

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-III (Food Processing Technology) Examination December 2009

Subject code:131403

Subject: Food Engineering Transport Phenomenon

Date:21 /12 /2009

Time: 11.00 am – 1.30 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) Define the terms: Fluid density, Specific volume, Specific gravity, Surface tension, Dynamic viscosity and Kinematic viscosity in detail. **06**
- (b) Find the kinematic viscosity of oil having density 981 kg/m^3 . The shear stress at a point in oil is 0.2452 N/m^2 and velocity gradient at that point is 0.2 per second. **04**
- (c) An open tank contains water up to a depth of 2 m and above it an oil of density 900 kg/m^3 for a depth of 1 m. Find the pressure intensity (i) at the interface of the two liquids, and (ii) at the bottom of the tank. **04**

- Q.2**
- (a) Develop Euler's equation of motion and from this equation develop Bernoulli's equation and using this equation solves following problem. **07**
Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2 m/s. Find the total head or total energy per unit weight of the water at cross section, which is 5 m above the datum line.
- (b) Find the volume of the water displaced and position of centre of buoyancy for a wooden block of width 2.5 m and of depth 1.5 m, when it floats horizontally in water. The density of wooden block is 650 kg/m^3 and its length 6 m. **04**

OR

- (b) The dynamic viscosity of oil used for lubrication between a shaft and sleeve is 6 poise. The shaft diameter 0.4 m and rotates at 190 rpm. Calculate shear force on the shaft, for a bearing of sleeve length of 90 mm. The thickness of oil film is 1.5 mm. **04**
- (c) An oil of Specific gravity 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil-mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$ **03**

OR

- (c) What is diffusion? Define mass fluxes and state Fick's law of diffusion. **03**

- Q.3**
- (a) What is the difference between U-tube differential manometers and inverted U-tube differential manometers? Where they are used? **04**
- (b) What is a venturimeter? Derive an expression for the discharge through a venturimeter. **05**
- (c) The water is flowing through a pipe having diameters 20 cm and 10 cm at sections 1 and 2 respectively. The rate of flow through pipe is 35 litres/sec. The section 1 is 6 m above datum and section 2 is 4 m above datum. If the pressure at section 1 is 39.24 N/cm^2 , find the intensity of pressure at section 2. **05**

OR

- Q.3** (a) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from first principle and state the assumption made for such a derivation. **07**
- (b) The head of water over the centre of an orifice of diameter 20 mm is 1 m. The actual discharge through the orifice is 0.85 litre/s. Find the coefficient of discharge. **03**
- (c) Define the terms: Laminar flow, Turbulent flow, Prandtl mixing length, Mach's Number **04**
- Q.4** (a) The pressure difference ΔP in a pipe of diameter D and length l due to turbulent flow depends on the velocity V , viscosity μ , density ρ and roughness k . Using Buckingham's π theorem, obtain an expression for ΔP . **06**
- (b) Define Model and Prototype. Give significance of Reynold's Number, Froude's Number, Euler's Number and Weber's Number. **05**
- Water is flowing through a pipe of diameter 30 cm at a velocity of 4 m/s.
- (c) Find the velocity of oil flowing in another pipe of diameter 10 cm, if the condition of dynamic similarity is satisfied between two pipes. The viscosity of water and oil is given as 0.01 poise and 0.025 poise respectively. The specific gravity of oil = 0.8. **03**

OR

- Q.4** (a) The force exerted by a flowing fluid on a stationary body depends upon the length L of the body, velocity V of the fluid, density ρ of fluid, viscosity μ of the fluid and acceleration g due to gravity. Find an expression for the force using dimensional analysis. **06**
- (b) The time period (t) of a pendulum depends upon the length (L) of the pendulum and acceleration due to gravity (g). Derive an expression for time period. Prove that equation $V = (2gH)^{1/2}$ where V = velocity, g = acceleration due to gravity, H = head is dimensionally homogeneous. **04**
- (c) What is similitude? Describe Geometric similarity, Kinematic similarity and Dynamic similarity. **04**
- Q.5** (a) Define Laminar flow and show that velocity distribution of fluid for laminar flow is parabolic in nature through circular pipes. Also prove that ratio of maximum velocity to average velocity for laminar flow is 2. **06**
- (b) A crude oil of viscosity 0.097 Ns/m^2 and relative density 0.9 is flowing through a horizontal circular pipe of diameter 100 mm and of length 10 m. Calculate the difference of pressure at the two ends of the pipes, if 100 kg of the oil is collected in a tank in 30 seconds. **05**
- (c) Water is flowing through a 200 mm diameter pipe with coefficient of friction $f = 0.04$. The shear stress at a point 40 mm from the pipe axis is 0.00981 N/cm^2 . Calculate the shear stress at the pipe wall. **03**

OR

- Q.5** (a) Define Laminar boundary layer and Turbulent boundary layer. Find the displacement thickness, the momentum thickness and the energy thickness for the velocity distribution in the boundary layer given by $u/U = y/\delta$, where u is the velocity at a distance y from the plate and $u = U$ at $y = \delta$, where δ = boundary layer thickness. Also calculate the value of δ^*/θ . **06**
- (b) Derive an expression for loss of head due to friction in pipes for turbulent flow. **04**
- (c) Determine the wall shearing stress in a pipe of diameter 100 mm which carries water. The velocities at the pipe centre and 30 mm, from the pipe centre are 2 m/s and 1.5 m/s respectively. The flow in pipe is given as turbulent. **04**
