

INSTRUCTION:

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

ARAHAN:

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

QUESTION 1**SOALAN 1**

CLO1

- (a) Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, and exchange of thermal energy between physical systems.

Pemindahan haba ialah satu disiplin kejuruteraan haba yang melibatkan penjanaan, penggunaan, penukaran, dan pertukaran tenaga haba antara sistem fizikal.

- (i) Define heat and energy.

Takrifkan haba dan tenaga.

[2 marks]

[2 markah]

- (ii) Define **TWO (2)** mechanisms of heat transfer.

Takrifkan DUA (2) mekanisme pemindahan haba.

[4 marks]

[4 markah]

CLO1

- (b) Explain the relation between the rate of heat conduction through a layer to the area, the thickness and the temperature difference across the layer.

Terangkan hubungkait diantara kadar konduksi haba menerusi suatu lapisan kepada luas permukaan, ketebalan dan perbezaan suhu lapisan tersebut.

[4 marks]

[4 markah]

CLO2

- (c) Consider a 5 m high, 8 m long and 0.22m thick wall whose representative cross section as given in the **Figure 1(c)**. The thermal conductivities of various materials used in $\text{W/m} \cdot ^\circ\text{C}$ are $K_A = K_F = 2$, $K_B = 8$, $K_C = 20$, $K_D = 15$, $K_E = 35$. The left and right surfaces of the wall are maintained at uniform temperatures of 300°C and 100°C , respectively. Assuming heat transfer through the wall to be one-dimensional.

Pertimbangkan tembok setinggi 5 m, panjang 8 m dan tebal 0.22 m yang garis lintangnya mewakili seperti yang ditunjukkan dalam Rajah 1(c). Kekonduksian terma pelbagai bahan yang digunakan dalam $\text{W/m} \cdot ^\circ\text{C}$ adalah $K_A = K_F = 2$, $K_B = 8$, $K_C = 20$, $K_D = 15$, $K_E = 35$. Permukaan kiri dan kanan dinding pada suhu seragam masing-masing 300°C dan 100°C . Dengan andaian pemindahan haba melalui dinding menjadi satu dimensi.

- (i) Calculate the thermal resistance total, R_{total} .

Kirakan jumlah rangkaian rintangan terma, R_{jumlah} .

[7 marks]

[7 markah]

- (ii) Calculate the rate of heat transfer through the wall.

Kirakan kadar pemindahan haba melalui dinding.

[8 marks]

[8 markah]

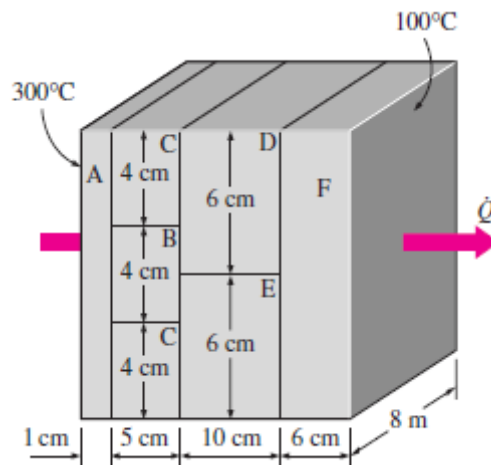


Figure 1(c) / Rajah 1(c)

QUESTION 2

SOALAN 2

CLO1

- (a) Define laminar and turbulent flow.

Takrifkan aliran lamina dan aliran bergelora.

[4 marks]

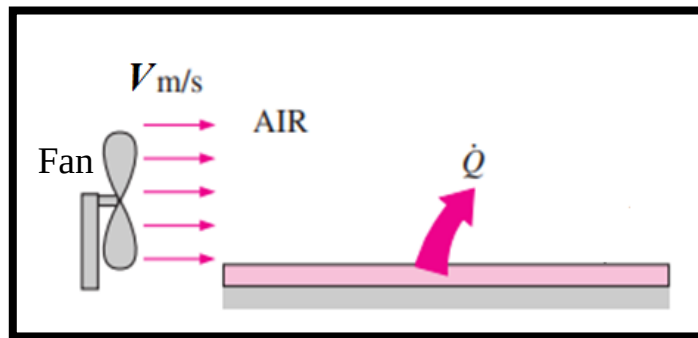
[4 markah]

CLO1

- (b) The mechanism of convection is the transfer of heat energy by actual physical movement of fluid molecule from one place to another in which there exists a temperature gradient.

