Total No. of Questions – [06] Total No. of Printed Pages: 3

G.R. No.	

DECEMBER 2021 - ENDSEM EXAM
B. TECH. (MECHANICAL) (SEMESTER - I)
COURSE NAME: DESIGN OF THERMAL SYSTEM
COURSE CODE: MEUA40181D
(PATTERN 2018)

Time: [1 hour] [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 scientific calculator is allowed**
4) **Use suitable data wherever required**

Q.1) a) Compare the different Passive techniques of heat transfer augmentation. [4 marks]

b) The Metal block is made up of Aluminum (k= 100 w/mK) of a height of 20 mm and a length of 40 mm. The surface temperature of a metal block is 400 ^{0}C exposed to ambient air of 27 ^{0} C with a heat transfer coefficient h= 35 w/m^{2}K. Rectangular fins are casted to the metal block to increase heat transfer to the surroundings. Consider 10 such fins of thickness 4 mm and length 25 mm, evaluate heat transfer to the surrounding with the fins? Consider Area of single fin (A_f)= 0.01 m^2 and total area of flow (A_t) =0.07 m^2 (Chart is attached) [6 marks]

OR

Q.2) a) Sketch at least 4 types of extended surface and discuss how extended surface increases heat transfer rate. [4 marks]

b) A metal rod (k= 50 W/m-deg) 1.5 cm in diameter and 6 cm long protrudes from a wall which is maintained at 125 ^{0}C. The rod is insulated at the tip and exposed to the environment of 27^{0}C and h= 45 W/m2-deg. Estimate fin efficiency and temperature at the tip of the fin. [6 marks]

Q.3) a) Differentiate the manufacture methods available for plate-fin heat exchanger. [4 marks]

b) Air enters the core of a finned-tube heat exchanger of the type shown in the accompanying figure (σ = 0.39,D_h = 0.52 cm) at 1 atm and 27 ^{0}C. The air flows at a rate of 1500 kg/hr perpendicular to the tubes and exits with a mean temperature of 90 ^{0}C. The core is 0.4 m long with a 0.2 m^2 frontal area. Air density at inlet = 1.177 kg/m^3 , Air density at outlet = 0.954 kg/m^3, μ (kg/ms)= 1.92 x 10^{-5} , Pr= 0.68, Cp= 1.005 kJ/kg K. Evaluate the average heat transfer coefficient on the air side.(Chart is attached) [6 marks]

OR

Q.4) a) Compare the different types of fins used in the plate-fin type of heat exchanger.

[4 marks]

b) Air at 1 atmosphere and 300 K flows with a velocity of u_∞ = 10 m/s across plain fins in a plate and fin heat exchanger with the following dimensions
σ (Free flow area / Frontal area) = 0.4, Hydraulic diameter Dh = 0.152 cm, Friction factor f = 0.030, L/D_h = 5. Air properties at the bulk mean temperature of 300 K are:

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

Investigate the core pressure drop in the heat exchanger (in Pa)

[6 marks]

Q.5) a) Justify the statement "The performance of the condenser and evaporator in terms LMTD is independent of the direction of the fluid" [4 marks]

b) Steam is condensing under quiescent conditions on the shell side of a bundle of 55 tubes. The bundle can be configured in a square inline arrangement or in a triangular staggered arrangement. For inline arrangement, 8 columns can be considered as 7 tubes in each column. For the Staggered arrangement, the number of columns is 11 and the number of tubes in each column is 5. Estimate average shell side heat transfer coefficient for each of the configurations [by using Nusselt correlation]. The heat transfer coefficient of the first tube is 1550 w/m^{2}K. Also, Calculate the heat transfer coefficient of the 5th tube for an inline arrangement (Use Nusselt and Kern relationship)

[6 marks]

OR

Q.6) a) Discuss the working of surface heat exchanger used in stream power plant.

[4 marks]

b) A steam condenser consists of 3000 brass tubes of 20mm diameter. Cooling water (Cp =4.187 kJ/kg K) enters the tubes at 20°C with a mass flow rate of 3000kg/s. The overall heat transfer coefficient is 6525.4 W/m^2°C. The steam condenses at 50°C, and the condenser load is 230MW. The latent heat of steam is 2380kJ/kg. Assuming counter-flow arrangement, Determine the length of the tube.

[6 marks]

Chart for 1b

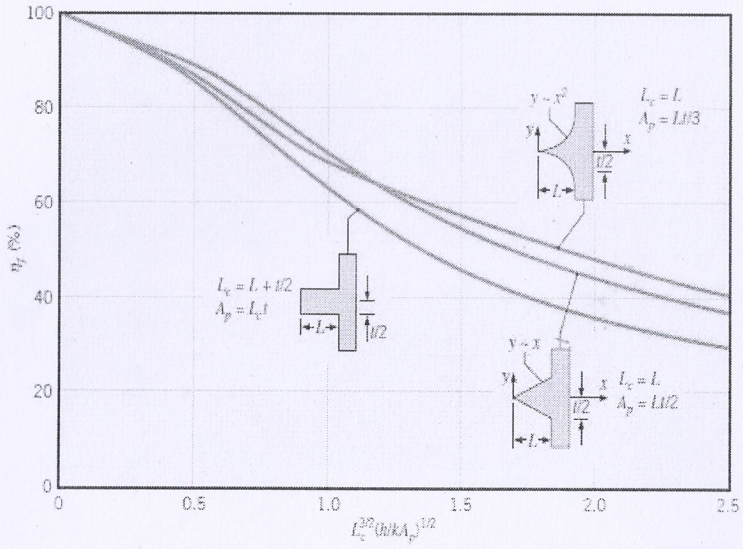

Chart for 3b