BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. 3rd SEMESTER (Met.E./Min.E.) FINAL EXAMINATION, NOVEMBER, 2011
Fluid Mechanics and Fluid Machines (AM 306)

Full Marks: 70 **Time: 3 Hours**

1st Half

All questions carry equal marks.
Answer any three questions from each half.

1.(a) Water flows through a horizontal conical pipe 2m long and having a diameter of 20 cm at the inlet and 15 cm at the exit. The friction factor, f, is 0.04 and the discharge is 40 litre/s. What is the head lost in the pipe.

1.(b) A cylindrical tank of radius, **R**, and length, **L**, lies on its side with its axis horizontal. The tank has a small orifice of area, **A**, at its bottom and is exactly half filled with water. Obtain an expression for the time required for emptying the tank. If $\mathbf{R} = 1$ m, $\mathbf{L} = 3$ m, $\mathbf{A} = 100$ cm^2 and $\mathbf{C_d} = 0.6$, compute the numerical value of the time required to empty the tank?

2. (a) A sharp-crested rectangular weir in a rectangular open channel of width 3.2 m carries a certain discharge with a head of 0.18 m over the crest of the weir. If the coefficient of discharge is 0.67, compute the discharge over the weir. Neglect the approach velocity.

2. (b) An prismatic open channel of trapezoidal cross-section has a bottom width of 3.85 m and side slopes of 1.5 horizontal to 1 vertical. If Mannings's roughness coefficient is 0.018, the flow depth is uniform at 1.3 m, and the discharge is 22 m^3/s, what is the longitudinal slope of the channel bottom?

3. (a) A centrifugal pump running at 1500 rpm delivers water at a net head of 15 m. At the outlet of the impeller, the vanes make an angle of 45° with the tangential direction. The impeller has an outer diameter of 35 cm and the width is 7 cm at the outlet. Assuming an overall efficiency of 1, calculate the discharge.

3. (b) Write down the expression for specific speed for pump, $\mathbf{N_{sp}}$, explaining clearly the notations used. What is the dimension of $\mathbf{N_{sp}}$ in **MLT** and **FLT** system and unit in **SI** and **CGS**.

4. (a) Two homologous pumps are operated at the same speed of 1500 rpm. One pump has an impeller diameter of 0.43 m and lifts water to a head of 20 m with a discharge of 0.05 m^3/s. If the second pump discharges 0.03 m^3/s, determine its output water head and its impeller diameter.

4. (b) A centrifugal pump has an impeller of outer diameter 30 cm whose width at the outer periphery is 6.0 cm. The radial component of velocity through the impeller is constant throughout and is 3.0 m/s. If the rotational speed of the pump is 1000 rpm and the hydraulic efficiency is 0.8, calculate the head produced and the discharge through the pump.

5. Using diagrams wherever necessary, write short notes on the following:
(i) Homologous series of pumps, (ii) Mechanical efficiency of centrifugal pumps, (iii) Multi-stage centrifugal pump.

SECOND HALF

Answer any **three** questions.

Q.6.(a) Define Compressibility. How is it related to bulk modulus of elasticity ? Elaborate the difference between dynamic viscosity and kinematic viscosity.

(b) In a 50 mm long journal-bearing arrangement, the clearance between the two at concentric condition is 0.1 mm. The shaft is 20 mm in diameter and rotates at 3000 rpm. The dynamic viscosity of the lubricant used is 0.01Pa-s and the velocity variation in the lubricant is linear. Considering the lubricant to be Newtonian, calculate the frictional torque the journal has to overcome and the corresponding power loss.

Q.7.(a) State and prove the Pascal's law and give some example and where this principle is applied.

(b) A triangular plate of base width 1.5 m and height 2 m lies immersed in water with the apex downward. The base of the plate is 1 m below and parallel to the free water surface. Calculate the total pressure on the plate and the depth of the centre of pressure.

Q.8.(a) Considering a one-dimensional frictionless steady flow of a compressible fluid in an infinitesimal stream tube, show that $\frac{d\rho}{\rho}+\frac{dA}{A}+\frac{du}{V}=0$.

Hence deduce the continuity equation $AV=$ constant for incompressible fluid flow.

(b) A pipe AB branches into two pipes C and D. The pipe has diameter of 45 cm at A, 30 cm at B, 20 cm at C and 15 cm at D. Determine the discharge at A if the velocity at A is 2 m/s. Also determine the velocities at B and D, if the velocity at C is 4 m/s.

Q.9.(a) From energy consideration what is the important signification of potential head, datum head and kinetic energy head and what is their relationship to the total head ?

(b) The rate of water through a vertical conical draft tube of a Kaplan turbine is 17.5 m^3/s. The diameter of the draft tube on the side connected to the outlet of the turbine runner is 2.5 m and the average velocity at exit is 1.5 m/s. If the pressure at inlet to the tube is not to be less than – 0.7 bar, how far the tube should extend above the tail race. Neglect frictional effects and pressure that exit of the draft tube lies 1.2 m below the tail water level.

Q.10.(a). State the momentum equation and mention some of its engineering application.

(b) A 30 cm diameter pipe carries water under a head of 20 metres with a velocity of 3.5 m/sec. If the axis of the pipe turns through 45^0, find the magnitude and direction of the resultant force on the head.