



UNIVERSITI KUALA LUMPUR  
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

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**FINAL EXAMINATION**  
**OCTOBER 2025 SEMESTER**

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COURSE CODE : SCB37703  
COURSE TITLE : HEAT TRANSFER AND THERMAL MANAGEMENT  
PROGRAMME NAME : BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN  
MECHANICAL DESIGN  
DATE : 03 FEBRUARY 2026  
TIME : 9:00AM - 11:30AM  
DURATION : 2 HOURS 30 MINUTES

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**INSTRUCTIONS TO CANDIDATES**

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1. Please read the instructions given in the question paper **CAREFULLY**.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of **TWO** sections.
4. Answer **ALL** questions for Section A.
5. Section B consist of four questions. Answer **THREE (3)** questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet.  *Tick if applicable*
9. Refer to the attached Formula/ Appendies.  *Tick if applicable*

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THERE ARE 8 PAGES OF QUESTIONS INCLUDING THIS PAGE

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## SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

## Question 1

A double-pane window (0.8 m long and 0.5 m wide) consists of two pieces of glass 3-mm-thick that enclose an air space, 12-mm-thick. The thermal conductivity of the glass and air are  $k_g = 0.78 \text{ W/m}\cdot^\circ\text{C}$  and  $k_a = 0.026 \text{ W/m}\cdot^\circ\text{C}$  respectively. The window separates room air at  $24^\circ\text{C}$  from outside air at  $-5^\circ\text{C}$ . The convection coefficient associated with the inner (room-side) surface,  $h_1$  is  $10 \text{ W/m}^2\cdot^\circ\text{C}$  and the one associated with the outer air is  $h_2 = 25 \text{ W/m}^2\cdot^\circ\text{C}$ . Neglect radiation and assume the air enclosed between the panes to be stagnant.

Refer Below - Figure1 : Double-pane window .

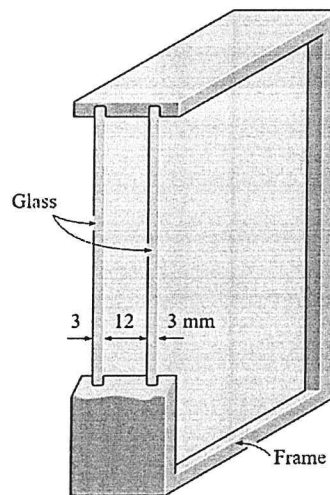


Figure 1: Double-pane window

- (a) Determine the rate of heat transfer through the window.

(15 marks)

- (b) Evaluate the inner and the outer surface temperatures of the window.

(5 marks)

**Question 2**

Answer the following questions.

- (a) State the Newton's Law of Cooling. Define each parameter in the equation and their units.

(5 marks)

- (b) In the following figure, air at 20°C flows with a velocity of 6 m/s over a 1.5 m x 6 m flat plate whose temperature is 140°C. Determine the rate of heat transfer and the total drag force on the plate if the air flows parallel to the 6-m long side.

*Refer Below - Figure2 : External convection of a flat plate .*

(15 marks)

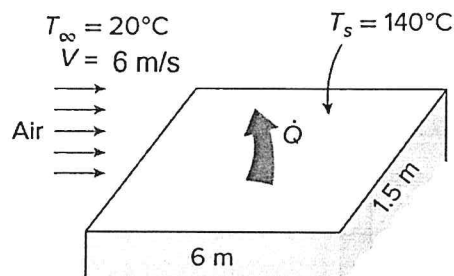


Figure 2: External convection of a flat plate

**SECTION B (Total: 60 marks)**

Answer **THREE (3)** questions only.

Please use the answer booklet provided.

**Question 1**

Answer the following questions.

- (a) Explain how fins enhance heat transfer from a surface. (2 marks)
- (b) Fins attached to a surface are determined to have an effectiveness of 0.8. Is the heat transfer rate from the surface has increased or decreased as a result of the addition of these fins? Justify your answer. (3 marks)
- (c) In the following figure, a plane wall with surface temperature of  $400^{\circ}\text{C}$  is attached with straight rectangular fins ( $k = 235 \text{ W/m}\cdot^{\circ}\text{C}$ ). The fins are exposed to an ambient air condition of  $20^{\circ}\text{C}$  and the convection heat transfer coefficient is  $180 \text{ W/m}^2\cdot^{\circ}\text{C}$ . Each fin has a length of 55 mm, thickness of 6 mm, and a width of 80 mm. Determine:  
*Refer Below - Figure3 : Rectangular fin .*

