SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI 2:2016/2017

BJJ2023: THERMOFLUIDS

TARIKH : 13 JUN 2017
MASA : 9.00 AM – 12.00 PM (3 JAM)

Kertas ini mengandungi **DUA BELAS (12)** halaman bercetak.
Bahagian ini mengandungi **LIMA (5)** soalan esei
Jawab **SEMUA** soalan
Dokumen sokongan yang disertakan : Rumus, Jadual stim

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This section consists of **FIVE (5)** questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **LIMA (5)** soalan . Jawab semua soalan.*

QUESTION 1

SOALAN 1

CLO1 C2

(a) Explain the following terms:

Terangkan istilah-istilah berikut:

i. Atmospheric pressure (P_{atm}) [2 marks]

Tekanan atmosfera(P_{atm}) *[2 markah]*

ii. Gauge pressure (P_G) [2 marks]

Tekanan tolok (P_G) *[2 markah]*

iii. Absolute pressure (P_{abs}) [2 marks]

Tekanan mutlak (P_{abs}) *[2 markah]*

CLO1 C3

(b) Nutrients dissolved in water are carried to upper parts of plants by tines tubes partly because of the capillary effect as shown in **Figure Q1(b)**. The surface tension of water at 20°C is σ_s = 0.073 N/m with a contact angle of 15°. The density of water can be taken to be 1000 kg/m^3. Calculate:

*Nutrien yang dilarutkan di dalam air dibawa ke bahagian atas pokok oleh tiub tines disebabkan oleh kesan kapilari seperti dalam **Rajah S1(b)**. Tegangan permukaan air pada 20°C adalah σ_s = 0.073 N/m dengan sudut hubungan 15°. Ketumpatan air yang boleh digunakan adalah 1000 kg/m^3. Kirakan:*

i. The water solution height of a 0.005 mm diameter tube through a tree as a result of the capillary effect.

Ketinggian air yang melalui pokok tersebut dalam tiub berdiameter 0.005 mm akibat daripada kesan kapilari.

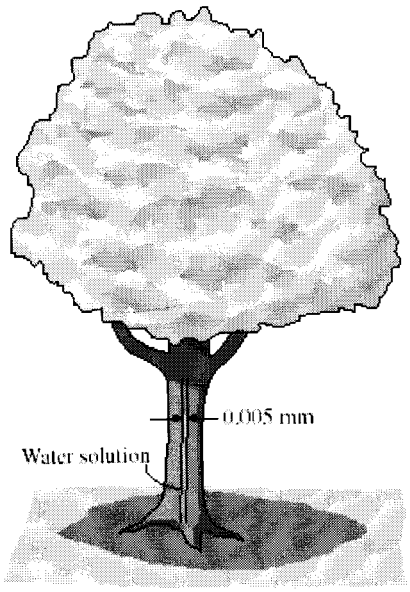

Figure Q1(b)

Rajah S1(b)

[4 marks]

[4 markah]

CLO2
C4

(c) Air at 110 kPa and 50^0C flows upward through a 6cm diameter inclined duct at a rate of 45 L/s as shown in **Figure Q1(c)**. The duct diameter is then reduced to 0.04 m through a reducer. The pressure change across the reducer is measured by a water manometer. The elevation difference between the two points on the pipe where the two arms of the manometer are attached is 0.20 m. Compute the differential height between the fluid level of the two arms of the manometer.

Use, $\rho = 1000$ kg/m^3

$R = 0.287$ kPa·m^3/kg·K

Udara pada 110 kPa dan 50^0C mengalir melalui saluran cenderung berdiameter 6cm pada kadar isipadu 45 L/s seperti dalam ***Rajah S1(c)*** *. Saluran diameter kemudiannya dikurangkan kepada 0.04 m melalui pengurang. Perubahan tekanan merentasi pengurang diukur oleh manometer air. Perbezaan ketinggian antara dua titik pada paip di mana dua lengan manometer adalah 0.20 m. Kirakan ketinggian perbezaan tahap cecair antara dua lengan manometer.*

Gunakan, $\rho = 1000\ kg/m^3$

$R = 0.287\ kPa \cdot m^3/kg \cdot K$

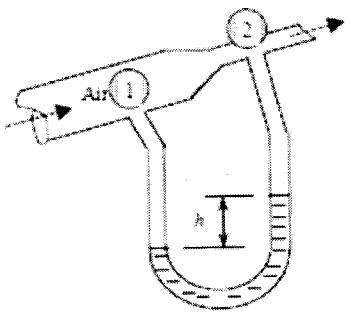

Figure Q1(c)

