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2022

BINA CHOWDHURY CENTRAL LIBRARY
(GIMT & GIPS)
Azara, Hatkhowapara,
Guwahati - 781017

B.Tech. 6th Semester End-Term Examination

HEAT TRANSFER – II

(New Regulation & New Syllabus)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer question No. 1 and any *four* from the rest.

1. Answer the following (MCQ/ Fill in the blanks) : (10 × 1 = 10)
- (i) Assertion (A): For the similar conditions the values of convection heat transfer coefficients are more in forced convection than in free convection.
- Reason (R): In case of forced convection system the movement of fluid is by means of external agency.
- (a) (A) and (R) are true and (R) is correct explanation of (A)
- (b) (A) and (R) true but (R) is not correct explanation of (A)
- (c) (A) is true but (R) is false
- (d) (A) is false but (R) is true
- (ii) For a flow over a flat plate, flow will be Laminar flow if the Reynolds No is less than or equal to _____.
- (iii) For calculation of heat transfer by natural convection from a horizontal cylinder, what is the characteristic length in Grash of Number?
- (a) Length of the cylinder
- (b) Circumference of the base of the cylinder
- (c) Diameter of the cylinder
- (d) Half the circumference of the base of the cylinder

[Turn over

- (iv) In a counter flow heat exchanger, If the entry and exit temperature of hot fluid are 90°C and 50°C and that of cold fluid is 20°C and 40°C. Determine LMTD in Kelvin _____
- (v) Fouling factor of heat exchanger
- (a) Increase thermal resistance
- (b) Decrease thermal resistance
- (c) Doesn't change thermal resistance
- (d) None of the above
- (vi) Water flow rate can be measured using a
- (a) Thermocouple
- (b) Venturimeter
- (c) Pyrometer
- (d) All of the above
- (vii) In a shell and tube heat exchanger, baffles are provided on the shell side to
- (a) Improve heat transfer
- (b) Provide support for tubes
- (c) Prevent stagnation of shell side fluid
- (d) All of these
- (viii) Write expression for effectiveness of heat exchanger for a Condenser in terms of NTU.
- (ix) For complete similarity between model and prototype, It is essential to have
- (a) geometric similarity
- (b) dynamic similarity
- (c) both (a) and (b)
- (d) None of the above
- (x) Drop wise condensation usually occurs on
- (a) Glazed surface
- (b) Smooth surface
- (c) Oily surface
- (d) Coated surface

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2. (a) Define Nusselt, Reynolds and Prandtl Numbers (5)
- (b) Velocity distribution for a flow over a flat plate, given that

$$\frac{u}{u_{\infty}} = \frac{3}{2} \left(\frac{Y}{\delta} \right) - \frac{1}{2} \left(\frac{Y}{\delta} \right)^3$$

Where,

u -velocity of flow

u_{∞} - free stream velocity

δ - velocity boundary layer thickness

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- (i) Draw the corresponding fully developed hydrodynamic boundary layer and velocity profile.
- (ii) Find out the displacement thickness in terms of velocity boundary layer thickness (δ). (10)
3. (a) Draw the natural convection current for hot horizontal and vertical plates kept in a quiescent medium. Mark the velocity and temperature profiles for hot vertical plate. (5)
- (b) A cylindrical body of 300 mm diameter and 1.6 m height is maintained at a constant temperature of 36.5°C. The surrounding temperature is 13.5°C. Determine the heat lost from the surface by natural convection per hour if $\rho = 1.025 \text{ kg/m}^3$; $C_p = 960 \text{ J/kg C}$; $\nu = 15.06 \times 10^{-6} \text{ m}^2/\text{s}$; $k = 89.2 \text{ J/mh}^\circ\text{C}$ and $\beta = 1/298 \text{ K}^{-1}$. Assume $Nu = 0.12 (\text{Gr.Pr})^{1/3}$. (10)
4. (a) Air at 20°C and 1 atm flows over a flat plate at 40 m/s. The plate is 80 cm long and is maintained at 60°C. Assuming unit depth in the z direction, calculate the heat transfer from the plate, Properties of air at 40°C are: $Pr = 0.7$, $k = 0.02723 \text{ W/mK}$, $c_p = 1.007 \text{ kJ/kgK}$ and $\mu = 1.906 \times 10^{-5} \text{ kg/ms}$. (7)
- (b) In a parallel flow heat exchanger operating under steady state, the heat capacity rates of the hot and cold fluid are equal. The hot fluid, flowing at 1 kg/s with $C_p = 4 \text{ kJ/kgK}$, enters the heat exchanger at 102°C while the cold fluid has an inlet temperature of 15°C. The overall heat transfer coefficient for the heat exchanger is estimated to be 1 kW/m²K and the corresponding heat transfer surface area is 5 m². Neglect heat transfer between the heat exchanger and the ambient. The heat exchanger is characterized by the following relation : $2\varepsilon = 1 - \exp(-2NTU)$. Determine exit temperature (in °C) for the cold fluid? (8)
5. (a) In a solar assisted air-conditioning system. 0.5 kg/s of ambient air at 270 K is to be reheated by the same amount of air leaving the system at 295 K. If a counter flow heat exchanger has an area of 30m² and the overall heat transfer coefficient is 25w/m²K. Determine the outlet temperature of the preheated air. Take C_p for air as 1000 J/kgK. (7)
- (b) A coaxial tube counter flow heat exchanger is used to cool 0.03 kg/s of benzene from 87°C to 37°C with a counter flow of 0.02 kg/s of water initially at 17°C. If the inner tube outside diameter is 2 cm and the overall heat transfer coefficient based on outside area is 650 Wm²/°C, determine the required length of the exchanger. Take the specific heats of benzene and water as 1880 and 4175 J/kg°C respectively. (8)

6. (a) Write short note on Orifice meter and Venturi meter. (5)
(b) Briefly describe about Subcooled boiling and Saturated boiling. (5)
(c) Draw boiling curve for pool boiling of water at saturation temperature and pressure and mark different boiling regimes. (5)
7. (a) Discuss the analogy between heat and mass transfer. (5)
(b) A fluid which is heated by a hot vertical plate and forced up due to buoyancy has seven variables that influence the heat transfer. They are heat transfer coefficient (h), fluid density (ρ), plate length (L), fluid dynamic viscosity (μ), thermal conductivity (k), specific heat (c_p) and buoyancy force ($\beta g \Delta T$). Find the possible dimensionless groups from these variables to estimate the heat transfer coefficient using dimensional analysis. (10)
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