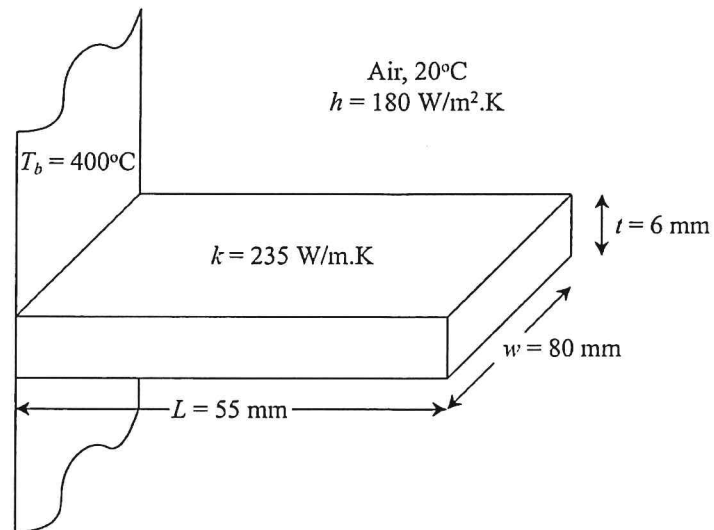


Figure 3: Rectangular fin

- i. The efficiency of each fin. (4 marks)
- ii. The heat transfer rate of the fin. (4 marks)
- iii. The effectiveness of the fin. (4 marks)
- iv. The increase of heat transfer due to the addition of fins. (3 marks)

## Question 2

Answer the following questions.

- (a) Differentiate between internal flow and external flow.

(2 marks)

- (b) Consider a 2-cm-diameter and 4-m-long smooth tube that is used for heating fluids (refer the following figure). The wall is heated electrically to provide a constant surface heat flux along the entire tube. Water enters the tube at 15°C and exits at 65°C. If the mass flowrate is maintained at 0.02 kg/s, determine:

*Refer Below - Figure4 : Internal convection of a tube .*

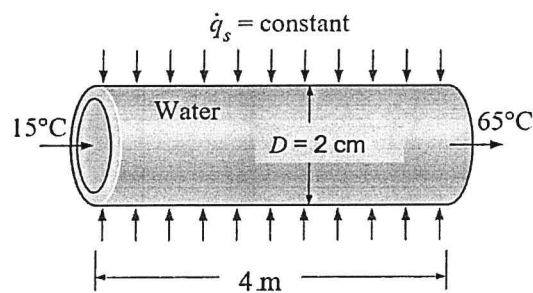


Figure 4: Internal convection of a tube

- i. The thermal entry length.

(8 marks)

- ii. The convection heat transfer coefficient for the water flow inside the tube.

(6 marks)

- iii. The tube surface temperature at the exit.

(4 marks)

**Question 3**

Answer the following questions.

- (a) Illustrate the difference between these types of heat exchangers: parallel-flow heat exchangers, counter-flow heat exchangers and cross-flow heat exchangers.

(6 marks)

- (b) In the following figure, a double-pipe counter-flow heat exchanger is to cool ethylene glycol ( $c_p = 2560 \text{ J/kg}\cdot^\circ\text{C}$ ) flowing at a rate of  $2.5 \text{ kg/s}$  from  $85^\circ\text{C}$  to  $35^\circ\text{C}$  by water ( $c_p = 4180 \text{ J/kg}\cdot^\circ\text{C}$ ) that enters at  $20^\circ\text{C}$  and leaves at  $60^\circ\text{C}$ . The overall heat transfer coefficient based on the inner surface area of the tube is  $300 \text{ W/m}^2\cdot^\circ\text{C}$ . The inner tube is thin-walled and has a diameter of  $1.5 \text{ cm}$ .

*Refer Below - Figure5 : Double-pipe heat exchanger .*

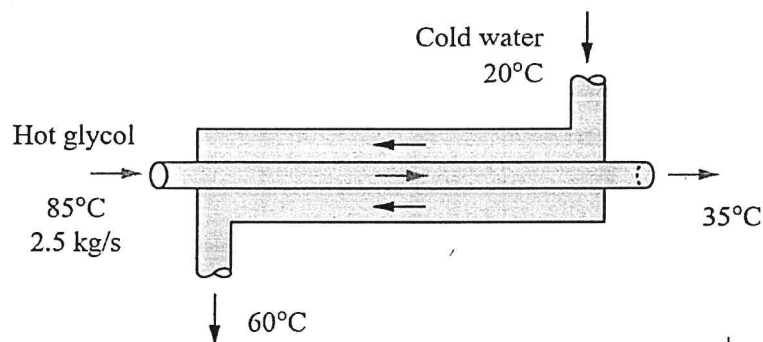


Figure 5: Double-pipe heat exchanger

- i. Determine the mass flow rate of water.
 

