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06ME55

Fifth Semester B.E. Degree Examination, June/July 2016
Turbo Machines

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of steam tables and thermodynamics data hand book permited.***

PART – A

1 a. Explain with neat sketch the different parts of a turbo machine. **(08 Marks)**

b. A centrifugal pump is required to handle water at a capacity of 6.75 m^3/sec, head of 125 m and a speed of 350 rpm. In designing a model of this pump the laboratory conditions impose a maximum capacity of 0.127 m^3/sec and a power consumption of 220 kW. If model and prototype efficiencies are assumed same, find the speed of the model and scale ratio. **(12 Marks)**

2 a. Show that with the help of velocity triangles, for maximum utilization energy transfer in impulse type axial flow turbine is twice as that of the 50% reaction axial flow turbine for the same rotor speeds. **(10 Marks)**

b. At a stage of an impulse turbine, the mean blade diameter is 80 cm, its rotational speed being 3000 rpm. The absolute velocity of fluid discharging from a nozzle inclined at 20° to the plane of the wheel is 300 m/s. If the utilization factor is 0.85 and the relative velocity at the rotor exit equals that at inlet, find the blade angles at inlet and exit. Also find the power output from the stage for a mass flow rate of 1 kg/s. **(10 Marks)**

3 a. A radial outward flow turbomachine has no inlet whirl. The blade speed at the exit is twice that at inlet. Radial velocity is constant throughout. Taking the inlet blade angle as 45°, show that degree of reaction, $R = \frac{2 + \cot\beta_2}{4}$

where β_2 is the blade angle at exit. **(10 Marks)**

b. In a radial inward flow turbine, the runner outer diameter is 75 cm and the inner diameter is 50 cm. The runner speed is 400 rpm, water enters the runner at a velocity of 15 m/s at an angle of 15° to the wheel tangent at inlet. The flow is radial at exit with a velocity of 5 m/s. Find the blade angle at inlet and exit. Also determine the power output for a flow rate of 1.5 m^3/s, degree of reaction and utilization factor. **(10 Marks)**

4 a. Obtain an expression for the overall isentropic efficiency interms of the stage efficiency, pressure ratio per stage, the number of stages and the ratio of specific heats for a turbine. **(10 Marks)**

b. A 16-stage axial flow compressor is to have a pressure ratio of 6.3 and tests have shown that a stage efficiency of 89.5% can be obtained. The intake conditions are 288 K and 1 bar. Find
i) Overall efficiency.
ii) Polytropic efficiency.
iii) Pre heat factor. **(10 Marks)**

PART – B

5 a. Draw the sketch of an axial flow compressor with inlet guide vanes and explain the working principle of the compressor. **(08 Marks)**

b. A centrifugal compressor rotor has inlet radius of 30 cm and exit radius of 60 cm. Entry is radial with a component of 60 m/s which is constant throughout. The compressor requires 700 kW of power to handle 20 kg of air per second. Find the blade angles at inlet and outlet if the compressor runs at 5100 rpm. Calculate the width at inlet and outlet, if specific volumes at inlet and outlet are respectively 0.85 m^3/kg and 0.71 m^3/kg. What is the degree of reaction? **(12 Marks)**

6 a. Derive an expression for head-capacity (H-Q) charecteristics curve for a centrifugal pump. Discuss the head-capacity for the forward, radial and backward curved blades. **(10 Marks)**

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

Calculatei) Vane angle at the inlet.

ii) Work done by the impeller on water/sec.

iii) Manometric efficiency. **(10 Marks)**

7 a. What is compounding in steam turbine? What is the necessity of compounding and explain with neat sketch pressure-velocity compounding. **(06 Marks)**

b. In a Curtis stage with two rows of moving blades, the rotors are equiangular. The first rotor has angle of 29° each while second rotor has angle of 32° each. The velocity of steam at the exit of nozzle is 530 m/s and the blade co-efficients are 0.9 in the first, 0.95 in stator and in the second rotor. If the absolute velocity at the stage exit should be axial, find

i) Mean blade speed.

ii) The rotor efficiency.

iii) Power output for a flow rate of 32 kg/s. **(14 Marks)**

8 a. Show that for maximum hydraulic efficiency of a pelton wheel, the speed of the wheel is equal to half of speed of jet. **(10 Marks)**

b. A pelton wheel produces 15456 kW under a head of 335 m running at a speed of 500 rpm. Turbine overall efficiency = 0.84. Jet velocity co-efficient = 0.98, speed ratio = 0.46. If the bucket deflect the incoming jet through an angle of 165°, determine

i) The number of jets as well as the dia of each jet.

ii) The tangential force exerted by the jets on the buckets. **(10 Marks)**

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