7. i) Derive formula for exact laminar hydrodynamic boundary layer thickness for fluid flowing over a flat plate. Also write all assumptions made for this.

ii) A hot square plate 40cm×40cm at 100°C is exposed to atmospheric air at 20°C. Make calculations for the heat loss from both surfaces of the plate, if

a) The plate is kept vertical

b) The plate is kept horizontal

The following empirical correlations have been suggested:

$Nu = 0.125(Gr.\mathrm{Pr})^{0.33}$ for vertical position of the plate; and

$Nu = 0.72(Gr.\mathrm{Pr})^{0.25}$ for upper surface

$Nu = 0.35(\mathrm{Gr.Pr})^{0.25}$ for lower surface

Where air properties are evaluated at the mean temperature. Take thermophysical properties of air are:

$\rho = 1.06 kg/m^3, \beta = 1/T_{mean}$

$k = 0.028 w/m - \deg, C_p = 1.008 kJ/kg\ k$,

$\nu = 18.97 \times 10^{-6} m^2/s$

8. Attempt any Two:-

i) Write aspects of Fick's law of diffusion

ii) Define absorptivity, reflectivity and transmissivity of any object.

iii) Show (draw) development of hydrodynamic boundary layer development for a fluid flowing

a) Over a flat plate and

b) In a pipe

iv) Derive an expression for heat dissipation from an infinitely long fin $(l \to \infty)$.

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Roll No ....

MMTP - 103

M.E./M.Tech., I Semester

Examination, December 2015

Heat And Mass Transfer

Time : Three Hours

Maximum Marks : 70

Note : i) Attempt any five from eight questions.

ii) Draw necessary diagram wherever required.

iii) Assume suitable data if required.

1. i) Find equivalent thermal resistance and heat transfer rate for conduction through a composite wall when layers are in series. Also write assumptions mode for this.

ii) The temperature distribution across a wall 1m thick at a certain instant of time is given by: $T(x) = a + bx + cx^2$. where T is in °C and x is in m; while $a = 300°C$, $b = -300°c/m$ and $c = -50°c/m^2$. A uniform heat generation, $q° = 1000\ w/m^3$, is present in the wall of area $20m^2$ having the properties $k = 40 w/m\text{-}k$, $\rho = 1600 kg/m^3$, $C_p = 4 kJ/kg\ k$. Determine :

a) The rate of heat transfer entering the wall $(x = 0)$ and learning the wall $(x = 1m)$

b) The rate of change of energy storage in the wall

c) The time rate of temperature change at $x = 0$ and $x = 0.25m$.

2. i) The temperature profile at a particular location on the surface of plate is prescribed by the identities:

a) $\dfrac{t_s - t}{t_s - t_0} = \sin\left(\dfrac{\pi y}{0.03}\right)$

b) $\frac{t_s - t}{t_s - t_\infty} = \frac{1}{2}\left(\frac{y}{0.006}\right)^3 + \frac{3}{2}\left(\frac{y}{0.006}\right)$

If thermal conductivity of air is stated to be 0.04w/m-deg, determine the value of convective heat transfer coefficient in each case.

ii) Define prototype, model and similitude. Also explain geometrically, kinematically, thermally and dynamically similar systems.

3. i) Explain the mechanism and cycle of bubble formation with the help of diagram.

ii) Explain the following factors which affecting condensing heat transfer:

a) Film temperature difference

b) Mass flow rates

c) Flow geometry

d) Presence of contaminants

4. i) A furnace emits radiation at 2000k. Treating it as a black body radiation, calculate the following:

a) Monochromatic radiant flux density at 1 μ wavelength

b) Wavelength at which emission is maximum

c) Total emissive power and

d) Wavelength λ such that emission from 0 to λ is equal to emission from λ to ∞. Take

$\lambda T\,(\mu\text{m}-\text{k})$:	4000	4200
$F_{0-\lambda}$:	0.4809	0.5160

ii) An electric heating system is installed in the ceiling of a room that measures 5m×5m with a height of 2.5m. The temperature of the ceiling is maintained at 320k where as under equilibrium conditions, the walls are at 300k. Workout the radiant heat loss from the ceiling to the walls. The floor is non-sensitive to radiations and the emissivities of the ceiling and wall are 0.7 and 0.6 respectively.

5. i) Explain Fick's law of diffusion with diagram. Also explain dependence of diffusion on concentration profile.

ii) Estimate the diffusion coefficient for ammonia in air at 25°C temperature and one atmospheric pressure.

For ammonia : molecular weight = 17 and molecular volume = 25.81cm^3/gm mole

For air : molecular weight = 29 and molecular volume = 29.89cm^3/gm mole

6. i) Explain different modes of heat transfer. Give any one example with all possible combination of heat transfer modes.

ii) A storage chamber of interior dimensions 10m×8m×2.5m high has its inside maintained at a temperature of –20°C while the outside is at 25°C. The walls and ceiling of the chamber have three layers made of : 60mm thick board (k=0.2w/m-deg) on the inside, 90mm thick insulation (k=0.04w/m-deg) at mid, 240mm thick concrete (k=1.8w/m-deg) on the outside. Neglecting flow of heat through the floor, determine the rate at which heat can flow towards inside of the chamber.