CBCS SCHEME

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18MR55

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define a Turbomachine. With a neat sketch, explain the parts of a turbomachine. **(10 Marks)**

b. The quantity of water available for a hydroelectric power station is 280m^3/S. The head developed is 1.5m. If the speed of the turbine is 60 rpm and the efficiency 85%, find the number of turbines. Assume specific speed to be 750. **(10 Marks)**

OR

2 a. Derive an expression for Polytropic efficiency of turbine i.e.

$$\left[\eta_p = \left(\frac{\gamma}{\gamma-1}\right)\left(\frac{n-1}{n}\right)\right].$$ **(10 Marks)**

b. The output of three stage gas turbine is 30MW at the shaft coupling at an entry temperature of 1500K. The overall pressure ratio across the turbine is 11.0 and efficiency is 88%. If the pressure ratio of each stage is the same, determine i) Pressure ratio of each stage ii) Polytropic efficiency iii) The mass flow rate iv) The efficiency and power of each stage. Assume $\gamma_{air} = 1.4$, $C_p = 1.005$kJ/kg K. $\eta_{mech} = 91\%$. **(10 Marks)**

Module-2

3 a. Define Utilization factor for a turbine. Derive an expression relating utilization factor with degree of reaction for an axial flow turbine. **(10 Marks)**

b. Draw the velocity triangles at inlet and outlet of an axial flow compressor from the following data : Degree of reaction 0.5 , Inlet blade angle 45° , Axial velocity of flow which is constant throughout 120m/s , Speed of rotation is 6500 rpm , Radius of rotation 2cm , Blade speed at inlet is equal to blade speed at outlet. Calculate angles at inlet and outlet. Also calculate power needed to handle 1.5 kg/s of air. **(10 Marks)**

OR

4 a. Derive an expression for Theoretical head capacity relationship of Radial outward flow devices. **(10 Marks)**

b. Outer diameter of a pump is 50cm and inner diameter is 25cm and runs at 1000 rpm against a head of 40cm. Velocity of flow is constant and is equal to 2.5m/s. Vanes are set back at an angle of 40° at the outlet. Width at outlet is 5cm. Find Vane angle at inlet, work done by impeller , manometric efficiency. **(10 Marks)**

Module-3

5 a. Derive the condition for maximum efficiency of an impulse turbine and show that the maximum efficiency is $Cos^2\alpha_1$. **(10 Marks)**

b. In a single stage impulse turbine the mean diameter of the blades is 2m. It runs at 3000 rpm. The steam supplied from a nozzle at a velocity of 450m/s and the nozzle angle is 20°. The rotor blades are equiangular. The blade friction factor is 0.92. Draw the velocity diagram and calculate the power developed if the axial thrust is 150N. **(10 Marks)**

OR

6 The first stage of an impulse turbine is velocity compounded with two rows of moving blades , steam enters the blade passage at an absolute of 760 m/s and at an angle of 17° to the plane of rotation. The mean blade diameter is 800mm and the exit angles from the first row of moving blades, the fixed blades and the second row of moving blades are 22° , 28° and 36° respectively. The blade velocity coefficients is 0.9 over each of the three rows of blades. The mass flow rate is 5.75 tonne/hr and the turbine shaft is 3120 rpm. Determine each of the following :
i) The blade inlet angles ii) The power developed iii) The diagram efficiency. **(20 Marks)**

Module-4

7 a. Show that for a Pelton wheel maximum hydraulic efficiency is given by

$$(\eta_H)_{max} = \frac{1+K\cos\beta_2}{2}$$ **(10 Marks)**

b. In a power station, Pelton wheel producers 15,000 kW under a head of 350m while running at 500rpm. Assume a turbine efficiency of 0.84, Coefficient of velocity for nozzle as 0.98 , $\phi = 0.46$ and bucket velocity coefficient 0.86. Estimate the number of jets , the diameter of jet and the tangential force exerted on the buckets. Take $\theta = 165°$. **(10 Marks)**

OR

8 a. With a neat sketch, explain the principle and working of Francis turbine. **(10 Marks)**
b. A Kaplan turbine develops 1500 KW under a head of 6m. The turbine is set 2.5m above the tail race level. A vacuum gauge inserted at the turbine outlet records a section head of 3.2m. If the efficiency is 85%, what will be the efficiency of the draft tube having inlet diameter of 3m. **(10 Marks)**

Module-5

9 a. With a neat sketch explain the working of Centrifugal pump. **(10 Marks)**
b. A Centrifugal pump impeller has outside diameter of 200mm and rotates at 2900 rpm. The vanes are curved backward at 25° to the wheel tangent. The velocity of flow is constant at 3m/s. Assume hydraulic efficiency as 75% and determine the head generated. Also determine the power required to run the impeller, if the breadth of the wheel at outlet is 15mm. Neglect the effect of vane thickness, mechanical friction and leakage in the pump. **(10 Marks)**

OR

10 a. What is minimum starting speed of a Centrifugal pump? Derive an expression for minimum starting speed. **(10 Marks)**
b. Write a note on the following with respect to Centrifugal pump :
i) Cavitation.
ii) Need for priming.
iii) NPSH.
iv) Pumps in series and parallel. **(10 Marks)**

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