CBCS SCHEME

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15ME53

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
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. Define Turbomachine. With a neat sketch, explain the parts of Turbomachine. **(04 Marks)**

b. Define specific speed of a pump. Obtain an expression for the same in terms of Discharge, Speed and head. **(06 Marks)**

c. Test on a Turbine Runner 1.25m in diameter at 30m head gives the following result, power developed 736kW, speed 180rpm, Discharge 2.7m/s. Find the Diameter, Speed and Discharge of a Runner to operate at 45m head and gives 1472kW power at same efficiency. **(06 Marks)**

OR

2 a. Derive an expression for polytropic efficiency of a compression process Interms of pressure and temperature ratio. **(06 Marks)**

b. A 16 stage Axial flow compressor is to have a pressure ratio of 6.3 and test have shown that a stage efficiency of 89.5% can be obtained. The Intake conditions are 288°K, 1 bar. Find:
i) Overall Efficiency
ii) Polytropic Efficiency
iii) Preheat factor. **(06 Marks)**

c. Explain static and stagnation state for a fluid. **(04 Marks)**

Module-2

3 a. Derive the alternate form of Euler's Turbine equation and state the significance of each components. **(08 Marks)**

b. As inward flow radial Vane Turbine has the following data: Power = 150kW, Speed = 32000rpm, Outer diameter of the Impeller = 20cm, Inner diameter of the Impeller = 8cm. Absolute velocity of gas at entry = 387m/s. Absolute velocity of gas at Exit = 193m/s and is Radial in direction, construct the velocity triangle at entry and exit of the Impeller and Determine:
i) Mass flow rate ii) Percentage energy transfer due to change of radius. **(08 Marks)**

OR

4 a. The total power Input at a stage in an axial flow compressor with symmetric inlet and outlet velocity triangle (R = 0.5) is 27.85kJ/kg of air flow. If the blade speed is 180m/s throughout the Rotor, Draw the velocity triangle and compute the inlet and outlet rotor blade angles. Assume axial velocity component to be 120m/s. **(08 Marks)**

b. The mean Rotor blade speed of an Axial flow turbine stage with 50% reaction is 210m/s. Steam emerges from the Nozzle inclined at 28° to the plane of the wheel with Axial component equal to blade speed. Assuming symmetric inlet and outlet velocity triangles. Determine the Rotor blade angle and utilization factor. Also determine the degree of reaction to make the utilization maximum if the axial velocity, blade speed as well as nozzle angle remain the same. **(08 Marks)**

Module-3

5 a. Define: i) Blade efficiency ii) Nozzle efficiency iii) Stage efficiency for impulse steam turbine. **(06 Marks)**

b. Derive an expression for condition for maximum efficiency of a reaction steam turbine. **(10 Marks)**

OR

6 a. In a 50% Reaction Turbine the blade speed is 65m/s dry steam at 1.5bar flows at 5kg/s the blade angles are 20° and 35°. Find: i) Blade height which is 1/10 diameter of the blade ring ii) Power developed iii) Heat drop if stage efficiency is 80%. **(08 Marks)**

b. In a Parsons Turbine the axial velocity of flow of steam is 0.5 times the mean blade speed. The outlet angle of the blade is 20°, the diameter of the blade ring is 1.3m and the Rotational speed is 3000rpm. Determine inlet blade angles, power developed for the steam flow of 65kg/s and the Isentropic Enthalpy drop if the stage efficiency is 80%. **(08 Marks)**

Module-4

7 a. Classify Hydraulic turbines with examples. **(04 Marks)**

b. With a neat sketch, explain Pelton Wheel Turbine. **(05 Marks)**

c. A Pelton Wheel is to be designed for the following specifications. Shaft power = 735kW, head = 200m, speed = 600rpm, overall efficiency = 0.75, the jet diameter not to exceed $1/10^{th}$ of the wheel diameter, $C_v = 0.958$, speed ratio = 0.5. Determine: i) Wheel diameter ii) Number of Jets required iii) Diameter of Jet. **(07 Marks)**

OR

8 a. A Kaplan Turbine has an outer diameter of 8m and inner diameter as 3m and developing 30.000kW at 80rpm under a head of 12m. The discharge through the runner is $300m^3$/sec if Hydraulic Efficiency is 95%. Determine Inlet and Outlet blade angles, Mechanical Efficiency, Overall Efficiency. **(08 Marks)**

b. A Francis Turbine has wheel diameter of 1m at the entrance and 0.5m at the exit. The guide vane angle is 15°. The water at exit leaves the vane without any Tangential component. The vane angle at the entrance is 90°. The head is 30m and the radial component of the flow is constant. What would be the speed of the wheel in rpm and vane angle at exit? **(08 Marks)**

Module-5

9 a. What is meant by cavitation in centrifugal pumps? What are the causes of cavitation? **(08 Marks)**

b. The outer diameter of the Impeller of a centrifugal pump is 40cm and width of the impeller at outlet is 5cm. The pump is Running at 800rpm and working against a total head of 15m. The vane angle at outlet is 40° and Manometric efficiency is 75%. Determine: i) Velocity of flow at outlet ii) Velocity of water leaving the vane iii) Angle made by the absolute velocity at outlet iv) Discharge. **(08 Marks)**

OR

10 a. Define the following terms of centrifugal compressor:
i) Overall pressure ratio ii) Pressure co-efficient iii) Slip factor iv) Power factor. **(08 Marks)**

b. An Axial flow compressor with 50%. Reaction is having a flow coefficient with 0.54. Air enters the compressor at stagnation condition of 1 bar and 30°C. The total-to-total efficiency across the rotor is 0.88 pressure coefficient is 0.45 and the workdone factor is 0.88. The Total-to-total pressure ratio across the rotor is 1.26. Mass flow rate is 15kg/sec. Calculate: i) Mean rotor blade speed ii) Rotor angles at inlet and exit iii) Power Input to the system **(08 Marks)**

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