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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME5DCTUM /16ME6DCTUM **Max Marks: 100**
Course: Turbo Machines **Date: 01.03.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.
3. Use of steam tables is permitted.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1	a)	Apply first and second law of thermodynamics to turbo machines	**10**
	b)	Define degree of reaction and utilization factor as applied to turbines. Obtain the relation between these two	**10**

UNIT - II

2	a)	The radial outward flow Turbo machine has no whirl at inlet. The blade speed at the exit is twice that at inlet. Radial velocity is constant throughout. Taking the inlet blade angle as 45°. Derive an expression for work done and discuss the effect of blade angle at out let on energy transfer/work done.	**10**
	b)	The theoretical head capacity characteristic of a centrifugal pump may be assumed to be a straight line of negative slope=280 and position of intercept on y-axis =+50. The width of impeller at outlet =2cm and pump is running at a constant speed of 1250 RPM. calculate the blade angles at outlet and also the theoretical power required when the pump discharge water at the rate of $0.12m^3/s$. sketch velocity triangles at inlet and outlet. Assume radial velocity is constant from inlet to outlet.	**10**

OR

3	a)	The following data refers to an axial flow compressor machine : degree of reaction is 0.5, inlet blade angle is 45°, where flow velocity is constant =100m/s. speed of the rotor is 6000 rpm, diameter of the rotor is 0.5m an mass flow rate of air is 2kg/s. calculate fluid angles at inlet and outlet, and power required	**10**
	b)	Derive an expression for pressure ratio of a single stage axial flow compression, considering the slip condition. Modify the equation for the exit blade angle equal to 90°.	**10**

UNIT - III

4	a)	Show that the pressure rise in the impeller of a centrifugal pump when the frictional and other losses in the impeller are neglected is given $(V_{f1}^2+U_2^2-V_{f2}^2Cosec^2\beta_2)/(2g)$. where V_{f1and} V_{f2} are the flow velocities at inlet and outlet of the impeller, U_2 = Tangential speed of impeller at exit ,β_2=Exit blade angle	**10**

b) A centrifugal pump has an impeller diameter of 25cm and width of 7.5cm at exit. It delivers 120lt/s of water working against a head of 24m at 1440 RPM. Assuming the vane blocks the area of flow by 5% and has a hydraulic efficiency of 0.85. Estimate the vane angle at exit. Also calculate the torque exerted on the driving shaft, if the mechanical efficiency is 95%. **10**

UNIT - IV

5 a) Prove that for a Parsons reaction turbine the maximum blade efficiency is given by $\eta_{b,max}=2\cos^2\alpha_1/(1+\cos^2\alpha_1)$ **10**

b) The velocity of steam exiting from a nozzle of a De-laval turbine is 1200 m/s. The nozzle angle being 22°. If the rotor blades are equiangular and the rotor tangential speed is 400 m/s. Compute: i) Power output assuming $V_{r1}= V_{r2}$ ii) Utilization factor. **10**

UNIT - V

6 a) Draw the inlet and exit velocity triangles for a pelton wheel turbine. Derive for maximum hydraulic efficiency **10**

b) A Pelton wheel is to be designed for a head of 60m when running at 200 rpm. The Pelton wheel develops 95.65 kW shaft power. The velocity of the buckets = 0.45 times the velocity of the jet, overall efficiency = 0.85 and coefficient of velocity is equal to 0.98. Find diameter of jet, diameter of wheel, size of buckets and number of buckets. **10**

OR

7 a) An inward flow Francis turbine with radial discharge with an overall efficiency 80% is required to develop 147KW. The head of water available is 8m, the peripheral velocity of the wheel is 12.03m/s, the radial velocity of flow is 4.51m/s, the wheel is to make 150 rpm and hydraulics losses are 22% of the available energy. Determine i) Guide blade angle at inlet ii) Vane angle at inlet iii) Diameter of the wheel iv) Width of the wheel at inlet. **10**

b) Kaplan turbine working under a head of 15m developed 7350KW. Outer diameter of the runner is runner is 4m and hub diameter is 2m. The guide blade angle at the extreme edge of the runner 30° the hydraulic and overall efficiency of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at at outlet determine i) runner vane angle at inlet and outlet at extreme edge of the runner ii) speed of the turbine **10**

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