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CBCS SCHEME

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BME502

Fifth Semester B.E./B.Tech. Degree Examination, June /July 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.

		Module – 1	M	L	C
Q.1	a.	Compare positive displacement machine with turbomachine.	06	L2	CO1
	b.	A centrifugal pump works against a manometric head of 30 m with an impeller diameter of 300 mm. When the pump was running at 1500 rpm it produced a head of 22 m. What changes in design do you suggest to get the designed head of 30 m.	08	L3	CO1
	c.	Define specific speed of turbine. Obtain the expression for specific speed of turbine.	06	L3	CO1
		OR			
Q.2	a.	For Power generating Turbomachine, define : i) total –to total Efficiency ii) total to static Efficiency	04	L1	CO1
	b.	Define the term infinitesimal stage Efficiency of a turbine. Show that the polytrophic Efficiency during the Expansion process is given by $\eta_P = \frac{\ln\left(\frac{T_2}{T_1}\right)}{\frac{\gamma-1}{\gamma}\ln\left(\frac{P_2}{P_1}\right)}$	08	L3	CO1
	c.	Air flows through an air turbine where its stagnation pressure is reduced in the ratio 5:1 the total to total Efficiency is 80%. The air flow rate is 5 kg/s. If the total power output is 500 kW, find : i) Inlet total temperature ii) actual exit total temperature iii) actual Exit Static temperature, if the flow velocity is 100 m/s iv) total to static Efficiency.	08	L3	CO1
		Module – 2			
Q.3	a.	Derive alternate form of Euler turbine Equation and explain the significance of each component of energy transfer.	07	L3	CO2
	b.	Show that $\in_{max}$ of an axial flow turbine with degree of reaction $R = \frac{1}{4}$, the relationship of blade speed U to absolute velocity at rotor inlet V_1, should be $\frac{U}{V_1} = \frac{2}{3}\text{Cos}\,\alpha_1$ Where α_1 – Nozzle angle at inlet. Assume flow velocity is constant from inlet to outlet.	07	L3	CO2

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	c.	At a 50% reaction stage axial flow turbine, the mean blade diameter is 60 cm. 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.	06	L3	CO2
		OR			
Q.4	a.	Obtain an Expression for Energy transfer $E = 2V_f^2(2-\text{Cot}\beta_2)$ and degree of reaction $R = \frac{2+\cot\beta_2}{4}$ Make the following assumptions i) $U_2 = 2U_1$ ii) Constant flow velocity $V_{f_1} = V_{f_2} = V_f$ iii) no inlet whirl velocity $V_{u_1} = 0$ iv) inlet blade angle $\beta_1 = 45°$	10	L3	CO2
	b.	In an axial flow compressor show that Energy transfer $E = uV_a(\cot\beta_1 - \cot\beta_2)$ and degree of reaction $R = \frac{V_a}{2U}(\cot\beta_1 + \cot\beta_2)$	10	L3	CO2
		Module – 3			
Q.5	a.	Prove that the maximum blade Efficiency for a single stage impulse turbine with equiangular rotor blades is given by $\eta_{b\,max} = (1+C_b)\frac{\cos^2\alpha_1}{2}$ Where C_b - blade velocity coefficient.	10	L3	CO3
	b.	Steam flows through the nozzle with a velocity of 450 m/s at a direction which is inclined at an angle of 16° to the wheel tangent. Steam comes out of the moving blades with a velocity of 100 m/s in the direction of 110° with the direction of blade motion. The blades are Equiangular and the steam flow rate is 10 kg/s. Find i) Power developed ii) The power loss due to friction iii) Axial thrust iv) Blade Efficiency v) Blade velocity coefficient	10	L3	CO3
		OR			
Q.6	a.	Show that for a Curtis stage the maximum Efficiency is given by $\eta_{max} = \cos^2\alpha_1$	12	L3	CO3
	b.	A stage of a turbine with Parson's blading deliver dry saturated steam at 2.7 bar (ρ = 1.496 kg/m^3) from the fixed blades at 90 m/s. The mean blade height is 40 mm and the moving blade Exit angle is 20°. The axial velocities of steam is ¾ of the blade velocity at the mean radius. Steam is supplied to the stage at the rate of 2.5 kg/s. The Effect of the blade tip on the annulus area can be neglected calculate i) The wheel speed ii) The diagram Efficiency iii) The diagram power	08	L3	CO3

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		Module – 4			
Q.7	**a.**	Show that for a Pelton wheel $\eta_{b\,max} = \frac{1+C_b \cos\beta_2}{2}$	**10**	**L3**	**CO4**
	b.	A double jet Pelton – wheel is required to generate Electric Power of 7500 kW when the available head at the base of the nozzle is 400 m. The jet is deflected through 165° and the relative velocity of the jet is reduced by 15% in passing over the buckets. Determine : i) Total Flow ii) The diameter of each jet iii) Force exerted by the jets in the tangential direction. Assume Generator Efficiency = 95%, Overall Efficiency η_o = 80%, Speed ratio = 0.47.	**10**	**L3**	**CO4**
		OR			
Q.8	**a.**	Draw the cross sectional view of a Kaplan turbine and explain its working. Also sketch the velocity triangles at inlet and outlet of a Kaplan runner.	**08**	**L2**	**CO4**
	b.	For francis turbine, show that hydraulic efficiency $\eta_h = \frac{2}{2+\tan^2\alpha_1}$; where α_1 – flow angle at inlet and given that i) Component of velocity normal to the tangential direction is constant from inlet to outlet $(V_{f_1} = V_{f_2})$ ii) Relative velocity at the inlet is radial iii) Absolute velocity at outlet is radial sketch the velocity triangles.	**06**	**L3**	**CO4**
	c.	What is Draft tube? Explain the functions of Draft tube.	**06**	**L2**	**CO4**
		Module – 5			
Q.9	**a.**	Define the following : i) Manometric head ii) Cavitation iii) Slip & Slip Factor	**06**	**L1**	**CO5**
	b.	Derive an Expression for minimum starting speed of a centrifugal pump.	**06**	**L3**	**CO5**
	c.	A centrifugal pump runs at 950 rpm. Its outer and inner diameters are 500 mm and 250 mm. The vanes are set back at 35° to the wheel rim. If the radial velocity of water through the impeller is constant at 4 m/s, Find : i) Vane angle at inlet ii) Velocity of water at the outlet and its direction iii) Workdone by the impeller per kg of water. Entry of water at inlet is radial.	**08**	**L3**	**CO5**
		OR			
Q.10	**a.**	With a neat sketch discuss the arrangements of pumps connected in i) Series ii) Parallel	**06**	**L2**	**CO5**
	b.	Explain surging and stalling in centrifugal compressors.	**06**	**L2**	**CO5**
	c.	A centrifugal compressor rotor has inlet diameter of 60 cm and outer diameter is 120 cm. Entry is radial with a component of 60 m/s which is constant throughout. The compressor requires 700 kW of power to handle 20 kg of air per second. Find the blade angles at inlet and outet if the compressor runs at 5100 rpm. Calculate the width at inlet and outlet, if specific volumes at inlet and outlet are respectively 0.85 m^3/kg and 0.71 m^3/kg. Take η_o = 1. What is the degree of reaction?	**08**	**L3**	**CO5**

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