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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2017/Jan - 2018

Turbo Machines

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit*
ii) Missing data if any may be suitably assumed.

UNIT - I

1 a. Compare turbo-machine with positive displacement machine. 10

b. Derive Euler turbine equation and then obtain alternate form of Euler turbine equation. 10

2 a. Define degree of reaction and prove that the utilization factor $\varepsilon = \frac{V_1^2 - V_2^2}{V_1^2 - RV_2^2}$ where V_1 and V_2 are the absolute velocity at inlet and outlet respectively and R is degree of reaction. 10

b. In an inward flow radial turbine water enters at an angle of 22º to the radial direction and leave the turbine radially. The rotor speed is 300 rpm. The flow velocity 3 m/s and is constant the inner and exit diameter of the arc 0.3 m and 0.6 m respectively the width of the wheel at the inlet is 15 cm. Calculate; 10

i) Rotor blade angles ii) Power developed.

Neglect the thickness of the blades.

UNIT - II

3 a. Define the following unit quantities and derive the expression for them : 10

i) Unit discharge ii) Unit power iii) Unit speed.

b. In a power station each pelton wheel produces 15456 kW under a head of 335 m. The turbine speed is 500 rpm. Assume a turbine efficiency of 0.84, jet velocity coefficient 0.98, speed ratio 0.46 and bucket velocity coefficient $C_b = 0.85$. Calculate; 10

i) The number of Jets ii) The diameter of Jets

iii) Tangential force exerted on the buckets.

Assume the bucket deflects the jet through 165°, and jet ratio m = 10.

4 a. Define; i) Gross head ii) Effective head of a hydraulic turbine. 4

b. Draw the neat sketch of pelton wheel and explain the main components. 8

c. Prove that for a pelton wheel maximum hydraulic efficiency occurs at a speed ratio of 0.5 and hence obtain the expression for maximum hydraulic efficiency. 8

UNIT - III

5 a. Draw any five types of runner used in reaction turbines giving their inlet velocity triangle also mention the range for Ns, α, Ø, β and b/D ratio for each runner. 10

b. *A*n inward flow Francis turbine is required to develop 3680 kW (5000HP) when operating under a head of 30 m with a specific speed of 270. Assuming the guide vane angle at full opening is 30º, *t*heoretical hydraulic efficiency 90% overall efficiency 87% radial velocity of flow at inlet is $0.3\sqrt{2gh}$ blade thickness coefficient 5%, draw the inlet velocity diagram. 10

Contd…2

Find,

i) Speed of the runner ii) The diameter and width of the wheel at the inlet

iii) Runner blade angle at the inlet.

6 a. What are the different types of draft tubes used in reaction turbines? Sketch any four types of draft tube. 5

b. For a conical draft tube, derive the expression for the pressure head at the inlet. 5

c. A Kaplan turbine produces 25 MW operating under a head of 40 m. The blade tip diameter is 2.5 times the hub diameter and the overall efficiency is 0.9. If the speed and flow ratio are 2.0 and 0.6 respectively, Calculate the diameter and the speed of the turbine. 10

UNIT - IV

7a. Why is compounding of steam turbine is necessary? Describe with neat sketch any two method of compounding. 10

b. Steam issuing from a nozzle to a De-Laval turbine with a velocity of 1000 m/s the nozzle angle is 20º. The mean blade velocity is 400 m/s. The blades are symmetrical, the mass flow rate is 1000kg/hr. Friction factor is 0.8, Nozzle efficiency is 0.95. Calculate; 10

i) Blade angles ii) Axial thrust iii) Work done /kg of steam

iv) Power developed v) Blade efficiency vi) stage efficiency.

8 a. Prove that for a Parson's reaction turbine (50% reaction) maximum blade efficiency $\eta_{D,\max} = \frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$. 10

b. The following particular refers to a Parson's reaction turbine consisting of one ring of fixed blade and one ring of moving blade. The mean diameter of the blade ring is 90 cm, and its speed is 3000 rpm. The inlet absolute velocity to the blade is 300 m/s. The blade out let angle is 20º. The rate of steam flow is 7.6 kg/s. Calculate the blade inlet angle tangential force and Power developed assuming no friction. 10

UNIT - V

9 a. Draw a neat diagram of centrifugal pump and explain the main parts. 10

b. A centrifugal pump having outer diameter equal to 2 times the inner diameter and running at 1000 rpm, working against a head of 30 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40º at the outlet. If the outer diameter is 50 cms and the width at the outlet is 5 cm. Calculate; 10

i) Vane angle at the inlet ii) Work done by the impeller on water per second

iii) Manometric efficiency.

10 a. Define; i) Manometric efficiency ii) Mechanical efficiency 6

iii) Overall efficiency of a centrifugal pump.

b. Define; 4

i) Static head ii) Manometric head of the Centrifugal pump.

c. A centrifugal pump with 1.2 m diameter runs at 200 rpm and pumps 1.88 m^3/s, the average lift being 6 m. The angle which the vane make at exit with the tangent to the impeller is 26º, the radial velocity of flow is 2.5 m/s. Find the monomeric efficiency, the least speed to start pumping if the inner diameter being 0.6 m. 10

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