

Total No. of Questions : [06]

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Paper code	V482-261D(ESE)
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**MAY 2022 - ENDSEM EXAM**  
**B. TECH. (MECHANICAL) (SEMESTER - II)**  
**COURSE NAME: DESIGN OF THERMAL SYSTEM**  
**COURSE CODE: MEUA40181D**  
**(PATTERN 2018)**

Time: [1 Hr]

[Max. Marks: 30]

**Instructions to candidates:**

- 1) Answer Q.1 OR Q.2, Q.3 OR Q.4, Q.5 OR Q.6.
- 2) Figures to the right indicate full marks.
- 3) Use of a scientific calculator is allowed
- 4) Use suitable data wherever required

**Q.1) a)** What are the methods to augment heat transfer rate without using any auxiliary power supply? [4]

- b)** The engine cylinder of a motorcycle is constructed of ( $k = 150 \text{ W/mK}$ ) aluminium alloy and is of height  $H = 0.3 \text{ m}$  and outside diameter  $D = 50 \text{ mm}$ . Under typical operating conditions, the outer surface of the cylinder is at a temperature of  $415 \text{ K}$  and is exposed to ambient air at  $305 \text{ K}$ , with a convection coefficient of  $65 \text{ W/m}^2\text{-K}$ . Annular fins are integrally cast with the cylinder to increase heat transfer to the surroundings. Consider Ten such fins, which are of thickness  $t = 6 \text{ mm}$ , length  $L = 20 \text{ mm}$ , and equally spaced. What is the heat transfer due to the use of the fins? [6]

**OR**

**Q.2) a)** Why the fins are always attached to the outer surface of the cylinder? How it increase the heat transfer rate? [4]

- b)** A metal rod ( $k = 73 \text{ W/m-deg}$ )  $2.55 \text{ cm}$  in diameter and  $9 \text{ cm}$  long protrudes from a wall which is maintained at  $250^\circ\text{C}$ . The rod is insulated at the tip and exposed to the environment of  $33^\circ\text{C}$  and  $h = 55 \text{ W/m}^2\text{-deg}$ . Estimate fin efficiency and temperature at the tip of the fin. [6]

**Q.3) a)** Discuss the manufacturing methods available for plate-fin heat exchangers elaborate anyone. [4]

- b) Air enters the core of a finned-tube heat exchanger of the type shown in the accompanying figure ( $\sigma = 0.494, D_h = 0.48 \text{ cm}$ ) at 1 atm and  $30^\circ\text{C}$ . The air flows at a rate of  $1555 \text{ kg/hr}$  perpendicular to the tubes and exits with a mean temperature of  $95^\circ\text{C}$ . The core is  $0.4 \text{ m}$  in length with a  $0.2 \text{ m}^2$  frontal area. Air density at inlet =  $1.177 \text{ kg/m}^3$ , Air density at outlet =  $0.954 \text{ kg/m}^3$ ,  $\mu \text{ (kg/ms)} = 1.92 \times 10^{-5}$ ,  $\text{Pr} = 0.72$ ,  $\text{Cp} = 1.005 \text{ kJ/kg K}$ . Evaluate the average heat transfer coefficient on the airside.

[6]

OR

- Q.4) a) In the plate-fin type of heat exchanger what different structures of fins are used. [4]

- b) Air at 1 atmosphere and  $330 \text{ K}$  flows with a velocity of  $u_\infty = 15 \text{ m/s}$  across plain fins in a plate and fin heat exchanger with the following dimensions  $\sigma$  (Free flow area / Frontal area) =  $0.52$ , Hydraulic diameter  $D_h = 0.178 \text{ cm}$ , Friction factor  $f = 0.035$ ,  $L/D_h = 5$ . Air properties at the bulk mean temperature of  $330 \text{ K}$  are:

$\rho \left( \frac{\text{kg}}{\text{m}^3} \right)$	$k \left( \frac{\text{W}}{\text{m.K}} \right)$	$C_p \left( \frac{\text{J}}{\text{kg.K}} \right)$	$\mu \left( \frac{\text{N}}{\text{m}^2.\text{s}} \right)$	Pr
0.6157	0.0390	1047	$2.95 \times 10^{-5}$	0.68

