Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2023

Subject Code:3150102 Date:20-12-2023

Subject Name: Fundamentals of Turbomachines

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	What is the basic working principle of all turbomachines?	**03**
	(b)	Write difference between fan, blower and compressor.	**04**
	(c)	Derive Euler's energy equation for turbo machine.	**07**
Q.2	**(a)**	Define flow coefficient and loading coefficient.	**03**
	(b)	Show pressure and velocity variation in axial flow compressor.	**04**
	(c)	With a neat sketch explain the working principle of axial flow compressor.	**07**
		OR	
	(c)	A 10 stage axial flow compressor provides an overall pressure ratio of 5:1 with an overall isentropic efficiency of 87%. When the temperature of air at inlet is 15ºC. The work is equally divided between the stages. A 50% reaction is used with a blade speed of 210 m/s and a constant axial velocity of 170 m/s. Estimate the blade angles. Assume a workdone factor of 1.	**07**
Q.3	**(a)**	List the losses in centrifugal compressor.	**03**
	(b)	Draw sketches of the three types of impellers and the velocity triangles at their exits.	**04**
	(c)	A centrifugal compressor runs at 10000 rpm and delivers 600 m3/min of free air at a pressure ratio of 4:1. The isentropic efficiency of compressor is 82%. The outer radius of impeller (which has radial blades) is twice the inner one and neglects the slip coefficient. Assume the ambient air conditions are 1 bar and 293 K. The axial velocity of flow is 60 m/s and is constant throughout. Determine (a) Power input to the compressor, (b) Impeller diameter at inlet and outlet and width at inlet, and (c) Impeller and diffuser blade angles at inlet.	**07**
		OR	
Q.3	**(a)**	Explain surging phenomenon.	**03**
	(b)	Compare axial compressor and centrifugal compressor.	**04**
	(c)	Define Degree of reaction and prove it is equal to $\frac{1}{2}\frac{V_f}{u}[\tan\beta_1 + \tan\beta_2]$.	**07**
Q.4	**(a)**	Define isentropic efficiency of centrifugal compressor.	**03**
	(b)	What is Pre-whirl? Draw the velocity diagram with and without pre-whirl.	**04**

	(c)	The convergent nozzle is having the pressure ratio of 2. The conditions at the nozzle entry are 25°C and 4.2 bar. The velocity at the entry is 30m/s. Calculate the Mach no at the entry and the exit of the nozzle and the stagnation and static properties at the exit to the nozzle. Nozzle efficiency is 85%.	**07**

OR

Q.4	**(a)**	Enlist the cooling technique used for gas turbine blades.	**03**
	(b)	Draw velocity triangle for an axial turbine stage.	**04**
	(c)	With a neat sketch explain the velocity compounded axial turbine stages.	**07**

Q.5	**(a)**	Explain the need of prime movers in gas turbine engines	**03**
	(b)	Draw and explain schematic diagram for a radial turbine stage.	**04**
	(c)	Explain in the detail the losses in turbomachines.	**07**

OR

Q.5	**(a)**	What is the effect of blade friction on turbine performance?	**03**
	(b)	Differentiate axial machines and radial machines.	**04**
	(c)	Explain the general matching procedure for the jet engines.	**07**

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