Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **M.Tech**
P1MEBC03

1st Semester Regular/Back Examination 2019-20
ADVANCED HEAT TRANSFER
BRANCH : CAD / CAM ENGG, DESIGN AND DYNAMICS, HEAT POWER & THERMAL ENGG, HEAT POWER ENGG, MACHINE DESIGN, MECH. ENGG (THERMAL & FLUID ENGG), MECH. ENGG., MECH. SYSTEM DESIGN, MECH. SYSTEMS DESIGN & DYNAMICS, PRODUCTION ENGG, PRODUCTION ENGG AND OPERATIONAL MGT, SYSTEM DESIGN, THERMAL & FLUID ENGG, THERMAL ENGG, THERMAL POWER ENGG
Max Marks : 100
Time : 3 Hours
Q.CODE : HRB657
Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

- **a)** What is the difference between diffusion and radiation heat transfer?
- **b)** Define overall heat transfer coefficient.
- **c)** Define and state the physical interpretation of the Biot number.
- **d)** Ice and snow are considered as black body. Explain.
- **e)** In a liquid to gas heat exchanger, it is best to put extended surfaces on the gas side. Why?
- **f)** What do you mean by thermal sleeves?
- **g)** State Lambert's cosine law.
- **h)** Differentiate between irradiation and radiosity.
- **i)** What is the critical insulation radius for a cylinder and sphere, when k=0.50 W/mK and h=10 W/m^{2}K?
- **j)** What is log mean area as applied to hollow cylinder?

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

- **a)** Differentiate between Dropwise condensation and Filmwise condensation
- **b)** Derive critical thickness of insulation over cylindrical pipe to reduce heat loss.
- **c)** Experimental results for heat transfer over a flat plate with an extremely rough surface were found to be correlated by an expression of the form

  $$\mathrm{Nu}_x = 0.04\,\mathrm{Re}_x^{0.9}\,\mathrm{Pr}^{1/3}$$

  Where Nu_x is the local value of the Nusselt number at a position *x* measured from the leading edge of the plate. Obtain an expression for the ratio of the average heat transfer coefficient between the leading edge and a location *x* to the local heat transfer coefficient at *x*.

- **d)** A fan that can provide air speeds up to 60 m/s is to be used in a low speed wind tunnel with atmospheric air at 35°C. If one wishes to use the wind tunnel to study flat plate boundary layer behavior up to Reynolds numbers of 10^8, what is the minimum plate length? At what distance from the leading edge would transition occur, if the critical Reynolds number is 5×10^5?
- **e)** State the five methods which are available for evaluation of convection heat transfer coefficient.
- **f)** Write a short note on Radiant energy transfer through absorbing, emitting and scattering media

g) What is an error function? Explain its significance in a semi-infinite body in transient state.

h) How is the mass transfer coefficient evaluated by dimensionless analysis?

i) Air at 1 atm,30°C, containing small quantities of iodine flows with a velocity of 5.18 m/s inside a 3.048 cm diameter tube. Determine the mass transfer coefficient for iodine transfer from the gas stream to the wall surface. If Cm is the mean concentrate of iodine in kg mol/m^3. In the air stream, determine the rate of deposition of iodine on the tube surface wher the iodine concentration is zero. Take kinematic viscosity of air is 1.58×10^{-5} m^2/s and D for air-iodine system at 1 atm, 298K is 0.826×10^{-5} m^2/s.

j) Give a comparison of Newton's law of viscosity, Fourier' s law of heat conduction and Fick's law of diffusion. How can you generalize them in terms of force and flux?

k) Explain the physical significance of Schmidt number, Lewis number and Prandtl number.

l) Explain an analytical method for solving two dimensional steady state heat conduction problem.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 One end of a rectangular straight fin is fixed to a wall of uniform temperature and the other end is insulated. The wall temperature is more than the surrounding atmospheric temperature. Derive an expression for temperature distribution and heat dissipation for the fin in standard form. **(16)**

Explain an analytical method for solving two dimensional steady state heat conduction problem.

Q4 What is a radiation shield? Derive the expression for heat transfer through "n "number of shields between two plates. **(16)**

A long cylindrical heater 25 mm in diameter is maintained at 660ºC and has surface emissivity of 0.8. The heater is located in a large room whose walls are at 27ºC. How much will the radiant transfer from the heater be reduced if it is surrounded by a 300 mm dia radiation shield of aluminum, having an emissivity of 0.2? What is the temperature of the shield?

Q5 Derive the ε-NTU for parallel flow heat exchanger. A parallel flow double pipe heat exchanger is to heat water from 20 °C to 80 °C at a rate of 1.2kg/s. The heating is to be accomplished by geothermal water available at 160 °C at a mass flow rate of 2kg/s. the inner tube is thin walled and has a diameter of 1.5cm. if the overall heat transfer coefficient of the heat exchanger is 640W/m^2 °C, determine the length of the heat exchanger required to achieve the heating. Use effectiveness-NTU method. **(16)**

Q6 How are the principal dimensionless parameters of natural convection determined from the boundary layer equations concerning continuity, momentum and energy? **(16)**

Air at 20C and at atmospheric pressure flows at a velocity of 4.5 m/s past a flat plate with sharp leading edge. The entire plate surface is maintained at a surface temperature of 60C. Assuming that the transition occurs at critical Reynolds number of 5×10^5, find the distance from the leading edge at which the flow in boundary layer changes from laminar to turbulent. At the location, find the followings :

(i) Thickness of hydrodynamic and thermal boundary layer
(ii) Local and average convective heat transfer coefficient
(iii) Heat transfer rate from both sides for unit width of the plate
(iv) Mass entrainment in the boundary layer.