Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- VII EXAMINATION-SUMMER 2023

Subject Code: 3171927 **Date: 21/06/2023**

Subject Name: Turbo Machines

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 are geometric, kinematic and dynamic similarities?	**03**
	(b)	Define turbomachine. Draw Schematic cross-sectional view of a turbine showing the principal parts of the turbomachine	**04**
	(c)	Comparison between positive displacement machines and Turbo machines	**07**
Q.2	**(a)**	Draw Multi stage velocity compounded Impulse turbine.	**03**
	(b)	List the aerodynamic losses occur in the radial turbine stage.	**04**
	(c)	Explain Condition for Maximum Utilization Factor or Blade efficiency with Equiangular Blades for Impulse Turbine	**07**
		OR	
	(c)	A ninety degree IFR turbine stage has the following data: total-to-static pressure ratio $p_{01}/p_3 = 3.5$ exit pressure 1 bar stagnation temperature at entry 650°C blade-to-isentropic speed ratio $\sigma = 0.66$ rotor diameter ratio $d_3/d_2 = 0.45$ rotor speed N = 16000 rpm nozzle exit air angle $a_2 = 20°$ nozzle efficiency $\eta_N = 0.95$ rotor width at entry $b_2 = 5$ cm Assuming constant meridional velocity, axial exit and that the properties of the working fluid are the same as those of air, determine the following quantities: (a) the rotor diameter, (b) the rotor blade exit air angle, (c) the mass-flow rate, (d) hub and tip diameters at the rotor exit, (e) the power developed and (f) the total-to-static efficiency of the stage.	**07**
Q.3	**(a)**	Draw Entry and exit Velocity triangles for a 50% reaction stages of turbine.	**03**
	(b)	Explain in radial turbine (1) stage terminal velocity, (2) Stage Efficiency, (3) Stage Losses, (4) Degree of Reaction	**04**
	(c)	Energy flow diagram for the impulse stage of an axial turbine	**07**
		OR	
Q.3	**(a)**	Give five applications of partial admission turbines.	**03**
	(b)	Discuss Effect of Exhaust Diffuser in radial stage turbine.	**04**
	(c)	What is creep? How does it affect the operation of gas turbine stages at elevated temperatures? List the various methods of cooling gas turbine blades.	**07**
Q.4	**(a)**	Draw a sketch of the two-stage axial flow compressor with inlet guide vanes.	**03**
	(b)	What is surging in axial-flow compressors? What are its effects? Describe briefly.	**04**

	(c)	Draw and explain Entry and exit velocity triangles for impeller with inducer blades, radial-tipped blades, $\beta_2 = 90°$	**07**

OR

Q.4	**(a)**	What is diffuser? Draw Diffuser ring with cambered blades.	**03**
	(b)	What are the advantages and disadvantages of supersonic stages?	**04**
	(c)	An axial compressor stage has the following data: Temperature and pressure at entry 300K, 1.0 bar Degree of reaction 50% Mean blade ring diameter 36 cm Rotational speed 18000 rpm Blade height at entry 6 cm Air angles at rotor and stator exit 25° Axial velocity 180m/s Work-done factor 0.88 Stage efficiency 85% Mechanical efficiency 96.7% **Determine:** (a) Air angles at the rotor and stator entry, (b) the mass flow rate of air, (c) the power required to drive the compressor, (d) the loading coefficient (e) the pressure ratio developed by the stage	**07**
Q.5	**(a)**	How is the volumetric efficiency of fans and blowers defined?	**03**
	(b)	Draw principle Elements of a centrifugal compressor stage.	**04**
	(c)	Determine the pressure ratio developed and the power required to drive a centrifugal air compressor (impeller diameter = 45 cm) running at 7200 rpm. Take zero swirl at the entry and T_{01} = 288 K. Assume isentropic flow with no shock, and radially tipped impeller blades.	**07**

OR

Q.5	**(a)**	Give three formulas to calculate the slip factor.	**03**
	(b)	State Types of Centrifugal Fans. Explain in brief any one of it.	**04**
	(c)	Derive an expression for the flow Mach number (M_2) at the impeller exit of a centrifugal compressor in terms of the following parameters: $M_2 = f\left(\frac{d_2}{d_1}, M_{b1}, \phi_2, \beta_2\right)$	**07**

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