CBCS SCHEME

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15ME53

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Turbo Machines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Distinguish between a Turbo Machine and a positive displacement machine. **(06 Marks)**

b. Define the specific speed of a turbine. **(02 Marks)**

c. A one-fifth scale model of a pump was tested in a laboratory at 1000rpm. The head developed and the power input at the best efficiency point were found to be 8m and 30kW respectively. If the prototype pump has to work against a head of 25m, determine its working speed, the power required to drive it and the ratio of the flow rates handled by the two pumps. **(08 Marks)**

OR

2 a. Define Mach number and explain with neat sketch: i) The subsonic flow ii) Sonic flow of a compressible fluid. **(08 Marks)**

b. An air compressor has eight stages of equal pressure ratio 1.3. The flow rate through the compressor and its overall efficiency are 45kg/s and 80% respectively. If the conditions of air at entry are 1 bar and 35°C determine: i) State of air at compressor exit ii) Polytropic efficiency iii) Stage efficiency. **(08 Marks)**

Module-2

3 a. Derive head-capacity relationship for centrifugal pump and explain the effect of discharge angle on it. **(08 Marks)**

b. At a 50% reaction stage axial flow turbine, the mean blade diameter is 60cm. The maximum utilization factor is 0.9, steam flow rate is 10kg/s. Calculate the inlet and outlet absolute velocities and power developed if the speed is 2000 rpm. **(08 Marks)**

OR

4 a. Show that $\in_{max}$ of an axial flow turbine with degree of reaction = 1/4, the relationship of blades speed 'U' to absolute velocity at rotor inlet 'V_1' should be $\frac{U}{V_1} = \frac{2}{3}\cos\alpha$. Where '$\alpha$' is nozzle angle at inlet. **(08 Marks)**

b. A single stage axial flow blower with no inlet guide vanes, operates at 3600RPM. The tip and hub diameters of the rotors are 20cm and 12.5cm respectively. The air flow through the stage is 0.45kg/s. The air turned through an angle of 20° towards the axial direction during the passage through the rotor at the mean diameter. Assuming standard atmospheric conditions, constant axial velocity and no losses in the rotor. Compare i) The power input in kW ii) Degree of reaction. **(08 Marks)**

Module-3

5 a. Define degree of reaction. Prove that moving blades and final blades should have the same shape for a 50% reaction. **(08 Marks)**

b. Following data refers to a De Laval steam turbine having equiangular blades;
Blade speed = 20m/s, Blade velocity co-efficient = 0.85, Mass flow rate of steam = 3kg/s, Absolute velocity of steam at exit from stage = 90m/s, Angle of absolute velocity of steam at exit from stage with tangent of wheel = 75°, Determine i) The blade angle ii) The nozzle angle iii) Absolute velocity of steam at inlet iv) Power developed. **(08 Marks)**

OR

6 a. What is compounding of steam turbine? Explain pressure compounding of steam turbine with a neat sketch. **(08 Marks)**

b. In a 50% reaction turbine, the blade tips are inclined at 35° and 20° in the direction of motion. At a certain place in the turbine, the drum diameter is 1 meter and the blades are 10cm high. At this place the steam having specific volume of $0.938 m^3/kg$, passes through the blades without shock. Find the mass of steam flow and power developed of the speed of the turbine is 250rpm. **(08 Marks)**

Module-4

7 a. Explain the working of Francis turbine with a neat sketch. **(08 Marks)**

b. Determine the power given by the jet of water to the runner of a pelton wheel which is having tangential velocity as 20m/s. The net head on the turbine is 50m and discharge through the jet water is $0.03 m^3/s$. The side clearance angle is 15° and take $C_V = 0.975$. Find also the manometric efficiency. **(08 Marks)**

OR

8 a. Derive an expression for maximum efficiency of the pelton wheel giving the relationship between the jet speed and bucket speed. **(08 Marks)**

b. The external and internal diameters of an inward flow reaction turbine are 1.2m and 0.6m respectively. The head on the turbine is 22m and velocity of flow through the runner is constant and equal to 2.5m/s. The guide blade angle is given as 10° and the runner vanes are radial at inlet. If the discharge at outlet is radial determine : i) The speed of the turbine ii) The vane angle at outlet of the runner iii) Hydraulic efficiency. **(08 Marks)**

Module-5

9 a. Derive an expression for the minimum speed for starting a centrifugal pump. **(08 Marks)**

b. A three stage centrifugal pump has impellers 40cm in diameter and 2cm wide at outlet. The vanes area curved back at the outlet at 45° and reduce the circumferential area by 10%. The manometric efficiency is 90% and the overall efficiency is 80%. Determine the head generated by the pump when running at 1000rpm, delivering 50 litres per second. What should be the shaft power? **(08 Marks)**

OR

10 a. With neat sketch, explain slip, slip coefficient and slip factor. **(06 Marks)**

b. Explain phenomenon of surging. **(02 Marks)**

c. An axial flow compressor has the following data:
Entry conditions : 1 bar and 20°C
Degree of reaction : 50%
Mean blade ring diameter : 36cm
Rotational speed : 18000rpm
Blade angle at rotor and stator exit : 65°
Axial velocity : 180m/s
Mechanical efficient : 96.7%
Find: i) Blade angle at rotor and stator inlet ii) Power required. **(08 Marks)**

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