T.E. (Mechanical) (Semester – II) Examination, 2010
FLUID MACHINERY (2003 Course)

Time : 3 Hours Max. Marks : 100

Instructions : *1) Answers to the* ***two*** *Sections should be written in* ***separate*** *books.*
2) ***Neat*** *diagrams must be drawn* ***wherever*** *necessary.*
3) Black figures to the ***right*** *indicate* ***full*** *marks.*
4) ***Use*** *of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is* ***allowed.***
5) Assume ***suitable*** *data, if* ***necessary.***

SECTION – I

Unit – I

1. a) What are hydrodynamic machines ? Explain different efficiencies of hydrodynamic machines. 8

b) A jet of water coming out of 10 cm diameter nozzle strikes a moving blade with a velocity of 15 m/s horizontally and tangentially. The blade is also moving with a velocity of 5 m/s in same direction as that of jet. The blade is so shaped that the jet is deflected through 145°. Neglecting the friction loss over the surface of the blade, find the following :

i) Force exerted by the jet on the vane in the direction of its motion

ii) Power developed

iii) Efficiency of the blade. 8

OR

2. a) A jet of water coming out from a nozzle of 2.5 cm diameter with a velocity 7.5 m/s strikes to hinged rectangular plate of 20 cm height whose point of action is 12 cm below the hinge.

i) Determine the horizontal force required to be applied at the C.G. of the plate to maintain the plate in vertical position.

ii) Find the required velocity of the jet if the plate is deflected through 25° to the vertical and the same force acts on the plate at its C.G. and along the same direction of original. The C.G. of the plate is 10 cm below the hinge and its weight is 60 N. 8

b) Show that when a jet of water impinges on a series of curved vanes, maximum efficiency is obtained when the vane is semi-circular in section and the velocity of the vane is half that at the jet. 8

Unit – II

3. a) With the help of neat sketch describe the main components of a pelton turbine. What are the limitations of a pelton turbine ? 8

b) A pelton wheel is operated by supplying water through a gross head of 500 m. The penstock carrying water from the dam to nozzle is 1m in diameter and 5 km long. The coefficient of friction for the penstock pipe is 0.008. The nozzle diameter supplying the water is 15 cm and it is deflected through 165° by the buckets. Because of friction, the velocity in the bucket passage is reduced by 15%. Find the power developed by the pelton wheel and brake power if the mechanical efficiency is 90%. Also find the hydraulic efficiency and over all efficiency. Take velocity ratio as 0.45. 8

OR

4. a) Prove that the maximum hydraulic efficiency of a pelton wheel is given by

$\eta_{hyd.max.} = \frac{1}{2} Cv^2[1 + k\cos\theta]$ where blade friction coefficient, $K = \frac{Vr_2}{Vr_1}$ and Cv is the coefficient of velocity. 8

b) The following data refers to an outward flow impulse turbine

Inner diameter	= 1.75 m
Outer diameter	= 2 m
Speed	= 300 rpm
No. of vanes	= 30
Vane tip thickness	= 2 cm at inlet, 3 cm at outlet
Supply head	= 50 m
Width of runner	= 25 cm at inlet, 20 cm at outlet
Flow rate	= 6 m^3/s

Calculate moving vane angles at inlet and exit for a radial discharge at exit, if velocity of coefficient, Cv = 0.98. 8

Unit – III

5. a) Differentiate between inward radial flow and outward radial flow reaction turbine. Why inward radial flow reaction turbines are preferred in practice ? 6

b) What is degree of reaction ? Explain its significance. 4

c) A reaction turbine works at 450 rpm under a head of 115 m. The diameter of runner at inlet is 1.2 m and flow area of 0.4 m^2. At the inlet the absolute and relative velocities make angle of 20° and 60° respectively with tangential velocity. Determine runner power and hydraulic efficiency. Assume the velocity of whirl at the outlet to be zero. 8

OR

6. a) What is cavitation ? On what factors does the cavitation in reaction turbines depend ? Explain the methods to avoid cavitations in water turbines. 9

b) A conical draft tube attached to a francis turbine has an inlet diameter of 3 m and its area at exit of 20 m^2. Water enters the draft tube with a velocity of 5 m/s. The inlet of draft tube is 5 m above the tail race level. If the frictional loss in the draft tube is 5% of the velocity head at outlet, find :

i) Pressure head at inlet

ii) Total head at inlet considering tail race level as datum

iii) Power of water at exit of runner

iv) Power lost to tail race

v) Power lost in the draft tube. 9

SECTION – II

Unit – IV

7. a) What do you understand by characteristic curves of a turbine ? Discuss different operating characteristic curves for reaction turbines. 8

b) The following data refers to a turbine at 200 rpm with full gate opening :

Head M	7.5	6.78	6.18	5.67	5.22	4.8
Power KW	266	231	201	176	153	131
Efficiency %	81.1	83.1	84.4	84.6	85.0	84.1

Draw graph of unit power and efficiency against unit speed. How much water is required per second for maximum output under a head of 6.3 m ? 10

OR

8. a) A francis turbine of diameter 3 m develops 7000KW at 300rpm when the head available is 50 m. A model of scale 1 : 8 is to be tested in the laboratory where the head available is 10 m. Find the size, speed, discharge and power developed by the model. Assume overall efficiency for both is 0.8. Also find specific speed for both. 8

b) Derive on expression for specific speed of a water turbine. What is its effect on the shape of runner in the water turbine ? 5

c) Define specific speed of a pump and explain its importance particularly for model testing. 5

Unit – V

9. a) What is cavitation and causes for creating the cavitation in centrifugal pump ? Explain the effects of cavitation and methods of its preventation. 8

b) A centrifugal pump is coupled with diesel engine and running at 1000 rpm. The water enters the pump radially and the velocity of flow is constant through the impeller. The inside and outside diameters of the pump are 20 cm and 40 cm respectively. The inlet and exit blade angles are 20°C and 30°C. Width of the vane at inlet is 2cm. Take overall efficiency as 70% and mechanical efficiency as 90%. Neglecting losses and blade thickness, calculate discharge through the pump and power input given by the diesel engine. 8

OR

10. a) The following table gives head discharge characteristics of a centrifugal pump at constant speed.

'Q' lpm	0	200	400	600	800	1000	12000
'H' m	15	14.6	13.2	11.0	8.4	7.2	5.8
%η	0	46	71	78	70	62	50

Two such pumps are connected in parallel with common suction and delivery pipes to operate against a static lift of 7.5 m. The frictional external losses to the pump are given by $2.05Q^2 \times 10^{-6}$ m where 'Q' is the discharge in lpm. Calculate the discharge, head and power required to drive the pumps when :

i) Only one pump is operated

ii) Two identical pumps are operated in parallel. 16

Unit – VI

11. a) Explain construction and working of a hydraulic torque converter with the help of neat sketch. **8**

b) A hydraulic ram delivers water at the rate of 5 litres/sec to a tank located at 40 m from the ram. The water is supplied to the ram from a tank of 5 m height from ram at a rate of 50 litres/sec. The length and diameter of the delivery pipe are 60 m and 6 cm respectively. Find the D'Aubuisson and Ronkine efficiencies of the ram. Take F = 0.01 for delivery pipe. **8**

OR

12. Write short notes on : **16**

i) Airlift pump

ii) Regenerative pump

iii) Deep well pump

iv) Fluid coupling.

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