Bengal Engineering and Science University, Shibpur
B.E. (Civil) 3rd Semester Examination, 2012 (November / December 2012)

Subject: Hydraulics –I — Code No. AM302
Time 3 hours — Full Marks: 70

(i) Answer any **six** questions taking **three** from each half
(ii) All questions in **each half** carry equal marks

First Half

1. (a) When pressure of a liquid is increased from 3 MN/m^2 to 6 MN/m^2, its volume is decreased by 0.1 %. What is the bulk modulus of elasticity of liquid?
(b) Inside a 60mm diameter cylinder, a piston of 59mm diameter rotates concentrically. Both the cylinder and piston are 80mm long. If the space between the cylinder and piston is filled with oil of viscosity of 0.3 Ns m^2 and a torque of 1.5Nm is applied, find the r.p.m. of the piston and power required.

2. (a) A trapezoidal channel 1.8 m wide at the bottom, 1.2 m deep has side slope of 45° such that the channel is wider at the top. Find the total force and the centre of pressure on the vertical gate closing the channel when water is full.
(b) Make calculations for the horizontal and vertical components of the total force acting on the outer surface of quadrant of a circular cylinder as shown. The surface has a width of 1m in the direction perpendicular to the plane of the paper. (Fig. 1)

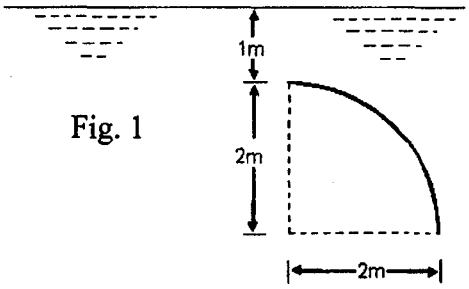

Fig. 1

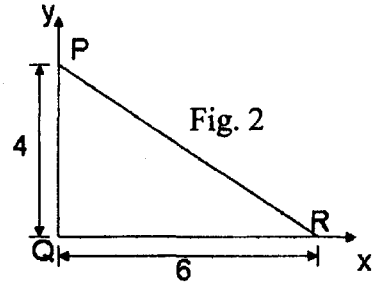

Fig. 2

3. (a) A two-dimensional flow field is given by $V = 2x^3 i - 6x^2 y j$. Check whether the flow is rotational or irrotational? If, rotational, determine the angular velocity, vorticity and shear strain. Also find the circulation about the circle $x^2 + y^2 - 2ay = 0$.

(b) A stream function is given by $\psi = 4x^2 y + (6+t)y^2$. Find the flow rates across the faces of the triangular prism PQR as shown having thickness 1 unit in the z – direction at time $t = 3$ s. (Fig. 2)

4. (a) Derive Euler's equation along a stream line. Comment on the validity of the statement that "Bernoulli's theorem is derived under assumption of no external force except that gravity is acting on the liquid".
(b) A horizontal pipe of diameter 15 cm enlarges to 20 cm in diameter. If the pressures at the two sections are 200kPa and 400kPa, respectively, calculate the flow rate of water.

5. (a) (a) Distinguish between (i) laminar flow and turbulent flow; (ii) steady flow and un-steady flow; (iii) uniform flow and non-uniform flow. State and explain the impulse momentum theorem.
(b) A 15 cm diameter pipe carries water under a head of 20m with a velocity of 3.5 m/s. If the axis of the pipe turns through 135° in the anticlockwise direction, find the magnitude and direction of resultant force on the bend?

Second Half

6. State 'Reynolds Law of similarity' and Froud's Law of similarity'. Hence show that the Model scale becomes a function of only fluid properties when both laws are applicable. Does existence of 'geometric similarity' and 'kinematic similarity' between two flow situations always implies the existence of 'dynamic similarity'?

A rotating disc 225 mm in diameter requires 1.1 Nm of torque to rotate in water at 23 rev/sec. Calculate the corresponding speed and torque required to rotate a similar disc 675 mm in diameter in air. Take dynamic viscosity and density of air as 1.86×10^{-5} PaS and 1.2 Kg/m^3 respectively and those for water as 1.01×10^{-3} PaS and 1000 Kg/m^3 respectively.

7.a) A single pipe 400 mm in diameter and 400 m long carries water at the rate of 0.5 m^3/sec. Find the increase in discharge if another pipe of 200 m long and 200 mm diameter is connected in parallel to first pipe over last half of its length. Assume friction factor for all the pipes to be same.

b) Three pipes of length L_1, L_2 and L_3 and diameters d_1, d_2 and d_3 connected in series are to be replaced by a single pipe of length L to give same discharge under the same head. Find the diameter of the single pipe if friction factor, f, for all the pipes are same. Neglect all minor losses.

8(a) Prove that, for transmission of maximum power through a pipe, the head loss due to friction is one-third the head available at inlet to the pipe.

(b) A pipe of 0.6 m diameter is 1.5 km long. In order to augment the discharge another pipe of same diameter is introduced in parallel to first pipe in the second half of its length. Neglecting minor losses find the increase in discharge due to introduction of the second pipe, if friction factor is 0.04 for both pipes. The head available at inlet in both cases is 30 m.

9. In a pipe network four junctions A, B, C and D are connected by five pipes AB, AC, AD, BC and CD. The resistances, r, for the five pipes AB, AC, AD, BC and CD are 2, 1, 4, 2 and 3 units respectively. There are inflows of 50 units of discharge each at A and B, while there are outflows of 25 and 75 units of discharge from C and D respectively. Determine the flow rate (with direction) through each pipe of the network following Hardy- Cross method.

10. Write short notes on any three of the following :

(i) Critical Reynolds Number , (ii) 'Hydraulically Smooth Pipe' and 'Hydraulically Rough Pipe', (iii) Hydraulic and Energy Grade Lines, (iv) Centre of Pressure, (v) Flow Net