(4 marks)
- ii. Evaluate the length of the heat exchanger required to achieve the desired cooling using the LMTD method.
 

(8 marks)
- iii. If the flow of the fluids is parallel, would your answer in part (b)(ii) increases or decreases? Justify.
 

(2 marks)

**Question 4**

In the following figure, hot oil ( $c_p = 2130 \text{ J/kg}\cdot^\circ\text{C}$ ) is to be cooled by water ( $c_p = 4180 \text{ J/kg}\cdot^\circ\text{C}$ ) in a 1-shell-passes and 8-tube-passes heat exchanger. The tubes are thin walled and are made of copper with a diameter of 1.2 cm. The length of each tube pass in the heat exchanger is 6 m, and the overall heat transfer coefficient is  $280 \text{ W/m}^2\cdot^\circ\text{C}$ . Water flows through the tubes at a total rate of 0.15 kg/s and the oil through the shell at a rate of 0.25 kg/s. The water and the oil enter at temperatures  $20^\circ\text{C}$  and  $150^\circ\text{C}$  respectively. Using the  $\epsilon$ -NTU method, determine:

*Refer Below - Figure6 : 1-shell and 8-tube-passes heat exchanger .*

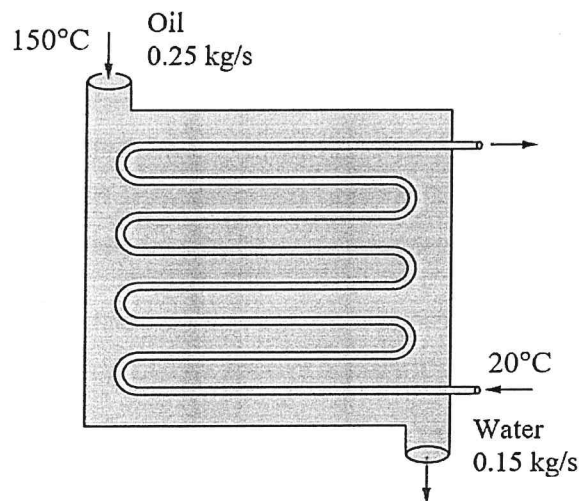


Figure 6: 1-shell and 8-tube-passes heat exchanger

- (a) the rate of heat transfer.

(16 marks)

- (b) the outlet temperatures of the water and the oil.

(4 marks)

**END OF EXAMINATION PAPER**



**APPENDIX – ADDENDUM**  
**SCB37703 HEAT TRANSFER & THERMAL MANAGEMENT**

Overall Fin Analysis

$$\begin{aligned}\dot{Q}_{fin} &= \eta_{fin} \times h \times A_{fin} \times (T_b - T_\infty) \\ \dot{Q}_{unfin} &= h \times A_{unfin} \times (T_b - T_\infty) \\ \dot{Q}_{nofin} &= h \times A_{nofin} \times (T_b - T_\infty) \\ \dot{Q}_{total,fin} &= \dot{Q}_{fin} + \dot{Q}_{unfin} \\ \epsilon_{overall} &= \frac{\dot{Q}_{total,fin}}{\dot{Q}_{nofin}}\end{aligned}$$

Internal Forced Convection

$$\begin{aligned}\dot{m} &= \rho \times A_c \times V = \rho \times \dot{V} \\ \dot{V} &= A_c \times V\end{aligned}$$

$\dot{m}$  = mass flow rate (kg/s)  
 $\dot{V}$  = volumetric flow rate (m<sup>3</sup>/s)

Heat Exchanger

$$\begin{aligned}\dot{Q}_h &= (\dot{m} \times c_p)_h (T_{h,in} - T_{h,out}) \\ \dot{Q}_c &= (\dot{m} \times c_p)_c (T_{c,out} - T_{c,in})\end{aligned}$$

Table for LMTD Method

	Fluid	Mass flow rate, $\dot{m}$	Sp. Heat capacity, $c_p$	$C = \dot{m} \times c_p$	$T_{in}$	$T_{out}$	$\dot{Q}$
HOT							
COLD							

Table for  $\epsilon$ -NTU Method

	Fluid	Mass flow rate, $\dot{m}$	Sp. Heat capacity, $c_p$	$C = \dot{m} \times c_p$	$C_{min}$ OR $C_{max}$	$T_{in}$	$\dot{Q}_{max} = C_{min} (T_{h,in} - T_{c,in})$
HOT							
COLD							