Mekanisme perolakan ialah pemindahan tenaga haba melalui pergerakan fizikal sebenar molekul bendalir dari satu tempat ke tempat lain di mana terdapat perbezaan suhu.

- (i) Explain the convection mechanism as shown in
- Figure 2(b)**
- .

*Terangkan mekanisme perolakan seperti yang ditunjukkan pada **Rajah 2(b)**.***Figure 2(b) / Rajah 2(b)**

[4 marks]

[4 markah]

- (ii) Explain the natural convection with an example.

Jelaskan perolakan semula jadi beserta contoh.

[3 marks]

[3 markah]

CLO2

- (c) Air at atmospheric pressure and 40°C flows with a velocity of $V = 5\text{ m/s}$ over a 2m long flat whose surface is kept at a uniform temperature of 120°C .

Udara pada tekanan atmosfera dan 40°C mengalir dengan halaju $V = 5\text{ m/s}$ di atas flat sepanjang 2 m yang permukaannya disimpan pada suhu seragam 120°C .

- (i) Calculate the film temperature, $T_f (^{\circ}\text{C})$, kinematic viscosity, $\nu (\text{m}^2/\text{s})$, Prandtl number, Pr , and Reynold number, Re .

Kirakan suhu filem, $T_f (^{\circ}\text{C})$, kelikatan kinematik, $\nu (\text{m}^2/\text{s})$, nombor prandtl, Pr , dan nombor Reynold, Re .

[7 marks]

[7 markah]

- (ii) Calculate the heat transfer rate between the 2 m plate and the air per 1m width of the plate.

Kirakan kadar pemindahan haba diantara 2 m plat dan udara per 1m lebar plat.

[7 marks]

[7 markah]

QUESTION 3**SOALAN 3**

CLO1

- (a) Blackbody radiation is the thermal electromagnetic radiation within, or surrounding.

Radiasi jasad hitam adalah radiasi elektromagnetik termal dalaman, atau persekitaran.

- (i) Explain blackbody.

Terangkan jasad hitam.

[3 marks]

[3 markah]

- (ii) Explain electromagnetic spectrum.

Terangkan spektrum elektromagnetik.

[3 marks]

[3 markah]

CLO2

- (b) For a blackbody maintained at 115°C , calculate

Sinaran jasad hitam dikekalkan pada 115°C , kirakan

- (i) the total blackbody emissive power.

kuasa pancaran keseluruhan jasad hitam.

[4 marks]

[4 markah]

- (ii) the wavelength at which the maximum monochromatic emissive power occurs and the maximum monochromatic emissive power.

panjang gelombang di mana daya pancaran monokromatik maksimum berlaku dan kuasa pelepasan monokromatik maksimum.

[7 marks]

[7 markah]

- CLO2 (c) The glass window with 3 mm thickness has transmitted 95% of the radiation between 0.40 and 3.0 μm and is essentially opaque for radiation at other wavelength. Calculate the rate of radiation transmitted through a 3 m x 3 m glass window from blackbody source at 2000 K.

Tingkap kaca dengan ketebalan 3 mm telah menghantar 95% sinaran antara 0.4 dan 3.0 μm dan pada asasnya legap untuk sinaran pada panjang gelombang lain. Kirakan kadar sinaran yang dihantar melalui tingkap kaca 3 m x 3 m dari sumber jasad hitam pada 2000 K.

[8 marks]

[8 markah]

QUESTION 4**SOALAN 4**

CLO1

- (a) By using appropriate diagram, indicate parallel flow and counter flow in heat exchanger application.

Menggunakan rajah yang sesuai, tunjukkan aliran selari dan aliran berlawanan dalam aplikasi pemindah haba.

