Total No. of Printed Pages:03

SUBJECT CODE NO: H-1859
FACULTY OF SCIENCE AND TECHNOLOGY
M.E. (Mechanical)
El-2 Advanced Heat Transfer
(REVISED)

[Time: Three Hours] **[Max.Marks:80]**

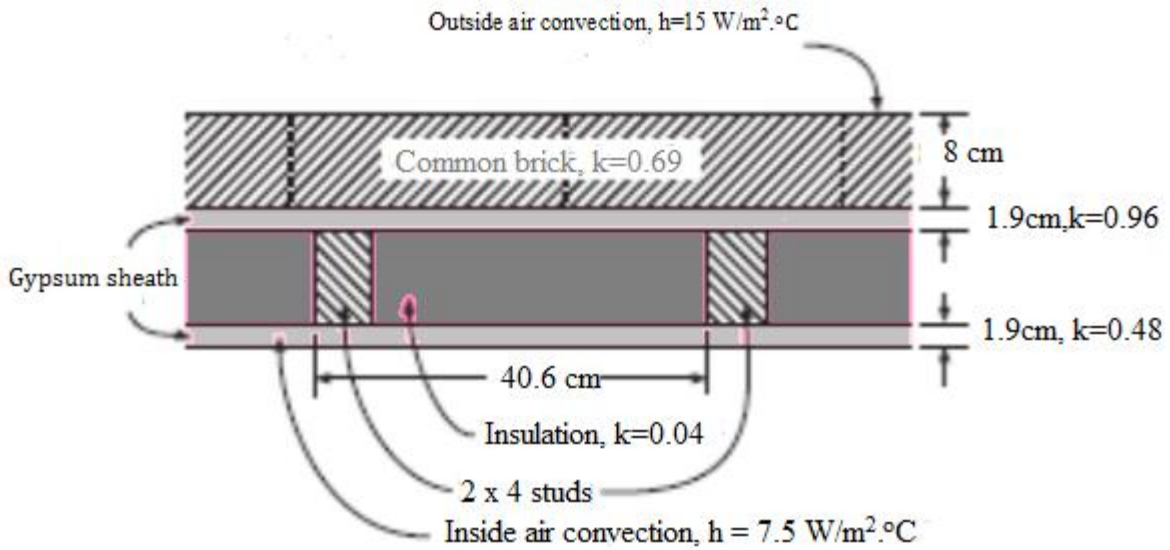
Please check whether you have got the right question paper.

N.B
i. Solve any three questions from each section.
ii. Figures to the right indicate full marks.
iii. Assume suitable data, if necessary.
iv. Use of non-programmable calculator is allowed.
v. Use of heat transfer data book and steam table are permitted.

SECTION – A

Q.1 a) State the basic laws of heat conduction, convection and radiation with practical example of each. 06

b) "Two – by – four" wood studs have actual dimensions of 4.13×9.21 cm and a thermal conductivity of 0.1 W/m℃. A typical wall for a house is constructed as shown figure below. Calculate the overall heat – transfer coefficient and R value of the wall. 08



Q.2 a) Compare the temperature distributions in a straight cylindrical rod having a diameter of 2 cm and a length of 10 cm and exposed to a convection environment with $h = 25 W/m^2$℃, for three fin materials: copper [$k = 385\ W/m$℃], stainless steel [$k = 17\ W/m.$℃], and glass [$k = 0.8\ W/m.$℃], Also compare the relative heat flows and fin efficiencies. 07

b) Write short note on 'conduction shape factor'. 06

Q.3 a) Consider a 0.8-m-high and 1.5-m-wide glass window with a thickness of 8 mm and a thermal conductivity of $k = 0.78\ W/m$℃. Determine the steady rate of heat transfer through this glass window and the temperature of its inner surface for a day during which the room is maintained at 20℃ while the temperature of the outdoors is −10℃. Take the heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10\ W/m^2$ ℃ $and\ h^2 = 40\ W/m^2$ ℃, which includes the effects of radiation. 07

b) Explain the Lumped heat capacity analysis. 06

Q.4 a) Explain the difference between the thermal boundary layer and hydrodynamic boundary layer with diagram. 06

b) A 6-m-long section of an 8-cm-diameter horizontal hot water pipe passes through a large room whose temperature is 20℃. If the outersurface temperature of the pipe is 70℃, determine the rate of heat loss from the pipe by natural convection. 07

The properties of air at the film temperature of $T_f = 45$℃ and 1 atm are

$k = 0.02699 W/m$℃ $Pr = 0.7241$ $v = 1.749 \times 10^{-5} m^2/s.$

SECTION – B

Q.5 a) How are the average frictions and heat transfer coefficients determined in flow over a flat plate? 06

b) A 25-cm-diameter stainless steel ball ($\rho = 8055\ kg/m^3, C_p = 480\ J/kg.$℃) is removed from the oven at a uniform temperature of 300℃. The ball is then subjected to the flow of air at 1 atm pressure and 25℃ with a velocity of 3 m/s, the surface temperature of the ball eventually drops to 200^0C. Determine the average convection heat transfer coefficient during this cooling process and estimate how long the process will take. 08

The dynamic viscosity of air at the average surface temperature is

$\mu_s = \mu_{@250℃} = 2.76 \times 10^{-5} kg/m.s.$

The properties of air at the free-stream temperature of 25℃ and 1 atm are

$k = 0.02551\ W/m.$℃ $v = 1.562 \times 10^{-5} m^2/s$

$\mu = 1.849 \times 10^{-5} kg/m.s$ $Pr = 0.7296$

Q.6 a) Draw the flow boiling curve and explain each regime of flow boiling. 07

b) What is the difference between pool boiling and flow boiling? 06

Q.7 a) Write note on 'design consideration of heat pipe'. 06

b) Consider the $5 - m \times 5 - m \times 5 - m$ cubical furnace, whose surfaces closely approximate black surfaces. The base, top, and side surfaces of the furnace are maintained at uniform temperatures of 800K, 1500K and 500 K, respectively. Determine (a) the net rate of radiation heat transfer between the base and the side surfaces, (b) the net rate of radiation heat transfer between the base and the top surface, and (c) the net radiation heat transfer from the base surface. 07

Q.8 a) Distinguish between specular and diffuse surfaces. 06

b) A mercury-in-glass thermometer having $\varepsilon = 0.9$ hangs in a metal building and indicates a temperature of 20℃. The walls of the building are poorly insulated and have a temperature of 5℃. The value of h for the thermometer may be taken as 8.3 W/m^2 ℃. Calculate the true air temperature. 07