Exam. No:_____

GANPAT UNIVERSITY
B.TECH SEM. VITH MECHANICAL ENGINEERING
REGULAR EXAMINATION MAY/JUNE - 2012
ME603: HEAT AND MASS TRANSFER

TIME: - 3 HOURS **TOTAL MARKS-70**

INSTRUCTIONS: (1) All questions are compulsory.
(2) Assume suitable data if necessary.
(3) Figure to the right indicates full marks.
(4) Scientific calculator is allowed.

SECTION-I

Que.-1 **a** Derive the general heat conduction equation in Spherical co-ordinates. **06**

b Heat flow occurs through the axis of a solid which has the shape of a truncated cone with circumferential surface insulated. The base is at 300°C and the area of the section at distance x measured from the base of the cone s given by: $A = 1.2 (1 - 1.5x)$ m^2 where x in meter. If plane at x = 0.2 m is maintained at 100°C, Find out (i) Heat flow (ii) temperature at x = 0.1 m (iii) The temperature gradient at two faces and at x = 0.1 m. Thermal conductivity of solid material is 2.5 W/m °C. **06**

OR

Que.-1 **a** Derive the heat conduction equation through a plane wall and also prove it by using Fourier rate equation. **06**

b A steam pipe, 7.5 cm external diameter and 25 m long, conveys 1000 kg of steam per hour at a pressure of 20 bar. The steam enters the pipe with dryness fraction 0.98 and it is required that the steam at exit from the pipe must have a minimum dryness fraction of 0.96; the task is accomplished by suitably lagging the pipe, the thermal conductivity of lagging being 0.7 kJ/m-hr-°C. Neglecting thermal resistance of the steam pipe (no temperature drop across the steam pipe), Find out the minimum thickness of lagging required to meet the necessary conditions. The temperature at the outside surface of lagging be taken as 25°C.Also Find out the temperature at the point half way between the inner and outer surface. **06**

Que.-2 **a** Derive two-dimensional energy equation for thermal boundary layer on a flate plate. **06**

b A thin flat plate of length l = 1 m and breadth b = 0.45 m is expose to a flow of air parallel to its surface. The velocity and temperature of the free stream flow of air are respectively u_∞= 2.5 m/s and t_∞ = 25°C. If the temperature at the surface of plate is t_s = 95°C, Find out heat loss from 50 cm length of plate measured from trailing edge. **05**

OR

Que.-2 **a** Air at atmospheric pressure and 20°C flow passed at flate plate with a velocity of 4 m/s. the plate is 30 cm wide, is heated uniformly throughout its entire length and is maintained at a surface temperature of 60°C. Make calculations for the following parameters at 40 cm distance from the leading edge: (i) Thickness of hydrodynamics and thermal boundary layers (ii) Local and average friction coefficient (iii) Local and average heat transfer coefficient and (iv) Total drag force on the plate. **06**

b Derive the integral energy equation for the boundary layer. Write assumptions made for this equation. **05**

Que.-3 **Attempt Any Three.** 12

a Explain the concept of Thermal boundary layer for following cases:
(i) Flow of cool fluid over a warm plate. (ii) Flow of warm fluid over a cool plate.

b Explain the concept of Thermal resistance and Thermal diffusivity.

c Explain the following dimensionless number:
(i) Grashof number (ii) Prandtl number

d Explain heat transfer versus thermodynamics with examples.

e Explain the measurement of thermal conductivity by using Guarded Hot plate method.

SECTION-II

Que.-4 a Derive the equation of Effectiveness for the parallel flow heat exchanger. 6

b Give the classifications of heat exchangers in details. 6

OR

Que.-4 a What do you mean by LMTD? Derive equation of LMTD for parallel flow heat exchanger. 6

b A counter flow heat exchanger is used to cool 2000 kg/hour of oil (Cp=2.5 kJ/kg K) from 105°C to 30°C by the used of water entering at 15°C. If the overall heat transfer coefficient is expected to be 1.5 kW/m^2 K, make calculations for the water flow rate, the surface area required and the effectiveness of heat exchanger. Presume that the exit temperature of the water is not to exceed 80°C. Use NTU- Effectiveness approach. 6

Que.-5 a State and explain the following laws relating to thermal radiation and temperature of radiating body: (i) Wien's displacement law (ii) Planck's law 6

b Define Lambert's cosine law of radiation and prove that the intensity of radiation is always constant at any angle of emission for a diffused surface. 5

OR

Que.-5 a Derive the net heat exchange equation between two infinite parallel plane with and without radiation shield. 6

b An industrial furnace in the form of a black body and emitting radiation at 2500°C for this furnace Find out: (i) Monochromatic emissive power at 1.2 μm length (ii) Wavelength at which the emission is maximum (iii) Maximum emissive power (iv) Total emissive power (v) Total emissive power of the furnace if it is assumed as a real surface with emissivityP equal to 0.9. 5

Que.-6 **Attempt Any Three.** 12

a Explain the meanings of terms: heat capacity ratio, effectiveness and number of heat transfer units as applied to heat exchangers.

b Explain the following terms:
(i) Concentrations (ii) Velocities (iii) Fluxes

c Explain the Fick's Law.

d Explain the terms absorptivity, reflectivity and transmissivity of radiant energy.

e Explain the salient features and characteristics of radiation.

END OF PAPER