CBCS SCHEME

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BME502

Fifth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
Turbo Machines

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.
3. Use of steam table and Mollies chart is permitted.

		Module – 1	M	L	C
Q.1	a.	Define a Turbo Machine. List any six differences between a Turbo machine and a positive displacement machine.	8	L2	CO1
	b.	Design specific speed of a turbine. Explain its significance.	4	L2	CO1
	c.	A $1/4^{th}$ scale turbine model is tested under a head of 10 m. The full scale turbine is required to work under a head of 28.5 m and runs at 415 rpm. At what speed must the model be run if it develops 94 kW and uses 0.96 m^3/s of discharge at this speed? What power will be developed from the full scale turbine? Name the type of the turbine.	8	L3	CO1
		OR			
Q.2	a.	With h-s diagram, define : i) total-to-total efficiency ii) total-to-static efficiency for a power generating turbo machine.	8	L3	CO1
	b.	Show that the polytropic efficiency for a compression process is given by $\eta_p = \left(\frac{n}{n-1}\right)\left(\frac{\gamma-1}{\gamma}\right)$ where γ = ratio of specific heats, n = polytropic index.	4	L1	CO1
	c.	Air flows through an air turbine where its stagnation pressure is decreased in the ratio 5 : 1. Total-to-total efficiency is 0.8. The air flow rate is 5 Kg/s. If the total power output is 500 kW, Find : i) inlet total temperature ii) actual exist total temperature iii) actual exist static temperature iv) total-to-static efficiency. Take the flow velocity as 100m/s.	8	L3	CO1
		Module – 2			
Q.3	a.	With usual notations and velocity triangles, derive alternate form of Euler-turbine equation and identify the components of energy transfer.	10	L3	CO2
	b.	At a stage in a 50% degree of reaction axial flow turbine running at 3000 rpm, the blade mean diameter is 68.5 cm. The maximum utilization factor for the stage is 0.915. Calculate the inlet and exit absolute velocities for the rotor assuming the velocity triangles at inlet and outlet to be symmetric. Find also the power output for a flow rate of 15 Kg/s.	10	L3	CO2

				Marks	Level	CO
		OR				
Q.4	a.	Draw the velocity triangles for an axial flow compressor and show that for an axial flow compressor having no axial thrust, the degree of reaction is given by $R = \frac{V_a}{2u}\left[\frac{\tan\beta_1 + \tan\beta_2}{\tan\beta_1 \tan\beta_2}\right]$ Where V_a = Axial flow velocity, β_1 and β_2 = Inlet and outlet blade angles with respect to tangential direction.		10	L3	CO2
	b.	An inward flow reaction turbine has inlet and outlet diameter as 1m and 0.5m respectively. The vanes are radial at inlet and the discharge is radial at outlet. The water enters the vanes at an angle of 10°. Assume the velocity of flow to be constant and equal to 3 m/s. Find : i) speed of the runner ii) vane angle at outlet.		10	L3	CO2
		Module – 3				
Q.5	a.	What do you mean by compounding of steam turbine? Explain with the help of a schematic diagram, a two row velocity compounded turbine stage.		8	L2	CO3
	b.	A single stage impulse turbine rotor has a diameter of 1.2m running at 3000 rpm. The nozzle angle is 18°. The blade speed ratio is 0.42. The blade friction coefficient is 0.9. The outlet angle of the blade is 3° less than the inlet angle. Steam flow rate is 5 Kg/s. Draw the velocity triangles and find : i) Axial thrust on bearing ii) Blade angles iii) Power developed iv) Blade efficiency.		12	L3	CO3
		OR				
Q.6	a.	With the help of inlet and outlet velocity triangles. Show that the maximum blade efficiency of a Parson's reaction turbine is $\frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$ where α_1 = Nozzle angle at inlet.		8	L3	CO3
	b.	Dry saturated steam at 10 bars is supplied to a single rotor axial flow impulse turbine, the condenser pressure being 0.5 bar. The nozzle efficiency is 94% and the nozzle angle at the rotor inlet is 18° to the wheel plane. The rotor blades are equiangular and move at a speed of 450 m/s. If the blade velocity coefficient for the moving blades is 0.92, determine : i) Power output for a mass flow rate of 1 Kg/s ii) Rotor efficiency iii) Stage efficiency iv) Axial thrust v) Direction of exist steam velocity		12	L3	CO3
		Module – 4				
Q.7	a.	Show that for Pelton wheel, the maximum hydraulic efficiency is given by $\eta_{h(max)} = \frac{1+K\cos\beta_2}{2}$ where K = blade velocity coefficient, β_2 = blade exist angle.		10	L3	CO4

	b.	A three jet Pelton wheel is required to generate 10,000 kW under a head of 400 m. The blade angle at outlet is 15° and the reduction in the relative velocity over the blades is 5%. If the overall efficiency = 80%, C_v = 0.98 and speed ratio = 0.46, find : i) diameter of jet ii) total flow rate iii) tangential force exerted on the buckets	10	L3	CO4
		OR			
Q.8	a.	Define the following efficiencies of a hydraulic turbine i) Hydraulic efficiency ii) Mechanical efficiency iii) Overall efficiency	6	L2	CO4
	b.	Explain the function of a draft tube in a reaction hydraulic turbine.	4	L2	CO4
	c.	A Kaplan turbine working under a head of 20 m develops 11,772 kW. The outer diameter of the runner is 3.5m and hub diameter is 1.75 m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiencies of the turbines are 0.88 and 0.84 respectively. If the velocity of whirl at outlet is zero, determine : i) Runner vane angles at inlet and outlet ii) Speed of the turbine	10	L3	CO4
		Module – 5			
Q.9	a.	What is cavitation in centrifugal pumps? What are the effects of cavitations? What are the steps to be taken to reduce the effects of cavitations?	4	L2	CO5
	b.	Derive an expression for the static pressure rise in the impeller of centrifugal pumps with velocity triangles.	8	L3	CO5
	c.	A centrifugal pump discharges 0.15 m^3/s of water against a head of 12.5 m. The speed of the impeller is 600 rpm. The outer and inner diameters of the impeller are 50 cm and 20 cm respectively. The vanes are bent back at 35° to the tangent at the exit. If the area of flow remains 0.07 m^2 from inlet to outlet, calculate : i) Manometric efficiency of the pump ii) Vane angle at inlet	8	L3	CO5
		OR			
Q.10	a.	Define the following with respect to centrifugal compressors : i) Power input factor ii) Pressure coefficient iii) Compressor efficiency	6	L1	CO5
	b.	Explain the phenomenon of surging as applied to a centrifugal compressor	6	L2	CO5
	c.	Derive an expression for pressure ratio in terms of impeller tip speed for a centrifugal compressor.	8	L3	CO5

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