Total No. of Printed Pages:03

SUBJECT CODE NO: H-124
FACULTY OF ENGINEERING AND TECHNOLOGY
T.E. (Mechanical)
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. Figure to the right indicate full marks.
iii. Assume suitable data, if necessary.
iv. Use of non-programmable calculator is allowed.

Section A

Q.1 a) Derive the equation for temperature distribution and heat transfer rate, under one dimensional steady state heat conduction, for hollow cylinder. 06

b) A pipe ($k = 180\ W/m℃$) having inner and outer diameters 80mm and 100mm respectively is located in a space at 25℃ . Hot gases at temperature 160℃ flow through the pipe. Neglecting surface heat transfer coefficients, calculate: 07
i) The heat loss through the pipe per unit length.
ii) The temperature at a point halfway between the inner and outer surfaces.

Q.2 a) Hot air at a temperature of 65℃ is flowing through a steel pipe of 120mm diameter. The pipe is covered with two layers of different insulating materials of thickness 60mm and 40mm and their corresponding thermal conductivities are 0.24 and $0.4W/m℃$. The inside and outside heat transfer coefficients are $60W/m^2\ ℃$ and $12W/m^2\ ℃$. The atmosphere is at 20℃, find the rate of heat loss from 60m length of pipe. 07

b) Derive the expression for critical thickness of insulation for a cylinder. 06

Q.3 a) Starting with boundary conditions, derive the expressions for temperature distribution along the length and heat flow rate for a very long fin using standard notations. 06

b) A longitudinal copper fin ($k = 300\ W/m℃$) 600mm long and 5mm diameter is exposed to air stream at 20℃. The convective heat transfer coefficient is $20W/m^2\ ℃$. If the fin base temperature is 150℃ , determine: 07
i) The heat transferred and
ii) The efficiency of the fin.

Q.4 a) 4800 kg/hr of water is heated from 30℃ to 60℃ by passing through a square duct of 30mm × 30mm. The duct is heated by condensing steam at 100℃ on its outer surface. Find the length of the duct required. 07

Take properties of water: Density = 995 kg/m^3 ; $\mu = 7.65 \times 10^{-4}$ kg/ms ; Cp = 4.174 kJ/kgK, k = 0.623 W/m℃ , conductivity of duct material = 24 W/mK.

Use : $Nu = 0.023\ Re^{0.8}\ Pr^{0.4}$ for turbulent flow

$Nu = 4.36$ for laminar flow.

b) Differentiate between Hydrodynamic boundary layer and Thermal boundary layer. 06

Q.5 Write short notes on (Any two) 14

i) Variable thermal conductivity
ii) Heat conduction through composite slab
iii) Grashoff Number & its significance

Section B

Q.6 a) Explain film and drop wise condensation. 06

b) Explain with figure forced convection boiling. 07

Q.7 a) State and explain Wien's displacement law. 06

b) Two large parallel plates with $\varepsilon = 0.5$ each, are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. 07

Q.8 a) A chemical (specific heat = 3.2 kJ/kg K) enters a parallel flow heat exchanger at 150℃ at a flow rate of 30,000kg/hr. Cooling water (specific heat = 4187 J/kg K) enters the heat exchanger at 20℃ at a flow rate of 1000kg/min. Heat transfer area of the heat exchanger is $12m^2$. Over all heat transfer coefficient can be taken as 1000W $/m^2$ K. Find the effectiveness of the heat exchanger and outlet temperatures of both chemical and water. 07

b) Derive LMTD for counter flow heat exchanger, 06

Q.9 a) Explain intensity of radiation and lambert's cosine law. 06

b) An oil cooler for a lubrication system has to cool 1000 kg/h of oil ($cp = 2.09$ kJ/kg℃) from 80℃ to 40℃ by using a cooling water flow of 1000 kg/h at 30℃. Give you choice for a parallel or counter flow heat exchanger, with reasons. Calculate the surface area of the heat exchanger, if the overall heat transfer coefficient is 24 W/m^2 ℃. 07

Q.10 Write explanatory notes on: (Any two) 14

i. Types of heat exchanger
ii. Radiation shield
iii. Shape factor