(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 140405 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. IV) THEORY EXAMINATION 2013-14

FLUID MACHINERY

Time : 3 Hours *Total Marks : 100*

Note :– (i) Attempt **all** questions.

(ii) All questions carry equal marks.

(iii) Assume suitably any relevant data, if required.

SECTION–A

1. Attempt **all** parts : **(10×2=20)**

(a) State the principle on which turbomachines are based.

(b) What are the hydraulic functions of spiral casing, guide vanes and the draft tube ?

(c) Why should it be necessary for the relative velocity vector at inlet to be tangential to the blade tip ?

(d) State the advantages of a Kaplan turbine over Francis turbine.

(e) How does a volute casing differ from a vortex casing for the centrifugal pump ?

(f) What is priming ? Why is it necessary ?

(g) Define slip, percentage slip and negative slip of a reciprocating pump.

(h) What is the difference between a hydraulic coupling and a hydraulic torque converter ?

(i) What is a jet pump ?

(j) What is an air vessel ? What are the uses of air vessels ?

SECTION–B

2. Attempt any **three** parts : **(3×10=30)**

(a) (i) Derive an expression for force F exerted by a jet of area 'a' which strikes a flat plate at an angle θ to the normal to the plate with velocity 'v'. The plate itself is moving with velocity 'u' in the direction of normal to the plate surface.

(ii) A 40 mm diameter jet having a velocity of 20 m/s strikes a flat plate, the normal of which inclined at 30° to the axis of jet. If the plate itself is moving with a velocity of 8 m/s parallel to itself and in the direction of normal to its surface, calculate : Normal forces exerted on the plate, work done per second and efficiency of jet.

(b) (i) How are hydraulic turbines classified ?

(ii) Derive and expression for maximum hydraulic efficiency of a pelton wheel.

(c) Derive an expression for the work done by the impeller of a centrifugal pump on liquid per second per unit weight of liquid.

(d) Show that work saved in overcoming friction in the pipeline by fitting air vessel is 84% for single acting pump and 39.2% for a double acting pump.

(e) Describe with the aid of neat sketch the construction and working of a hydraulic intensifier.

SECTION–C

Note:– Attempt **all** questions. **(5×10=50)**

3. Attempt any **one** part :

(a) A jet of water moving at 12 m/s impinges on a concave shaped vane to deflect the jet through 120° when stationary. If the vane is moving at 5 m/s, find the angle of jet so that there is no shock at inlet. Also compute the absolute velocity of jet at exit both magnitude and direction, and the work done per second per Newton of water. Assume that the vane is smooth.

(b) A stationary vane having an inlet angle of zero degree and an outlet angle of 25° receives water at a velocity of 50 m/s. Determine the components of force acting on it in the direction of jet velocity and normal to it. Also find the resultant force in magnitude and direction.

4. Attempt any **one** part :

(a) An inward flow reaction turbine works under a head of 30 m and discharge of 10 m^3/s. The speed of the runner is 300 rpm. the inlet tip of runner vane, the peripheral velocity of wheel is $0.9\sqrt{2gH}$ and the radial velocity of flow is $0.3\sqrt{2gH}$, where H is the head on the turbine. If the overall efficiency and the hydraulic efficiency of the turbine are 80% and 90% respectively, determine :

(i) the power developed in kW

(ii) diameter and width of runner at inlet

(iii) guide blade angle at intel

(iv) inlet angle at runner vane

(v) diameter of runner at outlet.

Assume that the discharge at outlet is radial.

(b) The following data pertain to a Kaplan turbine :

Power available at shaft = 22500 kW

Head = 20 m

Speed = 150 r.p.m.

Hydraulic efficiency = 95%

Overall efficiency = 88%

Outer diameter of runner = 4.5 m

Diameter of the hub = 2m

Assuming that the turbine discharges without whirl at exit, determine the runner vane angles at the hub and at the outer periphery.

5. Attempt any **one** part :

(a) Show that the rise of pressure in the impeller of a centrifugal pump when frictional and other losses in the impeller are neglected is given by :

$$\frac{1}{2g}\left[v_{f_1}^2 + u_2^2 - v_{f_2}^2 \operatorname{cosec}^2 \phi\right]$$

where :

v_{f_1}, v_{f_2} = velocities of flow at inlet and outlet respectively.

u_2 = tangential velocity of impeller at outlet.

ϕ = vane angle at outlet.

(b) A centrifugal pump is required to discharge 600 litres of water per second and develop a head of 15 m when the impeller rotates at 750 r.p.m. The manometric efficiency is 80%. The loss of head in the pump due to fluid resistance being assumed to be $0.027\ v^2$ m of water, where V is the velocity with which water leaves the impeller. Water enters the impeller without shock or whirl and the velocity of flow is 3.2 m/sec. Determine :

(i) the impeller diameter and outer area,

(ii) the blade angle at the outer edge.

6. Attempt any **one** part :

(a) A single acting reciprocating pump has a piston diameter of 150 mm and stroke length 350 mm. The centre of the pump is 3.5 m above the water surface in the sump and 22 m below the delivery water level. Both the suction and delivery pipes have the same diameter of 100 mm and are 5 m and 30 m long respectively. If the pump is working at 30 r.p.m., determine :

(i) The pressure heads on the piston at the beginning, middle and end of both suction and delivery strokes

(ii) The power required to drive the pump. Take atmospheric pressure as 10.3 m of water.

(b) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. Find an expression for the work done per second in case of a single-acting reciprocating pump.

7. Attempt any **one** part :

(a) Write short notes on the following :

(i) Hydraulic lift

(ii) Hyraulic press and

(iii) Hyraulic coupling.

(b) Explain with neat sketch, construction and working of hydraulic torque converter. Also find the expression for the efficiency of torque converter.