Total No. of Questions : 10]

SEAT No. :

**P2489**

[Total No. of Pages : 4

# [5253]-507
## T.E. (Mechanial)
## HEAT TRANSFER
## (2015 Pattern)

*Time : 2.30 Hours]* *[Max. Marks : 70*

***Instructions to the candidates:***

1) *Assume suitable data if necessary.*
2) *Figure to the right indicate full marks.*
3) *Use of scientific calculator is allowed.*

***Q1)*** a) Derive three Dimensional general heat conduction equation in Cartesian co-ordinates for an isotropic material for unsteady state condition with uniform internal heat generation. **[7]**

b) What is unsteady state? Define internal temperature gradient. When it can be neglected? **[3]**

OR

***Q2)*** a) An electric conductor of 10mm diameter insulated by PVC (k = 0.18 W/mK) is located in air at 30° C. The air has convective heat transfer coefficient of 7.8 W/m²K. If the surface temperature of base conductor is 85° C, calculate- i) Current carrying capacity of conductor when 2 mm thick insulation is provided. Resistivity of conductor is $70 \times 10^{-8}\ \Omega$ m ii) Critical Insulation thickness iii) Maximum current carrying capacity iv) Percentage increase in current carrying capacity by providing critical insulation. **[7]**

b) What is insulated Boundary Condition? Explain with diagram. **[3]**

***Q3)*** a) Explain time constant and response of thermocouple. **[4]**

b) What is Economical Thickness of Insulation? Explain with diagram. **[4]**

c) Explain different types of insulating materials. **[2]**

***P.T.O.***

OR

***Q4)*** a) One end of a long rod 3 cm in diameter is inserted into a furnace with the outer end projecting into the outside air. Once the steady state is reached the temperature of the rod is measured at two points, 15 cm apart and found to be 140° C and 100° C, when the atmospheric air is at 30° C with convection coefficient of 20 W/m² K. Calculate the thermal conductivity of the rod material. **[7]**

b) Explain difference between fin efficiency and fin effectiveness. **[3]**

***Q5)*** a) Explain the significance of following dimensionless Numbers : **[10]**

i) Prandtl Number

ii) Grashoff Number

iii) Reynold Number

iv) Nusselt Number

v) Biot Number

b) Explain with a neat sketch development of Hydrodynamic boundary layer and Thermal boundary layer assuming constant wall temperature, for fluid flow through a conduit. **[6]**

OR

***Q6)*** a) A refrigerated truck on the high way is moving at a speed of 90 km/hr in a desert area where the air temperature is 70° C. The body of a truck can be summed as rectangular box 9 m long, 3 m wide and 2 m high.

Consider the boundary layer is turbulent over all the surfaces and temperature of the surface is 10°C. Neglect the heat transfer from front and back end of the truck, find- **[10]**

i) Heat transfer coefficient for this situation.

ii) Heat loss per hour from the surface.

Data : $\rho = 1.128 kg/m^3$, $C_p = 1.007$ kJ/kg.K,

$\nu$ (Kinematic Viscosity) $= 16.96 \times 10^{-6}$ m²/sec, k = 0.027 W/mK

Use the following co relation -

$$N_u = 0.036\ R_e^{0.8.}\ Pr^{0.33}$$

b) What is the difference between Forced Convection and natural Convection. **[6]**

***Q7)*** a) Write a note on : **[6]**

i) Radiation Shape Factor

ii) Radiation Shield

b) Calculate all view factors for conical geometry shown in figure 1 Assume $F_{1-2} = 0.117$. **[10]**

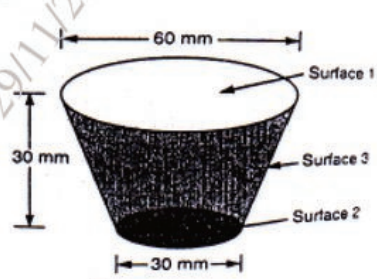


Figure 1

OR

***Q8)*** a) Write the statements and mathematical expressions of the following laws in radiation heat transfer - **[10]**

i) Plank's law

ii) Wien's law

iii) Kirchoff's law

iv) Lambert's cosine rule

v) Stefan's boltzman's law

b) What is a gray body? How does it differ from a black body? What is a diffuse gray surface? **[6]**

***Q9)*** a) Derive an expression for LMTD of counter flow heat exchanger. **[6]**

b) Compare Film wise and drop wise condensation. **[4]**

c) Water enters the tubs of a small single pass heat exchanger at 20°C and leaves at 40 °C on the shell side 25 Kg/min of steam condensed at 60 °C. Calculate the over all heat transfer coefficient and the required flow rate of water if the area of the exchanger is 12 $m^2$ (the latent heat of condensation of steam is 2358.7 kJ/kg.K at 60 °C) take specific heat of water as 4174 J/kg.K. **[8]**

OR

***Q10)***a) Explain the phenomenon of nucleate boiling. List the factors that affect nucleate boiling. **[4]**

b) Derive an expression for effectiveness of parallel flow heat exchanger. **[6]**

c) What is design and selection criteria for heat exchanger? **[4]**

d) What is Active cooling and Passive cooling methods? **[4]**

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