Rajah S1(c)

[10 marks]

[10 markah]

QUESTION 2

SOALAN 2

CLO1 C2

(a) Define the following terms:

Takrifkan istilah-istilah berikut:

i. Minor Loss coefficient, K_L [2 marks]

Pekali kehilangan turus, K_L *[2 markah]*

ii. Equivalent length, L_{equiv} [2 marks]

Panjang setara, L_{equiv} *[2 markah]*

CLO1 C3

(b) A certain part of cast iron piping of a water distribution system involves a parallel section. Both parallel pipes have a diameter of 30 cm and the flow is fully turbulent as shown in **Figure Q2(b)**. One of the branches (pipe A) is 1000 m long while the other branch (pipe B) is 3000 m long. If the flow rate through pipe A is 0.4 m^3/s, determine the flow rate through pipe B. Disregard minor losses and assume the water temperature to be 15^oC.

Sebahagian daripada sistem pengagihan air melibatkan pemasangan paip secara selari daripada paip besi tuang. Kedua-dua paip selari tersebut beraliran gelora dan mempunyai diameter 30 cm seperti dalam ***Rajah S2 (b).*** *Paip A mempunyai adalah 1000 m panjang manakala paip B adalah 3000 m panjang. Jika kadar alir yang melalui paip A adalah 0.4 m^3/s, tentukan kadar alir yang melalui paip B. Abaikan kehilangan turus dan anggarkan air pada suhu 15^OC.*

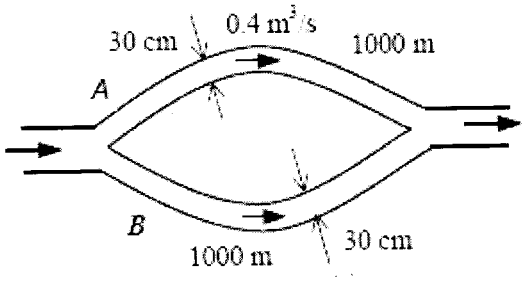

Figure Q2(b)

Rajah S2(b)

[6 marks]

[6 markah]

CLO2
C4

(c) Water at 10^0C (ρ = 999.7 kg/m^3 and μ = 1.307 x 10^{-3} kg/m.s) is flowing steadily in a 0.20 cm diameter, 15 m long pipe at an average velocity of 1.2 m/s as shown in **Figure Q2(c)**. Calculate:

Air pada suhu 10^0C (ρ = 999.7 kg/m^3 dan μ = 1.307 x 10^{-3} kg/m) mengalir dengan aliran stabil dalam paip berdiameter 0.20cm, panjang 15 m pada halaju purata 1.2 m/s seperti dalam ***Rajah S2(c)****. Kirakan:*

i. The pressure drop [4 marks]

Perbezaan tekanan *[4 markah]*

ii. The head loss [2 marks]

Kehilangan turus *[2 markah]*

iii. The pumping power requirement to overcome this pressure drop [4 marks]

Kuasa yang diperlukan bagi mengatasi kehilangan perbezaan tekanan *[4 markah]*

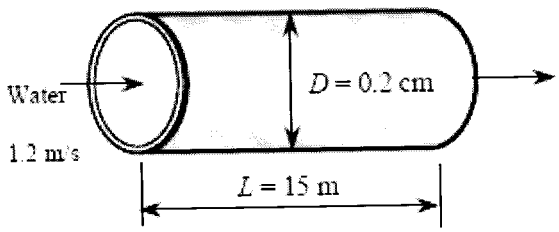

Figure Q2(c)

Rajah S2(c)

QUESTION 3

SOALAN 3

CLO1
C1

(a) Define the following terms:

Takrifkan istilah-istilah berikut:

i. System [2 marks]

Sistem *[2 markah]*

ii. Boundary [2 marks]

Sempadan *[2 markah]*

iii. Surroundings [2 marks]

Sekeliling *[2 markah]*

CLO1
C2

(b) In an experiment, a mass of 0.18 kg gas is at a temperature of 15 °C, pressure 130 kN/m^2 and volume 0.17 m^3. If the gas has a value of C_v = 720 J/kg K, compute the:

