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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; February / March - 2022

Turbo Machines

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Understand the principles and operations of Turbo-machines and the use of velocity triangles.

CO2: Apply basics of fluid machines for axial flow hydraulic turbines.

CO3: Apply basics of fluid machines for radial flow hydraulic turbines.

CO4: Apply basics of fluid machines on steam turbines.

CO5: Evaluate the performance parameters of pumps with the use of velocity triangles.

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.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	Define Degree of reaction.	2	L1	CO1	PO1
b.	Define the hydraulic 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.	What is an extraction turbine?	2	L2	CO4	PO1
e.	Define static head and write its expression.	2	L1	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
1 a.	Derive an expression for Euler's energy for a turbo machine.	9	L2	CO1	PO1
b.	An inward flow radial turbine has nozzle angle α_1 and rotor blades are radial at entry. The radial velocity is constant and there is no whirl velocity at discharge. Show that the utilization of factor is equal to $\varepsilon = \frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$.	9	L3	CO3	PO3
c.	At a 50% reaction stage axial flow turbine, the mean blade diameter is 60 cm. The maximum utilization of factor is 0.9 stream flow rate is 10 kg/s. Calculate the inlet and outlet absolute velocities and power developed, if the speed is 2000 rpm.	9	L3	CO2	PO1,8
	UNIT - II	**18**			
2 a.	Show that for maximum utilization, the speed of the wheel is equal to half of speed of jet.	9	L2	CO2	PO1
b.	What are design parameters considered for design of pelton turbine.	9	L2	CO2	PO1

Contd... 2

c. Pelton wheel produces 15456 kW under a head of 335 m running at a speed of 500 rpm. Turbine overall efficiency 0.84, jet velocity co-efficiency 0.98, speed ratio 0.46. If the buckets deflect the incoming jet through an angle of 165°. Determine; — 9 L2 CO2 PO3

i) The number of jet as well as the dia of each jet

ii) The tangential force exerted by the jets on the buckets

UNIT - III **18**

3 a. With a neat sketch, explain the working of Francis turbine. — 9 L3 CO3 PO2

b. An inward flow reaction turbine works under a total head of 20 m. The inner diameter is 0.6 m and outer diameter is double that of inner diameter. The water enters at an angle of 16° and the vane tip is radial at entry. The water leaves the draft tube has a velocity of 3.65 m/s. Calculate the speed of the wheel and the vane exit angle. Assume water leaves radially, what will be the power developed, if the width at inlet is 7.5 cm? — 9 L3 CO3 PO3

c. A Kalpan turbine produces 58,800 kW under a head of 25 m which has an overall efficiency of 90%. Taking the value of speed ratio ϕ 1.6, flow ratio ψ 0.5 and the hub diameter 0.35 times the outer diameter. Find the diameter and the speed of the turbine. — 9 L3 CO3 PO3

UNIT - IV **18**

4 a. With the axial notation, prove that the maximum blade efficiency $\eta_{b(\max)} = \dfrac{\cos^2\alpha_1\left(1+c_b k\right)}{2}$. — 9 L2 CO4 PO1

b. Define impulse and reaction turbine. List out the difference between impulse and reaction steam turbine. — 9 L3 CO4 PO3

c. Steam issuing from a nozzle to a De-Laval turbine with a velocity of 1000 m/s. The nozzle is 90°. The mean blade speed is 400 m/s. The blades are symmetrical. The mass flow rate is 1000 kg/hr, friction factor 0.8, nozzle efficiency 0.95. Calculate; — 9 L3 CO4 PO3

i) The blade angles

ii) Axial thrust

iii) Work done per kg of steam

iv) Power developed

v) Blade efficiency

vi) Stage efficiency

Contd... 3

UNIT - V **18**

		Marks	BL	CO	PO
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
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 40º 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	PO3
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 85% and overall efficiency is 75%. Determine the head generated by the pump, when running at 12000 rpm and discharge the water at 0.06 m^3/s. Find the shaft power also.	9	L3	CO5	PO3

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