(ii) Effective diameter, D_p of the particle.

(c) A solid particle of density ρ_p and diameter D_p is falling through a stagnant fluid of density ρ and viscosity μ under gravity. Obtain an expression of terminal velocity in Stoke's law regime.

1 + (2 + 3) + 6 = 12

9. (a) Air at 41^0C and 101.3 kPa absolute pressure flows at a velocity of 20 m/s past a sphere having a diameter 46 mm. What is the force on the sphere? [Data Given : viscosity of air = 1.915×10^{-5} Pa.s; $C_D = 0.47$].

(b) What do you understand by minimum fluidization velocity? Find out its expression for very small particles with particle Reynolds number less than 1.0.

(c) Write down two applications of fluidization and mention its advantages.

6 + 4 + 2 = 12

FLUID MECHANICS
(CHEN 2102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A fluid is a substance, that
(a) has to be kept in a closed container
(b) is almost incompressible
(c) has zero shear stress
(d) flows when even a small shear is applied to it

(ii) Bernoulli's equation deals with the law of conservation of
(a) mass (b) momentum
(c) energy (d) heat.

(iii) _____ fluid is called shear thinning fluid.
(a) Newtonian (b) Pseudoplastic
(c) Bingham plastic (d) Dilatant

(iv) The pressure drop in a packed bed for turbulent flow is given by
(a) Kozney-Karman equation (b) Blake-Plummer equation
(c) Hagen-Poiseuille equation (d) None of (a), (b) and (c).

(v) Mach number > 1 signifies _____ flow.
(a) Ultrasonic (b) Supersonic
(c) Subsonic (d) Sonic

(vi) The hydraulic diameter of an annulus of inner and outer radii R_i and R_o respectively is
(a) $4(R_o - R_i)$ (b) $\sqrt{R_o - R_i}$
(c) $2(R_o - R_i)$ (d) $R_o + R_i$.

(vii) In case of turbulent flow of fluid in a pipe, kinetic energy correction factor is approximately
(a) 2 (b) 1/2
(c) 1 (d) 3/2.

(viii) In the fluid flow, the stagnation point is defined as a point, where the _____ is zero.
(a) pressure (b) flow velocity
(c) total energy (d) total head

(ix) The SI unit of kinematic viscosity is
(a) stoke (b) poise (c) m^2/s (d) cm^2/s.

(x) For ensuring uni-directional flow through a pipeline you must use
(a) Globe valve (b) Check valve
(c) Butterfly valve (d) Gate valve.

Group – B

2. (a) A velocity field is given by $\mathbf{V} = 0.2x\,\mathbf{i} - 0.4\,y\,\mathbf{j}$.
(i) Find the streamline passing through the point (2,8,0).
(ii) If the particle passing through the point (2,8,0) at time $t_0 = 0$, determine the location of the particle at time t = 6 sec and also velocity at time t = 6 sec.

(b) A small capillary with an inside diameter of 2.4 mm and a length of 0.33 m is being used to continuously measure the flow rate of a fluid having a density of 860 kg/m^3 and viscosity of 1.13×10^{-3} Pa.s. The pressure drop reading across the capillary during flow is 0.066 m of water (density 996 kg/m^3). What is the flow rate in m^3/s if end-effect corrections are neglected?

(3 + 3) + 6 = 12

3. (a) Write the working principle of a U-tube manometer.

(b) What pressure in kPa is equivalent to head of 10 m of water?

(c) A circular plate of diameter 1.8 m is submerged in water vertically such that its top surface is 1.2 m below the free surface of the water. Determine the total pressure force on the plate and the position of the centre of pressure.

(d) Reynolds number can be expressed as a ratio of two forces-explain.

4 + 2 + 5 + 1 = 12

Group – C

4. (a) Water flows out through an opening of 20 cm in diameter, in the bottom of a constant level tank. The radius of the water jet is r at a depth Z below the tank bottom and H is the depth of the water in the tank. Obtain an expression for the profile of the jet expressing 'r' in terms of Z/H.

(b) Define 'kinetic energy correction factor'. Obtain its value for laminar flow of a fluid flowing through smooth, circular pipe.

(c) What do you understand by 'hydraulically smooth tube'?

5 + 6 + 1 = 12

5. (a) Water is flowing at a steady mass flow rate through a uniform diameter pipe. The entrance pressure of the fluid is 72 kN/m^2 absolute in the pipe, which connects to a pump which actually supplies 164 J/kg of fluid flowing in the pipe. The exit pipe from the pump is the same diameter as the inlet pipe. The exit section of the pipe is 3.56 m higher than the entrance and the exit pressure is 134 kN/m^2 absolute. The flow in the pipe is turbulent. Calculate the frictional loss in the system.

(b) In case of turbulent flow of fluid in a pipe, obtain an expression of frictional head loss due to sudden expansion in cross section .

7 + 5 = 12

Group – D

6. (a) A venturimeter of 150 mm pipe diameter and 75 mm throat diameter is used to measure the flow rate of oil having specific gravity of 0.9. The reading shown by the U tube manometer connected to the venturimeter is 150 mm of mercury column. Calculate the coefficient of discharge for the venturimeter if the flow rate is 1.7 m^3/min.

(b) Draw the characteristic curve for a centrifugal pump.

(c) What is NPSH.

6 + 3 + 3 = 12

7. (a) A pitot static tube is used to measure velocity of air flowing through a duct. The manometer shows a difference in head of 5 cm of water. If the density of air is 1.13 kg/m^3, determine the velocity of air. Assume the coefficient of pitot tube as 0.98.

(b) Write down the classification of positive displacement pump.

(c) Mention the advantage and disadvantages of using venturimeter over orifice meter.

6 + 3 + 3 = 12

Group – E

8. (a) Define sphericity.

(b) A packed bed is composed of cylinders having a diameter D = 0.02 m and length L = D. The bulk density of the overall packed bed is 970 kg/m^3 and the density of the solid cylinders is 1600 kg/m^3. Find
(i) The void fraction.