Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. Sem. – IV - Examination –June- 2011

Subject code: 140403

Subject Name: Principles of Process Engineering - I

Date:10/06/2011 **Time: 10.30 am – 01.00 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain in detail three modes of heat transfer with examples of each. **07**

(b) A flat furnace wall consists of 20cm of fire clay bricks, 10cm of insulating brick and 10cm of common brick linings. The temperature of the inside surface of the fire clay brick is 800°C and that of the outer surface of the common brick is 40°C. An accurate heat balance over the furnace shows the heat losses from the wall to be 200kcal/hr m^2. It is known that there is a thin layer of air between the insulating and the common brick linings. The thermal conductivities are: **07**

k = 1.3 kcal/ hr m °C for fireclay brick

= 0.12 kcal/ hr m °C for insulating brick

= 0.6 kcal/ hr m °C for common brick

Find: (i) To how many centimeters of insulating brick is the air layer equivalent? (ii) What is the temperature between the fire clay and the insulating brick linings?

Q.2 **(a)** Explain Fourier's law for heat conduction in detail. Also apply it for the case of plane wall and composite wall with neat sketches. **07**

(b) Derive the governing equation for unsteady state heat conduction with neat diagram. **07**

OR

(b) Derive Stefan – Boltzman law for black body radiation using Planck's law. **07**

Q.3 **(a)** Define: (i) Potential flow (ii) Streamline tube (iii) Viscosity (iv) Laminar flow (v) Specific weight (vi) Newtonian fluid (vii) Incompressible fluid **07**

(b) Derive the relation between shear stress at walls and skin friction. Also derive the relation between friction factor and skin friction for laminar flow of fluid in a circular pipe. **07**

OR

Q.3 **(a)** Starting from the definition of momentum correction factor prove that $\beta = 4/3$ for laminar flow of fluid in a circular pipe. **07**

(b) Prove that velocity profile for laminar flow of fluid in circular pipe is parabolic in nature and also derive the relation between local velocity, average velocity and maximum velocity. **07**

Q.4 **(a)** State the methods of dimensional analysis and Explain Rayleigh's method of dimensional analysis with a suitable example. **07**

(b) Explain industrial significance of fluidization. **07**

OR

Q.4 **(a)** A pump draws a solution with specific gravity 1.84 from a storage tank through 75mm pipe. The efficiency is 60% while the velocity in the suction line is 0.914m/s. The pump disch arges through a 50mm pipe to an overhead tank at a level of 15.2m. The total frictional loss in the pipe is 29.9J/kg. Calculate the total power input and total pressure developed by the pump. **07**

(b) Define: Heat Exchanger. Explain the construction and working of Shell and Tube heat exchanger with neat sketch. **07**

Q.5 **(a)** Define: Specific speed of a centrifugal pumps and also derive expression for N_s. **07**

(b) The diameter of a centrifugal pump, which is discharging 0.03 m^3/sec of water against a total head of 20m, is 0.40m. The pump is running at 1500 rpm. Find the head, discharge and ratio of powers of a geometrically similar pump of diameter of 0.25m when it is running at 3000 rpm. **07**

OR

Q.5 **(a)** Answer the followings: **07**

1. Give the significance of following dimensionless numbers in case of convection heat transfer (i) Prandlt number (ii) Grashoff number (iii) Reynold number (iv) Nusset number (v) Peclet number **05**

2. Write full form of LMTD and show the temperature profile for counter current and concurrent flow. **02**

(b) State different metering devices. Explain venturimeter in detail with neat sketch. **07**

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