Investigate the core pressure drop in the heat exchanger (in  $\text{Pa}$ ) [6]

- Q.5) a) Justify the statement "The performance of the Phase changer heat exchangers in terms LMTD is independent of the direction of the fluid" [4]

- b) A Shell and Tube heat exchanger act as a condenser have 80 tubes. For inline arrangement, 8 columns can be considered with 10 tubes in each column. For the Staggered arrangement, the number of columns is 11 and the number of tubes in each column is 7. Estimate the average shell side heat transfer coefficient for each of the configurations [ by using Nusselt correlation]. The heat transfer coefficient of the first tube is  $1625 \text{ W/m}^2\text{K}$ . Also, Calculate the heat transfer coefficient of the 5<sup>th</sup> tube for an inline arrangement (Use Nusselt and Kern relationship ) [6]

OR

- Q.6) a) Explain the different types of Evaporators with the application. [4]

- b) In a steam condenser there are 2500 numbers of tubes with  $30 \text{ mm}$  diameter. Cooling water ( $\text{Cp} = 4.187 \text{ kJ/kg K}$ ) enters the tubes at  $15^\circ\text{C}$  with a mass flow rate of  $2500 \text{ kg/s}$ . The steam condenses at  $65^\circ\text{C}$ , and the condenser load is  $180 \text{ MW}$ . The latent heat of steam is  $2380 \text{ kJ/kg}$ . Assuming a counter-flow arrangement, Determine the length of the tube. The overall heat transfer coefficient is  $7000 \text{ W/m}^2\text{C}$ . [6]

May 2022 - ENUSTC EXAM  
 B-Tech (Mechanical): Design of thermal system  
 Course Code: MEUA40181D.

Chart for 1b

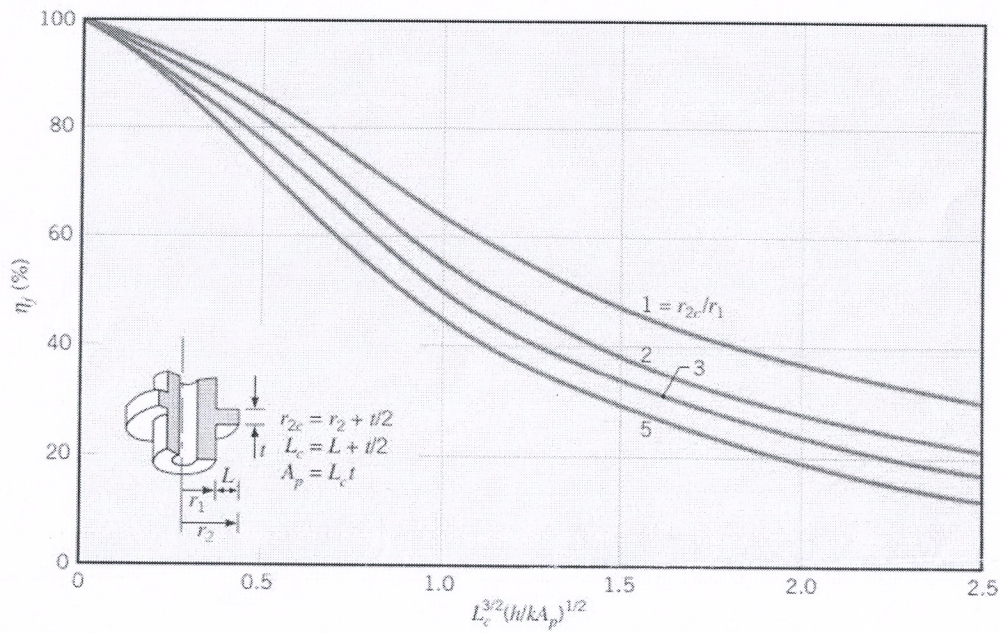


Chart for 3 b

