BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. 3rd SEMESTER (Met.E./Min.E.) FINAL EXAMINATION, NOVEMBER, 2012
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) An oil of relative density 0.9 flows upwards through a vertical pipe of diameter 10 cm. The flow is measured by a 20 cm X 10 cm venturimeter. If the throat is 10 cm above the inlet and the coefficient of discharge is 0.99, what is the (i) discharge for a mercury manometer reading of 9 cm, and (ii) mercury manometer reading for a discharge of 50 litre/s.

2. (b) Write down the expressions for specific speed for pump, $\mathbf{N_{sp}}$, and for turbine, $\mathbf{N_{st}}$, explaining clearly the notations used. What are the dimensions of $\mathbf{N_{sp}}$ and $\mathbf{N_{st}}$ in **MLT** and **FLT** system and unit in **SI** and **CGS**?

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) 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. (a) Using diagrams wherever necessary, write short notes on the following:
(i) Draft tubes in reaction turbines, (ii) Wicket gates in Francis turbines, (iii) Speed regulation in turbines.

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 and turbines, (ii) Spiral casing in Francis turbines, (iii) Multi-stage centrifugal pumps.

Second Half

Q.6.(a) State the Newton's Law of viscosity and give examples of its applications. Explain the importance of viscosity in fluid motion. What is the effect of temperature on viscosity of water and that of air ?

(b) Determine the viscosity of a liquid having kinematic viscosity 6 stokes and specific gravity 1.9.

Q.7.(a) How would you determine the horizontal and vertical components of the resultant pressure on a sub-merged curved surface ?

(b) A circular opening, 3 m diameter, in a vertical side of a tank is closed by a disc of 3 m diameter which can rotate about a horizontal meter. Calculate : (i) The force on the disc and (ii) the torque required to maintain the disc in equilibrium in the vertical position when the head of water above the horizontal diameter is 4 m.

Q.8.(a) Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into consideration.

(b) A pipe, through which water is flowing is having diameter, 20 cm and 10 cm at the cross-section 1 and 2 respectively. The velocity of water at section 1 is given 4.0 m/s. Find the velocity head at sections 1 and 2 and also rate of discharge.

Q.9.(a) What is a free jet of liquid ? Derive an expression for the path traveled by free jet issuing from a nozzle.

(b) A nozzle is situated at a distance of 1 m above the ground level and is inclined at an angle of 45^0 to the horizontal. The diameter of the nozzle is 50 mm and the jet of water from the nozzle strikes the ground at a horizontal distance of 4 m. Find the rate of flow of water.

Q.10.(a) State the momentum equation. What is the difference between momentum equation and impulse momentum equation ?

(b) A nozzle of diameter 20 mm is fitted to a pipe of diameter 40 mm. Find the force exerted by the nozzle on the water which is flowing through the pipe at the rate of 1.2 m^3/ minute.