Total No. of Printed Pages:2

SUBJECT CODE NO:- P-234
FACULTY OF ENGINEERING AND TECHNOLOGY
T.E.(MECH) Examination May/June 2017
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 and data – book is allowed.

Section A

Q.1 a) Derive general heat conduction equation in Cartesian coordinates. Under what condition does this gets reduced to Laplace equation. 06

b) A hollow copper sphere has outer radius 5cm. The internal temperature gradient may be assumed to be negligible and the temperature of sphere is to be maintained at 100°C by an embedded electric heater. It is proposed to reduce the heat loss by providing a layer of insulation at the outer surface$\left(K = \frac{0.5W}{MK}\right)$. A housewife says to her engineer husband "evon a 1cm thick layer can reduce the heat loss and 5cm thick layer can reduce it by about 50%." The husband calls the statement "wrong". Whose side of argument do you take? How will you convince the other party with the help of calculations? Assume outside air at 20°C. Unit surface conductance at the outer surface= $10W\ /m^2K$. 07

Q.2 a) Explain effectiveness and efficiency of fins. 06

b) A steel tube carries steam at a temperature of 320°C. A thermometer pocket of iron ($K = 52.3\ W/\ m$°C) of inside diameter 15mm and 1mm thick is used to measure the temperature. The error to be tolerated is 1.5% of maximum. Estimate the length of the pocket necessary to measure the temperature within this error. The diameter of the steel tube is 95mm. assume $h = 93\ W\ /m^2$°C and tube wall temperature is 120°C suggest a suitable method of locating the thermometer pocket. 07

Q.3 a) Discuss the difference between thermal and hydrodynamic boundary layer. 06

b) A vertical cylinder 1.5m high and 180mm in diameter is maintained at 100°C in an atmosphere environment of 20°C. Calculate heat loss by free convection from the surface of cylinder. Assume properties of air at mean temperature as $ρ = 1.06\ \frac{kg}{m^3}$, $\vartheta = 18.97\ \times 10^{-6}\ m^2/s$ $Cp = 1.004\ KJ\ /\ Kg$°C and $K = 0.1042\ W\ /m$°C 07

Q.4 a) Explain the mechanisms of conduction, convoction and radiation with suitable examples. 06

b) Hot air at a temperature of 60°C is flowing through a steel pipe of 10cm diameter. The pipe is covered with two layers of different insulating materials of thickness 5cm and 3cm and their corresponding. Thermal conductivity $are\ 0.23\frac{W}{MK}$ and$0.37\ \frac{W}{Mk}$. The ambient temperature is 25°C. Find the rate of heat loss from 50cm length of pipe. Neglect resistance of steel pipe. Also find temperature at inner and outer surface. 07

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Q.5 Write short notes on only two. 14

a) Buckingham's π therem
b) Significance of Biot Number, Fourier number and Nusselt number.
c) Thermal contact resistance.

Section B

Q.6 a) Differentiate between filmwise and dropwise condensation. 06

b) Assuming the sun (diameter $=1.4 \times 10^9 m$) as a black body having a surface temperature of 5750K and at a mean distance. of $15 \times 10^{10} m$ from the earth (diameter $=12.8 \times 10^6 m$), estimate the following: 07

i. The total energy emitted by the sun.
ii. The emission received per m^2 just outside the atmosphere of the earth.
iii. The total energy received by the earth if no radiation is blocked by the atmosphere of the earth.

Q.7 a) State, prove and explain Weins displacement law. 06

b) For a hemispherical furnace, the flat floor is at 700K and has an emissivity of 0.5. The hemispherical roof is at 1000K and has a emissivity of 0.25. Find the net radiations heat transfer from roof to floor. 07

Q.8 a) Derive an expression for LMTD in counter flow heat exchanger. 06

b) A counter – flow heat exchanger is used to cool 3600 kg/hr of oil $(Cp = 2000\ J/kgK)$at 150°C with the help of water $(Cp = 4178\ J/kgK)$flowing at the rate of 3710kg/hr. Water enters at 298K. The overall heat transfer coefficient is 500 $\frac{W}{m^2K}$ and the surface area is$4.872\ m^2$. Calculate exit temperatures of oil & water. 07

Q.9 a) Draw temperature profile for hot and cold fluids for 06

i. Evaporator
ii. Condenser.

Also mention relations to calculate their effectiveness.

b) A double walled flask may be idealized to be equivalent to two infinite parallel plates. The emissivities of walls are 0.3 and 0.7 respectively. The space between them is evacuated. A shield of polished aluminum of $\epsilon = 0.05$ is inserted between them. Find the reduction in heat transfer due to insertion of radiation shield. 07

Q.10 Write short notes on any two 14

a) Pool Boiling Curve
b) Black, White and Grey body.
c) Fouling and Fouling Factor.

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