1 \ln \left[\frac{P_1}{P_2} \right]$ $W = mRT \ln \left[\frac{V_2}{V_1} \right]$ $W = mRT \ln \left[\frac{P_1}{P_2} \right]$	0	$S_2 - S_1 = mR \ln \left(\frac{v_2}{v_1} \right)$ $S_2 - S_1 = mR \ln \left(\frac{P_1}{P_2} \right)$
➤ Isobaric ➤ Constant Pressure $P_1 = P_2$	$PV = mRT$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$Q = mC_p(T_2 - T_1)$	$W = P(V_2 - V_1)$	$U_2 - U_1 = Q - W$	$S_2 - S_1 = mC_p \ln \left(\frac{T_2}{T_1} \right)$
➤ Isometric ➤ Isochoric ➤ Constant Volume $V_1 = V_2$	$PV = mRT$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$Q = mC_v(T_2 - T_1)$	0	$U_2 - U_1 = Q$	$S_2 - S_1 = mC_v \ln \left(\frac{T_2}{T_1} \right)$
➤ Adiabatic ➤ Isentropic $PV^\gamma = C$	$P_1V_1^\gamma = P_2V_2^\gamma$ $\frac{T_2}{T_1} = \left[\frac{P_2}{P_1} \right]^{\frac{\gamma-1}{\gamma}} = \left[\frac{V_2}{V_1} \right]^{\gamma-1}$	0	$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1}$ $W = \frac{mR(T_2 - T_1)}{\gamma - 1}$	$U_2 - U_1 = -W$ $U_2 - U_1 = mC_v(T_2 - T_1)$	$S_2 - S_1 = 0$
➤ Polytropic $PV^n = C$	$P_1V_1^n = P_2V_2^n$ $\frac{T_2}{T_1} = \left[\frac{P_2}{P_1} \right]^{\frac{n-1}{n}} = \left[\frac{V_1}{V_2} \right]^{n-1}$	$Q = \left[\frac{\gamma - n}{\gamma - 1} \right] \times W$ $Q = W + \Delta U$	$W = \frac{P_1V_1 - P_2V_2}{n - 1}$ $W = \frac{mR(T_2 - T_1)}{n - 1}$	$U_2 - U_1 = Q - W$ $U_2 - U_1 = mC_v(T_2 - T_1)$	a) According to volume $S_2 - S_1 = mR \ln \left(\frac{v_2}{v_1} \right) - mC_v \ln \left(\frac{T_1}{T_2} \right)$ b) According to pressure $S_2 - S_1 = mR \ln \left(\frac{P_1}{P_2} \right) - mC_p \ln \left(\frac{T_1}{T_2} \right)$

5. SECOND LAW OF THERMODYNAMICS

$$W_{net} = Q_H - Q_L$$

Heat Engine

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

Refrigerator

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

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

Heat Pump

$$COP_{HP} = \frac{Q_{HP}}{W_{net}}$$

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

Power Cycle

$$\eta = \frac{W_{net}}{Q_{in}} = 1 - \frac{Q_L}{Q_H} = 1 - \frac{T_L}{T_H}$$

$$work\ ratio = \frac{W_{net}}{W_{gross}} = \frac{(h_2 - h_1) - (h_3 - h_4)}{(h_2 - h_1)}$$

$$s. s. c = \frac{3600}{W_{net}} = \frac{3600}{(h_2 - h_1) - (h_3 - h_4)}$$