[4 marks]

[4 markah]

CLO1

- (b) Heat exchangers are devices that facilitate the exchange of heat between two fluids that are at different temperatures while keeping them from mixing with each other. There are two types of flow arrangement which are possible in a double-pipe heat exchanger.

Penukar haba ialah peranti yang memudahkan pertukaran haba antara dua cecair yang berada pada suhu yang berbeza disamping menghalang mereka daripada bercampur antara satu sama lain. Terdapat dua jenis susunan aliran yang mungkin dalam penukar haba dua berkembar.

- (i) Explain the fluid flow of the heat exchanger shown in **Figure 4(b)**.

*Terangkan aliran bendalir bagi pemindah haba dalam **Rajah 4(b)**.*

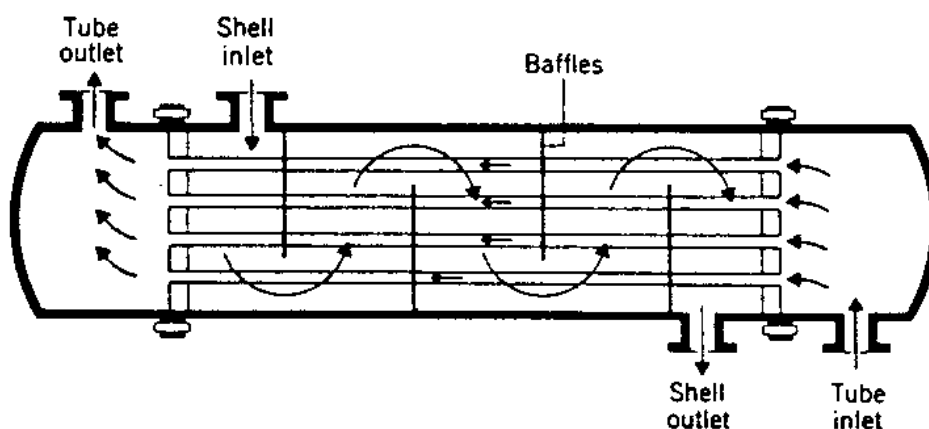


Figure 4(b) / Rajah 4(b)

[5 marks]

[5 markah]

- ii) The performance of heat exchangers usually deteriorates with time as a result of accumulation of deposits on heat transfer surfaces. Explain the thermal resistance due to fouling in a heat exchanger by considering the fluid velocity and temperature cause by the fouling.

Prestasi penukar haba biasanya merosot dengan masa disebabkan oleh pengumpulan mendapan pada permukaan pemindahan haba. Terangkan rintangan haba akibat kekotoran dalam penukar haba yang mengambil kira prestasi halaju bendalir dan suhu yang dipengaruhi kekotoran.

[5 marks]

[5 markah]

CLO2

- (c) A stream of hot oil ($C_p = 2.2 \text{ kJ/kg}^\circ\text{C}$) is cooled at a rate of 0.2 kg/s from temperature 150°C to 40°C in the tube side of a double-pipe counter-flow heat exchanger. Water ($C_p = 4.18 \text{ kJ/kg}^\circ\text{C}$) enters the heat exchanger at temperature 10°C with a rate of 0.15 kg/s . The outside diameter of the inner tube is 2.5 cm and its length is 6 m .

Aliran minyak panas ($C_p = 2.2 \text{ kJ/kg}^\circ\text{C}$) disejukkan pada kadar 0.2 kg/s daripada suhu 150°C kepada 40°C dibahagian dalam tiub penukar haba ganda dua aliran berlawanan. Air ($C_p = 4.18 \text{ kJ/kg}^\circ\text{C}$) memasuki penukar haba pada suhu 10°C dengan kadar 0.15 kg/s . Diameter luar tiub ialah 2.5 cm dan panjang 6 m .

- (i) Calculate the heat transfer rate and water outlet temperature.

Kirakan kadar pemindahan haba dan suhu air yang keluar.

[5 marks]

[5 markah]

- (ii) Calculate the overall heat transfer coefficient for the heat exchanger.

Kirakan pekali pemindahan haba keseluruhan bagi penukar haba.

[6 marks]

[6 markah]

SOALAN TAMAT