Total No. of Printed Pages:2

SUBJECT CODE : 33

FACULTY OF ENGINEERING AND TECHNOLOGY

T.E.(MECH) Examination Nov/Dec 2015

Heat Transfer

(Revised)

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

"Please check whether you have got the right question paper."

N.B
i) Attempt any three questions from each section.
ii) Use of data book, steam tables, Mollier charts, non-programmable calculator is allowed.
iii) Neat diagrams must be drawn wherever necessary.
iv) Figures to the right indicate full marks.
v) Assume suitable data, if necessary.

Section -A

Q.1 a) Derive general heat equation in Cartesian coordinate system. 08

b) A pipe (k = 180 W/m^{0}C)having inner and outer diameters 80mm and 100mm respectively is located in a space at 25^{0}C. Hot gases at temperature 160^{0}C flow through the pipe. Neglecting surface heat transfer coefficients, calculate: 05

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) Derive from fundamentals an expression for the critical radius of insulation for a cylinder. 08

b) An egg with mean diameter of 40mm and 20^{0}C is placed in a boiling water pan for 4 minutes and found to be boiled to the consumer's taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5^{0}c. Take the properties of egg as: k = 10 W/ m^{0}C. P =1200kg/m^3. C = 2 kJ/kg^{0}C and h (heat transfer coefficient)=100 W/ m^2 ^{0}C. Use lump theory. 05

Q.3 a) Derive the general form of the energy equation for one dimensional heat dissipation from an extended surface (rectangular fin) 08

b) Explain the advantages and limitations of dimensional analysis 05

Q.4 a) A castor oil at 25^{0}C flows at a velocity of 0.1 m/s past a flat, in a certain process. If the plate is 4.5m long and is maintained at a uniform temperature of 95^{0}C. Calculate the using exact solution: 08

i) The hydrodynamic and thermal boundary layer thickness on one side of the plate.

ii) The total drag force per unit width on one side of the plate.

iii) The local heat transfer coefficient at the trailing edge.

iv) The heat transfer rate. The thermo physical properties of oil at mean film temperature of (95+25)/2=60^{0}C are 'p' = 965.8kg/m3,
$'\alpha' = 7.2 \times 10^{-8} m^2/s$, $'k' = 0.213 W/m^0C$, $'v' = 0.65 \times 10^{-4} m^2/s$

b) A vertical slot of 20mm thickness is formed by two $25m \times 25m$ Square plates. If the temperature of the plates are 115^{0}C and 25^{0}C respectively. Calculate the following: 05

i) The effective thermal conductivity,

ii) The rate of heat flow through the slot.

Q.5 Write short notes on any TWO 14

a. Variable thermal conductivity
b. Fourier and Biot numbers
c. Empirical correlations for heat transfer in laminar flow over flat plate.

Section -B

Q.6 a) A nickel wire of 1 mm diameter and 400mm long, carrying current is submerged in a water bath which is open to atmospheric pressure. Calculate the voltage at the burnout point if at this point the wire carries a current of 190A. 05

b) Derive the Nusselt theory of laminar flow film condensation on a vertical plate. 08

Q.7 a) Explain intensity of radiation and lambert's cosine law. 08

b) The effective temperature of a body having an area of $0.12m^2$ is 527^0C. Calculate: 05

i) The total rate of energy emission,

ii) The intensity of normal radiation,

iii) The wavelength of maximum monochromatic emissive power.

Q.8 a) A truncated cone has top and bottom diameter of 10 and 20cm height of 10 cm. Calculate the shape factor between the top surface and the side and also the shape factor between the side and itself. The fraction of radiation leaving the top surface which is intercepted by the bottom surface is 0.12. 08

b) Explain the shape factor algebra and silent features of the shape factor. 05

Q.9 a) Derive LMTD for parallel flow. 08

b) An oil cooler for a lubrication system has to cool 1000kg/h of oil (cp = 2.09 kJ/kg^0C) from 80^0C to 40^0C by using a cooling water flow of 1000kg/h at 30^0C. 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 05

24 $W/m^2\,^0C$.

Q.10 Write explanatory notes on any TWO: 14

a. Wien's displacement law

b. The effectiveness –NTU method for counter flow heat exchanger

c. Types of heat exchanger.