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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Feb. - 2021

Turbomachines

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Explain basic design concept, failure theories and Solve for stresses induced in simple machine elements subjected to static loads.

CO2: Explain concepts of fatigue loading and impact loading and model simple machine elements under fatigue loading conditions.

CO3: Solve for the sizes and stresses in transmission shafts and Muff coupling and rigid flange coupling.

CO4: Explain threaded joints and power screws and solve for the efficiency of joints.

CO5: Classify methods of riveting and welded joints and Analyze the joint efficiency for boiler and structural applications.

***Note: I) PART - A** is compulsory. **Two** marks for each question.*

***II) PART - B**: Answer any **Two** sub questions (from a, b, c) for Maximum of **18 marks** from each unit.*

***III)** Missing data may be suitably assumed.*

Q. No.		Questions	Marks	BLs	COs	POs
		I : PART - A	**10**			
I	a.	Define degree of reaction.	2	L1	CO1	PO1
	b.	Define volumetric efficiency of hydraulic turbine.	2	L1	CO2	PO1
	c.	List out the different types of draft tubes used in hydraulic reaction turbine.	2	L1	CO3	PO1
	d.	Define blade efficiency of a steam turbine.	2	L1	CO4	PO1
	e.	Define static head and write its expression.	2	L1	CO5	PO1
		II : PART - B	**90**			
		UNIT - I	**18**			
1	a.	Derive the Euler turbine equation with usual notations.	9	L2	CO1	PO1
	b.	Derive an expression for degree of reaction with respect to utilization factor.	9	L2	CO1	PO1
	c.	At a stage in a 50% reaction axial flow turbine running at 3000 rpm, the blade mean diameter is 685 mm. If the maximum utilization for the stage is 0.915. Calculate the inlet and outlet absolute velocities for the rotor. Draw the velocity triangles and find power output for a rate of 15 kg/s.	9	L3	CO1	PO1,PO8
		UNIT - II	**18**			
2	a.	Derive an expression for force, power, and efficiency of a pelton turbine assuming no frictional losses with the help of velocity triangles.	9	L2	CO2	PO1
	b.	A pelton turbine is required to develop 10 MW of power, when working under a head of 200 m. The runner is having a speed of 650 rpm. Assuming overall efficiency of 88%. Determine; i) Quantity of water required ii) Diameter of the wheel Assume $C_v = 0.98$ and ϕ as 0.48.	9	L3	CO2	PO1

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c.	A three jet pelton turbine is required to generate 10,000 kW under a net head of 400 m. The blade angle at outlet is 15° and the reduction in the relative velocity while passing over the blades is 5%. If the overall efficiency of the wheel is 80%, C_v = 0.98 and the speed ratio is 0.46 then, find; i) Total flow in m^3/s ii) Discharge through each jet iii) Diameter of the jet iv) Force exerted by the jet on the wheel	9	L3	CO2	PO1
	UNIT - III	**18**			
3 a.	List out the difference between Francis turbine and Kaplan turbine. Explain with neat sketch Kaplan turbine working principle.	9	L3	CO3	PO2
b.	Show that the utilization factor for an inward flow reaction turbine with relative velocity component at inlet perpendicular to the tangent of the wheel and the absolute velocity at the exit is radial is given by, $\in = 2\cos^2 \alpha_1 / (1+\cos^2 \alpha_1)$ Where α_1 is the angle made by the entering fluid with tangent of the wheel.	9	L3	CO3	PO3
c.	A Kaplan turbine develops 9000 kW under a head of 10 m. Overall efficiency of the turbine is 85%. The speed ratio based on the outer diameter is 2.2 and the flow ratio is 0.66. Diameter of the boss is 0.4 times the outer diameter of the runner. Determine the diameter of the runner, boss diameter and specific speed of the runner.	9	L3	CO3	PO3
	UNIT - IV	**18**			
4 a.	How does the stage efficiency is affected by Reheat factor?	9	L3	CO4	PO3
b.	List out the differences between impulse and reaction steam turbine. Define impulse, and reaction turbine.	9	L3	CO4	PO3
c.	An axial flow impulse steam turbine has a mean rotor diameter 55 cm and runs at 3300 rpm. The speed ratio is 0.45 and the blade velocity coefficient is 0.91. If the nozzle angle at rotor inlet is 20°. Find; i) Rotor blade angles assuming axial exit ii) Power output for a flow rate of 1 kg/s	9	L3	CO4	PO3
	UNIT - V	**18**			
5 a.	List out pump losses and also define the following: i) Manometric efficiency ii) Mechanical efficiency iii) Volumetric efficiency iv) Overall efficiency	9	L3	CO5	PO2

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b.	The outer diameter of the impeller of a centrifugal pump is 40 cm and the width of the impeller at outlet is 5 cm. The pump is running at 800 rpm and is working against a total head of 15 cm. 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 with the direction of motion at outlet iv) Discharge	9	L3	CO5	PO2
c.	A three stage centrifugal pump has impeller of 40 cm diameter and 2.5 cm wide at the outlet. The vanes are curved back at the outlet at 30° and reduce the circumferential area by 15%. The Manometric efficiency is 85% and overall efficiency 75%. Determine the head generated by the pump, when running at 12000 rpm and discharging the water at 0.06 m^3/s. Find the shaft power also.	9	L3	CO5	PO3

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