

Total number of printed pages – 8 B. Tech  
BENG 1208

Third Semester Examination – 2008

FLUID MECHANICS AND  
HYDRAULICS MACHINES

Full Marks – 70

Time – 3 Hours

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

*The figures in the right-hand margin  
indicate marks.*

1. Answer the following questions in brief and to the point : 2×10
- (a) If the specific gravity of a liquid is 0.79, determine its mass density and specific weight.
- (b) The pressure at a particular location of a centrifugal pump measured by a Bourdon

P.T.O.

tube pressure gauge is found to be  $2.3 \text{ kgf/cm}^2$ . Determine the equivalent water head at this location.

- (c) Differentiate between impulse turbine and reaction turbine with an example of each.
- (d) What do you mean by priming of centrifugal pump? Why is it necessary?
- (e) When the pressure of a fluid increased from  $3.5 \text{ MPa}$  to  $6.5 \text{ MPa}$  and the corresponding decreased in volume is found to be  $0.08$  percent. Determine bulk modulus of elasticity of the fluid.
- (f) For a steady incompressible flow, the velocity components are given by  $u = x^2 + y^2$ ,  $v = x - y$ , show if the flow is possible and find relevant stream function.
- (g) What do you mean by total hydrostatic pressure and centre of pressure? Give

examples of three hydraulic structures whose design based on the magnitude of this force and its location.

- (h) Draw the velocity diagram at inlet and outlet for a jet striking at the centre of an impulse turbine blade. Consider three possible cases at outlet side.
  - (i) Define slip and percentage of slip. State possible reason for occurrence of negative slip in case of a reciprocating pump.
  - (j) Mention three possible ways to increase the sensitivity of manometer.
2. (a) Water is flowing in a pipe of  $90 \text{ mm}$  diameter with a mean velocity of  $2 \text{ m/sec}$ . The pressure is measured to be  $350 \text{ kPa}$ . If the pipe is  $8 \text{ m}$  above the datum, determine total head of water. Neglect head loss due to friction.

(b) A pipe of 450 mm in diameter branches into two pipes of diameter 300 mm and 200 mm respectively. If the average velocity in 450 mm diameter is 3 m/sec, determine : 6

(i) Discharge through 450 mm diameter pipe.

(ii) Velocity of flow in 200 mm diameter pipe if the average velocity in 300 mm pipe is 2.5 m/sec.

3. A 300 mm × 150 mm venturimeter is provided in a vertical pipe line carrying oil of sp. Gravity 0.9 and flow being upward. The difference in elevation of the throat section and entrance section of venturimeter is 300 mm. The differential U tube mercury manometer shows a deflection of 250 mm. Find :

(a) Discharge of oil through the pipe.

(b) Pressure difference (in kPa) between inlet and through section of venturimeter. Assume coefficient of discharge of the meter 0.98. 10

4. (a) Explain with neat sketch the metacentre and metacentric height. 3

(b) A rectangular pontoon 10 m long, 7 m broad and 2.5 m deep weighs 686.7 kN. It carries on its upper deck an empty boiler of 5 m diameter weighing 588.6 kN. The centre of gravity of the boiler and the pontoon are at their respective centres along a vertical line. Find the metacentric height. Assume specific weight of sea water is 10.104 kN/m<sup>3</sup>. 7

5. The following data refer to a radial flow reaction turbine :

Overall efficiency = 80%

Power to be developed = 140 kW

Available head = 8 m

Speed ratio = 0.96

Flow ratio = 0.36

Speed of the turbine = 150 rpm

Hydraulic losses = 22 % of available energy

Draw neat sketches and find : 10

- (a) Angle of guide blade at inlet
  - (b) Wheel vane angle at inlet
  - (c) Diameter of wheel
  - (d) Width of wheel at inlet.
6. (a) Draw and label theoretical indicator diagram of a single acting reciprocating pump. Superimpose the effect of acceleration and friction of flow over the same diagram. 4
- (b) A single acting reciprocating pump has a plunger diameter 100 mm and stroke length 200 mm. The length and diameter of suction pipe are 6.5 m and 50 mm

respectively. If the suction lift of the pump is 3.2 m and separation occurs when the pressure inside the cylinder falls below 2.5 m of water absolute and manometer reads 763 mm of mercury. Find the maximum speed at which the pump can be run without separation. 6

7. (a) Describe what do you mean by pumps in series and pumps in parallel as in case of centrifugal pump? What advantage we get from the above two arrangement? 4

- (b) The following data refer to a centrifugal pump :

The diameter of impeller at inlet and outlet = 180 mm and 360 mm respectively.

The width of impeller at inlet and outlet = 144 mm and 72 mm respectively.

The rate of flow through pump = 17.28  
litre/sec

Vane angle at outlet =  $45^\circ$

Neglecting vane thickness and losses  
through the impeller, determine the  
pressure rise in the impeller. 6

8. Answer the following questions : 2.5×4

- (a) Differentiate between venturimeter and orifice meter.
- (b) Compare steady, non steady, uniform and non uniform flow.
- (c) Explain the advantages of using air vessel in suction and delivery pipe of reciprocating pump.
- (d) Give a neat sketch of an impulse turbine governing mechanism.