CBCS SCHEME

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BME502

Fifth Semester B.E./B.Tech. Degree Examination, June/July 2025
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 is permitted.

		Module – 1	M	L	C
Q.1	a.	Draw and explain the parts of general turbomachines.	6	L2	CO1
	b.	Distinguish between turbomachines and positive displacement machines.	6	L2	CO1
	c.	1/5 scale model of a pump was tested in a laboratory at 1000 rpm. The head developed and power input at the best efficiency point were found to be 8 m and 30 KW. If the prototype pump has to work against a head of 25 m, determine its working speed, power required to drive it and the ratio of flow rates handled by the two pumps.	8	L3	CO1
		OR			
Q.2	a.	Define the static and stagnation state of fluid.	4	L2	CO1
	b.	Define the following with the help of h-s diagram for power absorbing and power generating machine. i) Total to total efficiency ii) Total to static efficiency iii) Static to total efficiency iv) Static to static efficiency.	8	L2	CO1
	c.	Show that the polytrophic efficiency during expansion process is given by $\eta_p = \dfrac{\ln(T_2/T_1)}{\left(\dfrac{\gamma-1}{\gamma}\right)\ln(P_1/P_2)}$	8	L3	CO1
		Module – 2			
Q.3	a.	Define degree of reaction and utilization factor. Establish relation between them.	10	L2	CO2
	b.	Draw the velocity triangle at inlet and outlet of turbo machines and derive the Euler turbine equation with usual notations.	10	L2	CO2
		OR			
Q.4	a.	Derive head-capacity relationship for centrifugal pump and explain the effect of discharge angle on it.	10	L2	CO2

	b.	An inward flow radial vane turbine has the following data, power = 150 kW, speed = 32000 rpm, out diameter of the impeller = 20 cm, inner diameter of the impeller 8 cm, absolute velocity of gas at entry = 387 m/sec. Absolute velocity of gas at exit = 193 m/sec and radial in direction. Construct the velocity triangles at entry and exit of the impeller and determine: i) Mass flow rate ii) Percentage energy transfer due to change of radius.	10	L3	CO2
		Module – 3			
Q.5	a.	Prove that maximum blade efficiency of a single impulse turbine is given by $\eta_b = \cos^2\alpha_1$ with combined velocity diagram.	10	L2	CO3
	b.	The nozzle of a D-laval turbine delivers 2 kg /sec of steam at a speed of 2400 m/sec. The nozzle are inclined at an angle of 16 degree to the plane of the wheel. The blade velocity is 600 m/sec. Allowing a blade velocity coefficient of 0.72, calculate: i) Blade efficiency ii) Power developed by the blades iii) Energy lost in the blades. The blade angle at outlet may be taken as 25°.	10	L3	CO3
		OR			
Q.6	a.	Prove the condition for maximum efficiency of a reaction turbine using a combined velocity diagram.	10	L2	CO3
	b.	The following particulars refer to a stage of an impulse reaction turbine. Outlet angel of fixed blade = 20°, outlet angle of moving blades = 30°, radial height of fixed and moving blades = 10 cm, mean blade velocity = 138 m/sec, blade speed ratio = 0.625, specific volume of steam at fixed blade outlet = 1.235 m^3/kg, specific volume of steam at moving blade out = 1.305 m^3/kg, speed of the rotor = 3000 rpm, calculate the degree of reaction, the adiabatic heat drop in pair of blade rings and gross stage efficiency, Given the following coefficient which are same for both fixed and moving blades, η = 0.9, carry over coefficient = 0.86.	10	L3	CO3
		Module – 4			
Q.7	a.	Define and write mathematical equation. i) Hydraulic efficiency ii) Mechanical efficiency iii) Overall efficiency iv) Volumetric efficiency.	10	L2	CO4
	b.	In a power station, a pelton wheel produce 15000 KW under a head of 350 m, while running at 500 rpm. Assume a turbine efficiency of 0.84, coefficient of velocity for Nozzle as 0.98, speed ratio 0.46 and bucket velocity coefficient 0.86. Calculate: i) Number of jet ii) Diameter of each jet iii) Tangential force exerted on the buckets if the bucket deflect the jet through 165°.	10	L3	CO4

		OR			
Q.8	**a.**	Explain with a next sketch working of hydro electric power plant.	**6**	**L1**	**CO4**
	b.	With a neat sketch. Explain the working of draft tube and list out the application.	**4**	**L2**	**CO4**
	c.	The following data is given for a Francis turbine. Net head = 70 m, speed = 600 rpm, power at the shaft = 367.5 kW, overall efficiency = 85%, hydraulic efficiency = 95%, flow ratio = 0.25, width ratio = 0.1, outer diameter to inner diameter ratio = 2.0. The thickness of vanes occupies 10% of the circumferential area of runner, velocity of flow is constant at inlet and discharge is radial at outlet. Determine: i) Guide blade angle ii) Runner vane angle at inlet and outlet iii) Width of the wheel at inlet iv) Diameter of runner at inlet and outlet.	**10**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	Derive an expression for a minimum starting speed of a centrifugal pump.	**5**	**L2**	**CO5**
	b.	Derive an expression for the static pressure rise in the impeller of a centrifugal pump with inlet and outlet velocity diagram.	**5**	**L2**	**CO5**
	c.	A centrifugal pump running at 1000 rpm. The outlet angle of vane is 45° and the velocity of flow at outer let is 2.5 m/sec, the discharge through the pump is 200 lit/sec, when the pump is working against the total head of 20 m, if the nanometric efficiency of the pump is 80%, determine : i) Diameter of the impeller ii) Width of the impeller at outlet.	**10**	**L3**	**CO5**
		OR			
Q.10	**a.**	Explain with a neat sketch working of centrifugal compressor.	**5**	**L2**	**CO5**
	b.	Explain the surging and choking in centrifugal compressor.	**5**	**L2**	**CO5**
	c.	An axial flow compressor stage draws air from with the stagnation conditions 1.013 bar and 308 K. Assuming 50% reaction stage with a flow coefficient of 0.52 and the ratio $\Delta V_{w/h}$ = 0.25, find the rotor blade angle at the inlet and exit as well as the mean rotor speed. The total to total efficiency of the stage is 0.87 when the stage produces a total to total pressure ratio of 1.23. Find also pressure coefficient and the power input to the system, assuming the work input factor to be 0.86. The mass flow rate is 12 kg/sec.	**10**	**L3**	**CO5**

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