Di dalam satu ujikaji, suatu gas yang berjisim 0.18 kg berada pada suhu 15 °C, tekanan 130 kN/m^2 dan isipadu 0.17 m^3. Sekiranya gas tersebut mempunyai nilai C_v= 720 J/kg K, kirakan:

i. gas constant, *R* [2 marks]

pemalar gas, R *[2 markah]*

ii. molecular weight, *M* [2 marks]

berat molekul, M *[2 markah]*

iv. specific heat at constant pressure, C_p [2 marks]
haba tentu pada tekanan tetap, C_p *[2 markah]*

CLO1 C3

(c) A cylinder containing 0.07 kg of gas has a pressure of 1 bar, a volume of 0.06 m^3 and a specific internal energy of 200 kJ/kg. After polytropic compression, the pressure, volume and specific internal energy of the gas are 9 bar, 0.011 m^3 and 370 kJ/kg respectively. Solve:
Suatu silinder mengandungi 0.07 kg gas pada tekanan 1 bar, isipadu 0.06 m^3 dan tenaga dalam tentu 200 kJ/kg. Selepas mampatan politropik, tekanan, isipadu dan tenaga dalam tentu gas masing-masing adalah 9 bar, 0.011 m^3 dan 370 kJ/kg. Selesaikan:

i. polyropic index, n [3 marks]
indeks politropik, n *[3 markah]*

ii. work energy required for the compression [2 marks]
tenaga kerja yang diperlukan untuk mampatan *[2 markah]*

iii. the quantity and direction of the heat energy that flows during the compression [3 marks]
nilai dan arah tenaga haba yang mengalir semasa mampatan *[3 markah]*

QUESTION 4
SOALAN 4

CLO1 C2

(a) Describe briefly **TWO (2)** conditions which must be satisfied by all of the processes in the steady flow process. [4 marks]
*Terangkan secara ringkas **DUA (2)** syarat-syarat yang mesti dipatuhi oleh semua proses dalam proses aliran mantap.* *[4 markah]*

CLO1 C3

(b) The pressure of steam is at 105 bar and specific enthalpy is 2100 kJ/kg. With reference to the Steam Tables, calculate:
Diberi tekanan stim adalah 105 bar dan entalpi tentu 2100 kJ/kg. Dengan berpandukan kepada Jadual Stim, kirakan:

i. steam dryness fraction [3 marks]
pecahan kekeringan stim *[3 markah]*

ii. specific internal energy [3 marks]
tenaga dalaman tentu *[3 markah]*

CLO2
C4

(c) Air flow through an air compressor in a steady flow system. Air mass flow rate is 0.5 kg/s.
The air compressor inlet condition as follows: -
velocity of 15 m/s, pressure 1.02 bar and specific volume is 0.95 m^3/kg.
At the exit of the compressor, air condition as follows: -
velocity of 7 m/s, pressure of 7.5 bar and the specific volume of 0.35 m^3/kg.
Specific internal energy at the outlet is 85 kJ/kg higher than the specific internal energy at the inlet. Cooling water flowing around the body of the compressor absorb heat at a rate of 15 kJ/s. Estimate :

Udara mengalir sekata melalui sebuah pemampat udara di dalam system aliran sekata. Kadar alir jisim udara ialah 0.5 kg/s.
Udara pada bahagian masuk pemampat berkeadaan seperti berikut:-
halaju 15 m/s, tekanan 1.02 bar dan isipadu tentu 0.95 m^3/kg.
Pada bahagian keluar pemampat, udara berkeadaan seperti berikut :-
halaju 7 m/s, tekanan 7.5 bar dan isipadu tentu 0.35 m^3/kg.
Tenaga dalam udara pada bahagian keluar adalah 85 kJ/kg lebih tinggi daripada tenaga dalam udara pada bahagian masuk. Air penyejuk yang mengalir di sekeliling badan pemampat menyerap haba pada kadar 15 kJ/s. Dapatkan :

i. the work done on or by the system in kW. [7 marks]
kerja yang dilakukan ke atas atau oleh sistem dalam unit kW. *[7 markah]*

ii. the inlet and outlet pipe ratio [3 marks]
nisbah luas paip masuk dan paip keluar *[3 markah]*

QUESTION 5
SOALAN 5

CLO1 C2

(a) State **TWO (2)** types of heat transfers and explain each process.
*Nyatakan **DUA (2)** jenis pemindahan haba dan berikan penerangan bagi setiap proses tersebut.*

[4 marks]
[4 markah]

CLO2 C3

(b) The inner surface of a plane brick wall is 50°C and the outer surface is 30°C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 250 mm thick. The thermal conductivity of the brick is 0.52 W/m K.

