B. Tech Degree IV Semester Examination, April 2008

ME 405 HYDRAULIC MACHINERY

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART - A

(Answer ***ALL*** questions)
(All questions carry ***EQUAL*** marks)

(8 x 5 = 40)

I. (a) Explain the physical interpretation of Reynolds number and Mach number. Also discuss their significance in similitude.

(b) Explain the concept of conservation of linear momentum and angular momentum. How these principles are used in analyzing problems of jet propulsion and hydraulic machinery?

(c) Derive an expression for specific speed of turbines stating all the necessary assumptions and simplifications. How turbines are selected based on specific speed values?

(d) Explain the phenomenon of cavitation in turbines. Why is it inherently absent in impulse turbines?

(e) What is NPSH? Explain its significance.

(f) Compare Reciprocating pumps and Centrifugal pumps using vital points.

(g) Explain the function of surge tank in power plants. Where it is located?

(h) Explain pressure intensifier with a neat sketch.

PART – B

II. (a) Explain Buckingham's Pi-theorem. (5)

(b) Experiences indicates that the head ΔH_D developed by turbo machines depends upon the following variables,

Diameter of rotor, **D**
Rotational speed, **N**
Volume flow through machine, **Q**
Kinematic viscosity, υ

and

Gravity, **g**

Show that,

$$\frac{\Delta H_D}{D} = f\left(\frac{Q}{ND^3}, \frac{g}{N^2 D}, \frac{ND^2}{\upsilon}\right).$$ (10)

OR

III. A 7.5 cm diameter water jet having a velocity of 15 m/s. impinges on the bucket of a wheel. The axis of jet coincides with the axis of the bucket. The bucket is a part of sphere and has a radius of 20 cm, the depth being 10 cm. Determine the force exerted by the jet on the bucket when,

(i) Bucket is fixed

(ii) The bucket is moved in the same direction of jet with a velocity such that work done per second by jet on the bucket would be maximum

(iii) There is a series of buckets in place of only one, and moving with a velocity such that the efficiency is maximum

For each case find out work done and efficiency. (15)

IV. (a) Explain working of Pelton turbine with a neat sketch showing all of its components. (7)

(b) The mean bucket speed of a Pelton turbine is 14 m/s. The rate of flow of water supplied by jet under a head of 45 m is 800 litres per second. If the jet is deflected by the bucket at an angle of 165° from its original course, find the power developed and efficiency of the turbine. Assume no friction on the buckets and coefficient of velocity for the nozzle as 0.985. (8)

OR

V. (a) What is a draft tube? In which turbines they are used? Explain with necessary sketch and theory how it is used to save the head of water leaving from runner exit. (8)

(b) A Kaplan turbine develops 8,000 HP under an effective head of 5 m. Its speed ratio is 2 and flow ratio is 0.6. The diameter of boss is 0.35 times external diameter of runner. Mechanical efficiency of turbine is 90%. Calculate the diameter of the runner, speed of runner and its specific speed. (7)

VI. (a) Derive an expression for the centrifugal head in a cylindrical forced vortex. From this concept obtain the minimum starting speed for the centrifugal pump. (7)

(b) A diffusion type centrifugal pump has a suction lift of 1.5 m and delivery tank is 13.5 m above the pump. The velocity of water in the delivery pipe is 1.5 m/s and the radial velocity of flow through the wheel is 3 m/s. The tangent to the vane at exit from the wheel makes an angle of 120° with the direction of motion. Assuming that water enters radically and neglecting friction and other losses, find

(i) Velocity of wheel at exit

(ii) The pressure head at the exit from wheel

(iii) The velocity head at exit from wheel

(iv) The desirable direction of fixed guide vanes. (8)

OR

VII. (a) Explain the working of Air-vessel in a reciprocating pump with a neat sketch. (7)

(b) The plunger in a reciprocating pump moves with a simple Harmonic motion. Diameter of plunger is 25 cm and stroke is 45 cm. The suction pipe is 125 mm in diameter and 12 m long. The suction lift is 3 m. Calculate the speed at which the pump can operate without separation occurring, separation head being 2.5 m of water. The pump is now equipped with an air vessel on the suction side such that length of the suction pipe form the cylinder to the air vessel is 1.5 m and the mean water level in air vessel is 0.6 m below the centerline of cylinder. Find the speed at which pump can operate with air vessel fitted, separation head remaining the same. Assume a friction factor of 0.01. (8)

VIII. Explain construction, working and principle of operation of Hydraulic ram in detail. (15)

OR

IX. (a) Differentiate between Hydraulic coupling and Hydraulic torque converter. (10)

(b) The weight of a 350 mm plunger of an accumulator is 4,500 Kg. What additional weight is to be placed upon it to develop a hydraulic pressure of 42 Kgf/cm^2. (5)

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