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06ME55

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Turbo Machines

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define turbo machines. How do you classify turbo machines? **(05 Marks)**

b. Derive on the basis of dimensional analysis, suitable parameters to present the thrust developed by a propeller. Assume that the thrust developed 'P' depends upon the angular velocity 'W', speed of advance 'V', diameter 'D', dynamic viscosity 'μ', mass density 'ρ'.Elasticity of the fluid medium which can be denoted by the speed of sound in the medium 'C'. **(10 Marks)**

c. Two geometrical similar pumps are run at the same speed for 1000 rpm. One pump has an impeller diameter of 0.3 meter and lift water at the rate of 20 litre/second against the head of 15 meter. Determine the head, the impeller diameter of the other pump to deliver half of the discharge. **(05 Marks)**

2 a. Derive Euler's turbine equation in terms of components. State the assumptions. **(08 Marks)**

b. In a Francis turbine of inward flow reaction type the discharge is radial. At inlet the blade speed is found to 20 m/sec and tangential component of fluid is 15m/sec. The radial velocity of flow is constant and equal to 2m/sec. The water flows at the rate of $0.7m^3$/sec. If the utilization factor is 0.8.

Find i) Energy transfer /unit mass flow
ii) Power developed in kws
iii) Inlet blade angle
iv) Degree of reaction **(12 Marks)**

3 a. An Inward flow radial turbine has nozzle angle α with respect to tangential direction and two rotor blades are radial at entry. The radial velocity is constant and there is no whirl velocity at discharge, show that

$$\epsilon = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$$ **(10 Marks)**

b. At a stage of 50% degree of reaction, axial flow turbine the mean blade diameter is 600mm. The maximum utilization factor is 0.89, steam flow rate is 10 kg/sec. Find the inlet and outlet absolute velocities and power developed if the speed is 2000 rpm, also write velocity triangles. **(10 Marks)**

4 a. Derive an expression for polytropic efficiency for a compression process. **(05 Marks)**

b. Discuss reheat factor with T-S diagram. **(05 Marks)**

c. Turbine 'A' has inlet conditions of 5.6 bar, 735°C and a velocity of 170m/sec. The pressure at the discharge is one bar, the temperature 182°C and velocity 230m/sec. Turbine B consists of 8 stages each of total head efficiency of 87% and total head pressure of 1.25. The discharge velocity is 100m/sec. The inlet conditions are same as for turbine A. Which turbine delivers more shaft work? **(10 Marks)**

PART – B

5 a. With the help of inlet and outlet velocity triangle show that degree of reaction for a axial flow compressor.

$R = \frac{Va}{u} \tan \beta m$ where Va = Axial velocity u= blade speed

$\tan \beta m = \frac{\tan \beta_1 + \tan \beta_2}{2}$

β_1 and β_2 are inlet and outlet blade angle with respect to axial direction. **(10 Marks)**

b. A centrifugal compressor runs at 15,000 rpm and provides a stagnation pressure ratio of 4 between the impeller inlet and outlet. The stagnation conditions of the air at the compressor intake are one atmosphere and 25°C respectively. The absolute velocity at the compressor intake is axial. If the compressor has radial blades at the exit such that Vr_2 = 135 m/sec and the total efficiency of the compressor is 78% draw the velocity triangle at the exit of the rotor and calculate the slip and slip co-efficient. Rotor diameter at the outlet in 580mm. **(10 Marks)**

6 a. Explain with sketches different types of casings used in a centrifugal pump. **(05 Marks)**

b. Derive an expression for the minimum speed for starting centrifugal pump. **(05 Marks)**

c. A centrifugal pump delivers 50 liter of water per second against a head of 24 meter, running at 1500 rpm. The velocity of flow of 2.4m/sec is constant and the blades are bend back at 30°. The inner diameter is half the outer diameter. If mano metric efficiency is 80% determine the blade angle at inlet and power required to drive the pump. **(10 Marks)**

7 a. Why steam turbines are compounded? Describe the pressure velocity compounding with a neat sketch. **(08 Marks)**

b. Velocity of steam flow from a nozzle of D.Laval steam turbine is 1500 m/sec. The nozzle angle is 25°, If the rotor blades are equiangular and the rotor tangential speed is 600m/sec. find blade angles at inlet and outlet, tangential force on the rotor blades and power output. **(12 Marks)**

8 a. Sketch a Kaplan turbine and indicate all the parts. **(03 Marks)**

b. A Kaplan turbine produces 58,800 kws under head of 25 meters which has an overall efficiency of 90%. Taking the value of speed ratio 1.6, flow ratio 0.5 and the hub diameter is 0.35 times the outer diameter. Find the diameter and speed of the turbine. **(07 Marks)**

c. A double jet pelton wheel is required to generate 7500kws when the available head at the base of the nozzle is 400 meter. The jet is deflected through 165° and the relative velocity of the jet is reduced 15%, where passing over the buckets. Determine

i) Diameter of each jet

ii) Total flow

iii) Force exerted by the jets in tangential direction. Assume generator efficiency as 95%, over all efficiency 80%, speed ratio 0.47, the coefficient of velocity for the nozzle is 0.98. **(10 Marks)**

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