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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. - 2019

Turbo Machines

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Derive the alternate form of Euler-Turbine equation with components of energy transfer. 10

b. At a 50% reaction stage axial flow turbine, the mean blade diameter is 0.6 m the maximum utilization factor is 0.9 with a steam flow rate of 10 kg/s. Calculate the absolute velocities and power developed, if the speed is 2000 rpm. 10

2 a. Draw the velocity triangles with conditions for the following in turbines: 10

i) Discharge is radial ii) Blades are radial

b. Define a turbo machine. State the difference between turbo machine and positive displacement machine with respect to, 10

i) Action ii) Volumetric efficiency

iii) Mechanical features iv) Operation

UNIT - II

3 a. Define unit quantities and obtain the expression for the same with significance. 10

b. A 137 mm diameter jet of water is suing from a nozzle impinges on the buckets of a pelton wheel and the jet is deflected through an angle of 135°. The head available at the nozzle is 400 m. Assume $C_v = 0.97$ and speed ratio = 0.46 with a reduction in relative velocity of 15%, Find; 10

i) Force exerted by the jet in the tangential direction ii) Power developed by the turbine

4 a. With usual notation, prove that the hydraulic efficiency, $\eta_{hy} = \dfrac{2U\left(vw_1 + vw_2\right)}{V_1^2}$ for Pelton wheel. 10

b. Design a Pelton wheel for a head of 60 m, when running at 200 rpm. It develops 95.64 kW shaft power. The velocity of bucket is 0.45 times the jet velocity. Take overall efficiency to be 0.85 and velocity coefficient of 0.98. 10

UNIT - III

5 a. The external and internal diameters of a Francis turbine are 1.2 m and 0.6 m respectively. The head of the turbine is 22 m and the velocity of flow is constant and is 2.5 m/s. The guide blade angle is 10° and vanes of runner are radial at inlet. If the discharge is radial at outlet. Determine; 10

i) Speed of turbine

ii) The vane angle at outlet

iii) Draw velocity triangles

Contd…2

b. Why draft tube is required for reaction turbines? Obtain an expression for efficiency of draft tube. 10

6 a. State the important features of Kaplan turbine. 4

b. In a power plant, a Kaplan turbine operates a 5 MW generator at 150 rpm under a head of 5.5 M. The generator efficiency is 93% and overall efficiency of turbine is 88%. Calculate the total discharge through turbine. 6

c. A Kaplan turbine runner is to be designed for 7357.5 kW shaft power. The net head is 5.5 m. Assume speed ratio = 2.09, flow ratio of 0.68, overall efficiency of 60%, the diameter of boss is 1/3 of runner diameter. Find; 10

i) Diameter of runner ii) Speed iii) Specific speed

UNIT - IV

7 a. Explain the need for compounding. With sketch, explain velocity compounding. 8

b. In a single stage impulse turbine, the diameter of blade ring is 1m and speed is 3000 rpm. The steam is issued from a nozzle at 300 m/s and nozzle angle is 20°. The blades are equiangular. If $V_{r2}/V_{r1} = 0.8$. Find the power developed when the axial thrust on the blade is 90 N. 12

8 a. Prove that for 50% degree of reaction, the velocity triangles are symmetric? Name the turbine. 8

b. Obtain an expression for maximum blade efficiency in a reaction staging. 8

c. Explain the effect of speed ratio on the blade efficiency in a turbine staging (impulse). 4

UNIT - V

9 a. A centrifugal pump is running at a speed of 1000 rpm. The outlet vane angle is 45° and velocity of flow at outlet is 2.5 m/s, the discharge through the pump is 200 LPS when the pump is working against a head of 20 m. If the Manometric efficiency is 80%. Determine; 10

i) Diameter of impeller

ii) Width of impeller at outlet

b. Explain the different ways of expressing Manometric head in a centrifugal pump with equations. 10

10 a. Obtain an expression for minimum speed for starting a centrifugal pump. 6

b. Explain the necessity of primping a pump. 4

c. A 3 stage centrifugal pump has impeller 40 cm in diameter and 2 cm wide at outlet. The vane tip angle at outlet is 45° and reduces the circumferential area by 10%. The Manometric efficiency = 90% and overall efficiency is 80%. Determine the head generated by the pump when running at 1000 rpm delivering 50 LPS, what should be the shaft power? 10

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