INSTRUCTION:

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

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) Heat transfer is a critical aspect of designing and analyzing a wide range of systems and engineering processes.

Pemindahan haba adalah aspek kritikal dalam mereka bentuk dan menganalisis pelbagai sistem dan proses kejuruteraan.

(i) Define the rate of heat transfer ($\dot{Q}$) and heat flux ($\dot{q}$**)**.

Takrifkan kadar pemindahan haba dan fluks haba.

[2 marks]

[*2 markah*]

CLO1 (ii) State the definition of blackbody and real body.

Nyatakan definisi jasad hitam dan jasad nyata.

[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 differences across the layer.

Terangkan hubungan antara kadar pengaliran haba melalui lapisan kawasan, ketebalan dan perbezaan suhu merentas lapisan.

[4 marks]

[*4 markah*]

c) The theory of conduction is governed by several principles, mathematical formulations, and laws that describe how heat flows within solid materials.
Teori pengaliran dikawal oleh beberapa prinsip, rumusan matematik, dan undang-undang yang menerangkan bagaimana haba mengalir dalam bahan pepejal.

CLO2

(i) A brick wall that has dimensions of 500 cm x 600 cm with a thickness of 0.3 m and a thermal conductivity of 0.69 W/m·°C is maintained at the temperatures of 20 °C and 5 °C, respectively. Calculate the rate of heat transfer through the wall, in W.
Dinding bata yang mempunyai dimensi 500 cm x 600 cm dengan ketebalan 0.3 m dan kekonduksian terma 0.69 W/m·°C dikekalkan pada suhu 20 °C dan 5 °C, masing-masing. Hitung kadar pemindahan haba melalui dinding, dalam W.

[7 marks]
[*7 markah*]

CLO2

(ii) The wall of a house, 7 m wide and 6 m high is made from 0.3 m thick brick with k = 0.6 W/m.K. The surface temperature on the inside of the wall is 16 °C and that on the outside is 6 °C. Calculate the rate of heat transfer and the heat flux through the wall.
Dinding sebuah rumah, 7 m lebar dan 6 m tinggi diperbuat daripada bata setebal 0.3 m dengan k = 0.6 W/m.K. Suhu permukaan di bahagian dalam dinding ialah 16 °C dan di luar ialah 6 °C. Kirakan kadar pemindahan haba dan fluks haba melalui dinding.

[8 marks]
[*8 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Define the convection mechanism and the classification of convection mechanism.

Takrifkan mekanisme perolakan dan klasifikasi mekanisme perolakan.

[4 marks]

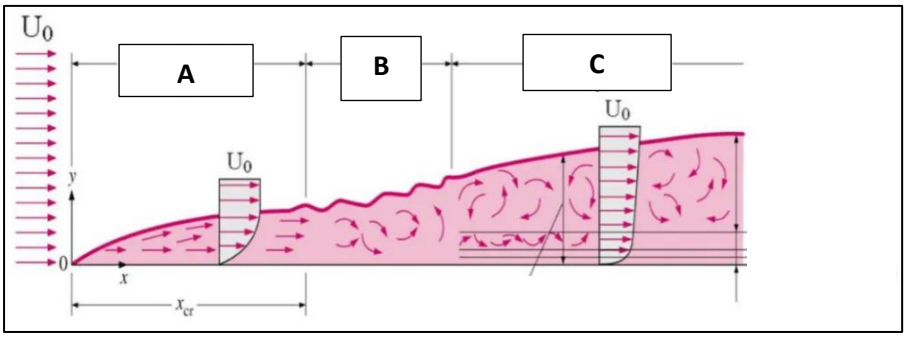
[*4 markah*]

(b) The velocity boundary layer is the region of fluids velocity that undergoes significant changes due to the surface.

Lapisan sempadan halaju ialah kawasan halaju bendalir yang mengalami perubahan ketara disebabkan oleh permukaan.

CLO1 (i) Fill in A, B and C with the correct region of fluid velocity.

Isikan halaju cecair di kawasan A, B dan C dengan betul.



[4 marks]

[*4markah*]

CLO1 (ii) Describe the fluid motion of laminar and turbulent flows.

Huraikan pergerakan bendalir aliran laminar dan bergelora.

[3 marks]

[*3 markah*]

(c) Materials engineers must understand the thermal conductivity, heat capacity, and thermal expansion of materials.

Jurutera bahan mesti memahami kekonduksian terma, kapasiti haba, dan pengembangan haba bahan.

CLO2

(i) Engine oil at 70 °C flows over a 1000 cm long flat plate which the temperature is 10 °C with a velocity of 2.5 m/s. Calculate the rate of heat transfer over the entire plate width per unit.

Minyak enjin pada 70 °C mengalir ke atas plat rata sepanjang 1000 cm yang suhunya ialah 10 °C dengan halaju 2.5 m/s. Kirakan kadar pemindahan haba ke atas keseluruhan plat per unit lebar.

