Fourth Semester Examination – 2008

FLUID MECHANICS AND HYDRAULIC MACHINES

Full Marks – 70

Time : 3 Hours

Answer Question No. ***1*** *which is compulsory and any* ***five*** *from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (i) Differentiate between coefficient of dynamic viscosity and kinematic viscosity. State the units of each in SI units.

   (ii) Briefly explain the term total pressure and centre of pressure. Give example of at least 3 hydraulic structures whose design involves determination of total pressure and centre of pressure.

   (iii) With the help of a neat sketch (floating body) explain metacentre and metacentric height.

   (iv) Distinguish between one dimensional, two dimensional and three dimensional flow. Give sketches.

   (v) A flow field is described by $V = (y^2 + z^2)\, i + (x^2 + z^2)\, j + (x^2 + y^2)\, k$. Find the rotational components at (1, 2, 3).

   (vi) Distinguish between hydrodynamic force and hydrostatic force in impact of jet context. Which principle employed to evaluate the magnitude of hydrodynamic force ?

   (vii) Define specific speed of a hydraulic turbine. Write its expression.

   (viii) What do you mean by synchronous speed of generator ? Write its expression.

(ix) What do you mean by cavitation with reference to centrifugal pump ? Where does it occur ?

(x) Compare the discharge vrs crank angle plot in suction and delivery stroke of a single acting and double acting reciprocating pump.

2. (a) 0.0113 m^3 of liquid at pressure 6.87 MPa was compressed to 0.0112 m^3. The final pressure becomes 13.73 MPa. Determine the Bulk modulus of elasticity. 3

(b) A circular lamina 125 cm in diameter is immersed in water at an angle with vertical so that the distance of its edges measured vertically below the free surface varies from 60 cm to 150 cm. Find the total force due to water acting on one side of lamina and the vertical distance of the centre of pressure below the free surface. 7

3. (a) State Pascal's law and with the help of a neat diagram and prove it. Give three examples where this principle is applied. 5

(b) Derive equation for head loss due to friction in pipe (Darcy Weisbach equation). 5

4. (a) Briefly discuss the constructional feature like the angle of convergence and angle of divergence including the length of both portion stating the reason there of in case of venturimeter. Use a sketch. 5

(b) A venturimeter is used for measuring the flow of petrol with sp. gravity 0.81 in a pipe line inclined at 35° to horizontal . The inlet to throat area ratio is 4. If the difference in the mercury level in the gage is 50 mm, calculate the flow in litres per hour if the pipe diameter is 0.3 m. Assume discharge coefficient of meter is 0.975. 5

5. A double overhung Pelton wheel unit is to operate at 30,000 kW generator under an effective head of 300 m at the base of the nozzle. Find

   (a) Size of the jet

   (b) Mean diameter of runner

   (c) Synchronous speed of wheel

   (d) Specific speed

   Assume Generator efficiency 93%, Pelton wheel efficiency 85%, Coefficient of velocity of nozzle = 0.97, Speed ratio = 0.46, Jet ratio =12, No. of poles of generator = 36. 10

6. (a) With the help of a neat labeled diagram, discuss the governing of an impulse turbine. 5

   (b) A single acting reciprocating pump has its piston diameter 15 cm and stroke of 30 cm.

It discharges 300 litres of water per minute at 60 rpm. The suction and delivery heads are 5 m and 15 m respectively. Find the theoretical discharge,coefficient of discharge and percentage of slip of the pump. How much HP will be required to drive the pump with its efficiency is 70%. 5

7. (a) Define specific speed of centrifugal pump. Derive its expression. 3

   (b) A centrifugal pump is required to deliver 40 litres of water per second to a height of 25 m through a 150 mm diameter and 100 m long pipe. The overall efficiency of pump is 75% and Darcy's friction factor for pipe is 0.06. Determine the motor power to drive the pump. Assume no other losses in the pipe line. 7