[6 marks]
Suhu permukaan dalam dinding bata adalah 50°C dan permukaan luar adalah 30°C. Kirakan kadar pemindahan haba per m^2 kawasan permukaan dinding, yang mempunyai tebal 250 mm. Nilai keberaliran haba bata adalah 0.52 W / m K.

[6 markah]

CLO2 C4

(c) A furnace has a composite wall consisting of 3 different materials. The thermal conductivity of the inner layer (material A) and the outer layer (material C) are 25 W/m °C and 60 W/m °C respectively. The thickness for the materials for both layers are 400 mm and 180 mm. Layer 2 (material B) is constructed between layer 1 (material A) and layer 3 (material C) with a thickness of 180 mm. The temperature for the outer surface and inner surface are 28°C and 700°C respectively, while the air temperature inside the furnace is 1100 °C. Coefficient of heat transfer for the hot air inside the furnace is 15 W/m^2 °C. Calculate:

Relau A mempunyai dinding komposit yang terdiri daripada 3 bahan-bahan yang berbeza. Keberaliran haba lapisan dalaman (bahan A) dan lapisan luar (bahan C) masing-masing adalah 25 W/m °C dan 60 W/m °C. Ketebalan untuk bahan-bahan untuk kedua-dua lapisan adalah 400 mm dan 180 mm.

Lapisan 2 (bahan B) dibina antara lapisan 1 (bahan A) dan lapisan 3 (bahan C) dengan ketebalan 180 mm. Suhu untuk permukaan luar dan permukaan dalaman adalah 28°C dan 700°C masing-masing, manakala suhu udara di dalam relau 1100 °C. Pekali pemindahan haba untuk udara panas di dalam relau adalah 15 W/m^2 °C. Kirakan:

i. Draw the temperature profile diagram for the furnace. [2 marks]
Lukiskan gambarajah profail suhu untuk relau tersebut. *[2 markah]*

ii. The thermal conductivity for layer 2 (material B) [8 marks]
Keberaliran haba untuk lapisan 2 (bahan B) *[8 markah]*

SOALAN TAMAT

FLUID AND PROPERTIES

$$h = \frac{2\sigma s \cos\Phi}{\rho g H}$$

MASS, BERNOULLI AND ENERGY EQUATIONS

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$$

FLOW IN PIPES

head loss:

$$h_L = f\frac{L}{D}\frac{V^2}{2g}$$

pressure drop:

$$\Delta P_L = f\frac{L}{D}\frac{\rho V^2}{2}$$

FIRST LAW OF THERMODYNAMICS AND ITS PROCESSES

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2} \qquad PV = mRT \qquad R = C_p - C_v$$

$$R = \frac{R_o}{M} \qquad \gamma = \frac{C_p}{C_v}$$

1. Isothermal Process

$$W = mRT_1 \ln\frac{V_2}{V_1} = mRT_1 \ln\frac{p_1}{p_2}$$

2. Adiabatic process

$$\frac{T_2}{T_1} = \left[\frac{p_2}{p_1}\right]^{\frac{\gamma-1}{\gamma}} = \left[\frac{V_1}{V_2}\right]^{\gamma-1}$$

$$W = \frac{p_1V_1 - p_2V_2}{\gamma - 1} = \frac{mR(T_1 - T_2)}{\gamma - 1}$$

3. Polytropic process

$$W = \frac{p_1V_1 - p_2V_2}{n - 1} = \frac{mR(T_1 - T_2)}{n - 1}$$

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

4. Constant volume (isochoric) process

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

5. Constant pressure (isobaric) process

$$W = p\,(V_2 - V_1)$$

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

PROPERTIES OF PURE SUBSTANCES

Steam

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

Flow process

$$\dot{m} = \frac{C_1 A_1}{v1} = \frac{C_2 A_2}{v_2}$$

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

$$C_2 = \sqrt{2(h_1 - h_2) + C_1^2}$$

HEAT TRANSFER

$$q = \frac{Q}{A} = \frac{k(t_1 - t_2)}{x}$$

$$q = \frac{Q}{A} = h_A(t_A - t_1)$$

$$\frac{1}{U} = \left(\frac{1}{h_A} + \Sigma\frac{x}{k} + \frac{1}{h_B}\right)$$

$$q = U(t_A - t_B)$$

$$R_T = \frac{1}{h_A A} + \Sigma\left(\frac{x}{kA}\right) + \frac{1}{h_B A}$$

$$q = \frac{(t_A - t_B)}{R_T}$$