[7 marks]

[*7 markah*]

CLO2

(ii) 25 cm diameter stainless steel ball (ρ = 8055 kg/m^3, Cp =480 J/kg·°C) is removed from the oven at a uniform temperature of 300°C. The ball is then subjected to the flow of air at 1 atm pressure and 25°C with a velocity of 3 m/s. The surface temperature of the ball eventually drops to 200°C. Calculate the convection heat transfer coefficient, h, $W/m^2.K$.

Bebola keluli tahan karat berdiameter 25 cm (ρ = 8055 kg/m^3, Cp =480 J/kg·°C) dikeluarkan dari ketuhar pada suhu seragam 300°C. Bola itu kemudiannya tertakluk kepada aliran udara pada tekanan 1 atm dan 25°C dengan halaju 3 m/s. Suhu permukaan bola akhirnya turun kepada 200°C. Kirakan pekali pemindahan haba perolakan, h, $W/m^2.K$.

[7 marks]

[*7 markah*]

QUESTION 3

SOALAN 3

CLO1 (a) Thermal radiation is a type of electromagnetic radiation that is emitted by a body due to its temperature.

Sinaran terma ialah sejenis sinaran elektromagnet yang dipancarkan oleh jasad kerana suhunya.

(i) Explain electromagnetic spectrum.

Terangkan spektrum elektromagnet.

[3 marks]

[*3 markah*]

CLO1 (ii) Discuss the blackbody and its existence in radiation.

Terangkan benda hitam dan kewujudannya dalam sinaran.

[3 marks]

[*3 markah*]

CLO2 (b) The radiation energy emitted by a light source reach a maximum in the blue range, $\lambda = 0.66$ μm. Calculate

Tenaga sinaran yang dipancarkan oleh sumber cahaya mencapai maksimum dalam julat biru, $\lambda = 0.66$ μm. Kirakan

(i) the temperature of this light source.

suhu sumber cahaya ini.

[4 marks]

[*4 markah*]

(ii) the fraction of radiation it emits in the visible range ($\lambda = 0.40 - 0.76$ μm).

pecahan sinaran yang dipancarkannya dalam julat yang boleh dilihat. ($\lambda = 0.40 - 0.76$ μm).

[7 marks]

[*7 markah*]

CLO2

(c) The temperature of filament of a lightbulb is 5000 K. Assume the filament is a blackbody, calculate the friction of the radiant energy emitted by the filament that falls in the visible range. The visible range of the electromagnetic spectrum extends from $\lambda_1 = 0.3$ μm to $\lambda_2 = 0.6$ μm.

Suhu filamen mentol lampu ialah 5000 K. Andaikan filamen itu ialah jasad hitam, kira geseran tenaga sinaran yang dipancarkan oleh filamen yang jatuh dalam julat yang boleh dilihat. Julat spektrum elektromagnet yang boleh dilihat menjangkau dari $\lambda_1 = 0.3$ *μm hingga* $\lambda_2 = 0.6$ *μm.*

[8 marks]

[*8 markah*]

QUESTION 4

SOALAN 4

CLO1 (a) Parallel flow and counter flow refer to the two primary configurations for heat exchangers, which are devices used to transfer heat between two fluids without mixing them. Give the diagram of counter flow in the heat exchanger.

Aliran selari dan aliran balas merujuk kepada dua konfigurasi utama untuk penukar haba, iaitu peranti yang digunakan untuk memindahkan haba antara dua cecair tanpa mencampurkannya. Berikan rajah aliran balas dalam penukar haba.

[4 marks]

[*4 markah*]

CLO1 (b) Thermal resistance due to fouling in a heat exchanger is a significant factor that can degrade the heat transfer efficiency.

Rintangan terma akibat kekotoran dalam penukar haba adalah faktor penting di mana ia merendahkan kecekapan pemindahan haba

(i) Explain the thermal resistance due to fouling in a heat exchanger accounted the performance and the relation between fluid velocity and temperature that affect the fouling.

Terangkan rintangan haba akibat kekotoran dalam penukar haba mengambil kira prestasi dan kaitan antara halaju bendalir dan suhu yang mempengaruhi kekotoran.

[5 marks]

[5 *markah*]

CLO1 (ii) Explain the characteristics of heat exchangers according to flow type.

Terangkan ciri-ciri penukar haba mengikut jenis aliran.

[5 marks]

[5 *markah*]

(c) A stream of hot oil (C_p = 2.2 kJ/kg. °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 kJ/kg. °C) enters the heat exchanger at a temperature of 10 °C with a rate, 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 kJ/kg. °C) disejukkan pada kadar 0.2 kg/s dari suhu 150 °C hingga 40 °C di bahagian tiub penukar haba aliran balas dua paip. Air (C_p = 4.18 kJ/kg. °C) memasuki penukar haba pada suhu 10 °C dengan kadar, 0.15 kg/s. Diameter luar tiub dalam ialah 2.5 cm dan panjangnya ialah 6 m.

CLO2

(i) Calculate the heat transfer rate and water outlet temperature.
Kirakan kadar pemindahan haba dan suhu keluar air. [5 marks]
[*5 markah*]

CLO2

(ii) Calculate the overall heat transfer coefficient for the heat exchanger.
Kirakan pekali pemindahan haba keseluruhan untuk penukar haba.
[6 marks]
[*6 markah*]

SOALAN TAMAT