Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– V (New) EXAMINATION – WINTER 2019

Subject Code: 2150102 **Date: 02/12/2019**

Subject Name: Fundamentals of 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.**

Q.1	**(a)**	Enlist classification of turbomachines.	**03**
	(b)	Discuss choking in turbomachines.	**04**
	(c)	Draw velocity triangle for an axial turbine stage.	**07**
Q.2	**(a)**	Define Degree of reaction, flow coefficient and loading coefficient.	**03**
	(b)	Defne: design condition, off design condition, matching point and equilibrium running point w.r.t. turbomachines.	**04**
	(c)	Explain the need of multistaging of turbomachines in jet engines. Draw velocity triangle for pressure compounded turbines.	**07**
		OR	
	(c)	Draw h-s diagram for an axial turbine stage.	**07**
Q.3	**(a)**	Differentiate an impulse stage and a reaction stage.	**03**
	(b)	Prove that $C_{y2} + C_{y3} = W_{y2} + W_{y3}$ for axial turbine.	**04**
	(c)	Air at the rate of 2Kg/s enters the impeller of a centrifugal compressor in axial direction. The stagnation temperature and stagnation pressure at inlet are 300K and 1bar. The rotor has 20 radial vanes and rotates at 15000rpm. The stagnation pressure ratio between diffuser outlet and impeller inlet is 4.2 and the overall efficiency is 83%. Mechanical efficiency is 96%, density at impeller outlet is 2Kg/m^3, calculate power required to drive the compressor and the impeller tip radius. Width at impeller exit is 12mm. determine absolute Mach number at that point. Slip factor is 0.88.	**07**
		OR	
Q.3	**(a)**	Which are the different impellers used in centrifugal compressor stage.	**03**
	(b)	Draw velocity triangle for centrifugal compressor stage.	**04**
	(c)	Draw h-s diagram for centrifugal compressor stage.	**07**
Q.4	**(a)**	Enlist losses occurs in turbomachines.	**03**
	(b)	Draw and explain the velocity triangle for stage of axial compressor.	**04**
	(c)	Following data refers to mean section of free vortex axial turbine stage hub diameter 460mm, tip diameter 780mm, rotational speed 6000rpm, absolute velocity at rotor entry is 267 m/s, air angles at rotor entry and exit 75° and 45° respectively, axial velocity is constant and is 70m/s, calculate followings for the hub section. 1. Air angles and blade angles, 2. Degree of reaction, 3. Flow coefficient, 4. Loading coefficient and Work done by the turbine	**07**
		OR	
Q.4	**(a)**	Enlist benefits of axial machines over radial machines.	**03**
Q.4	**(b)**	Draw schematic of centrifugal compressor used in jet engines.	**04**

	(c)	A 50% reaction, axial flow compressor runs at a mean blade speed of 50m/s. the pressure ratio developed by the machine is 1.3. Determine the blade and air angle if the mean flow velocity was 200m/s. condition at inlet are 1bar and 300K.	**07**
Q.5	**(a)**	Discuss surge in a compressor stage.	**03**
	(b)	What is degree of reaction? Derive its expression for axial turbine stage.	**04**
	(c)	A multistage gas turbine is to be designed with impulse stages, and is to operate with an inlet pressure and temperature of 6 bar and 900 K and at outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75° and equal outlet and inlet blade angles. Mean blade speed of 250 m/s and equal inlet and outlet gas velocities. Estimate the number of stages required considering optimum blade to gas speed ratio.	**07**

OR

Q.5	**(a)**	Define utilization factor, wok done factor and slip factor.	**03**
	(b)	Draw velocity triangle for ninety degree IFR turbine.	**04**
	(c)	The flow of air at 20m/s enters to the nozzle with pressure 6bar and temperature 900K. The mass flow rate of air is 10Kg/s, find inlet Mach number, the stagnation and static pressure and temperature at nozzle exit if mach number at the exit is limited to 0.7.	**07**

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