Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-Vth Examination December 2010

Subject code: 150102
Subject Name: Fundamentals of Turbo Machines

Date: 15 /12 /2010 **Time: 03.00 pm - 05.30 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)**	Determine the impeller diameters an the width at the impeller exit and the power required to drive the compressor, from the following given data: Speed 12500 rpm, mass flow 15 kg/s, pressure ratio 4:1, isentropic efficiency 75%, slip factor 0.9, flow coefficient at impeller exit 0.3, hub diameter of eye 15 cm, velocity of air at the entry to and the exit from the impeller 150m/s, stagnation temperature and stagnation pressure at inlet 295 K and 1bar. Assume equal pressure ratio in the impeller and diffuser.	**07**
	(b)	Define degree of reaction and derive the expression for the same. Define the low reaction stage and high reaction stage.	**07**
Q.2	**(a)**	Draw and explain the H-S diagram for the axial turbine stage. Also define the performance coefficient for the same.	**07**
	(b)	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 15º and equal outlet ad 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	
	(b)	Draw and explain zero percent, fifty percent and hundred percent reaction axial turbine stages.	**07**
Q.3	**(a)**	How the radial turbine differs than axial turbine? Show the entry and exit velocity triangle for a general inward flow radial turbine stage.	**07**
	(b)	For a ninety percent IFR turbine stage derive the expressions for power, stage loading coefficient and degree of reaction.	**07**
		OR	
Q.3	**(a)**	How the spouting velocity is to be defined? Derive the expression for the stage efficiency for the radial turbine stage in terms of pressure ratio and loading coefficient.	**07**
	(b)	An IFR turbine impulse stage with cantilever blades has a flow coefficient of 0.4 and develops 100KW with a total to total efficiency of 90% at 12000 rpm. If the flow rate is 2 kg/s at an entry temperature of 400 K determine the rotor diameters, blade angles at the entry and exit, the nozzle exit air angle and the stagnation pressure ratio across the stage. Take d_3=0.8d_2, zero swirl and constant meridional velocity.	**07**

Q.4 **(a)** Explain the stalling and surging for an axial compressor stage. **07**

(b) Air at temperature of 290K enters a ten stage axial flow compressor at the rate of 3kg/s. the pressure ratio is 6.5 and the isentropic efficiency is 90%, the compression process being adiabatic. The compressor has symmetrical blades. The axial velocity of 110 m/s is uniform and the peripheral speed of each stage is 180 m/s. determines the rotor and stator blade angles and flow angles and also the power given to the air. Assume temperature change in each stage is constant. **07**

OR

Q.4 **(a)** The conditions of air at entry of an axial compressor stage are 768 mm Hg and 314 K. the air angles are β_1=51º, β_2= 9º, α_1=α_3=7º. The mean diameter and peripheral speed are 50 cm and 100 m/s. mass flow rate 25 kg/s, the work done factor 0.95 and mechanical efficiency is 92%. Assuming a stage efficiency 88% determine: air angle at the stator entry, blade height at entry and the hub tip diameter ratio, stage loading coefficient and stage pressure ratio. **07**

(b) Draw and explain the sketch of two stage axial compressor with IGVs. **07**

Q.5 **(a)** Explain the matching procedure for the compressors and turbines. **07**

(b) What is an equilibrium diagram? How to find out the equilibrium points from the characteristic curves? **07**

OR

Q.5 **(a)** Classify and explain the turbo machines with respect to flow direction, types of fluid and degree of reaction. **07**

(b) Derive the dimenless parameter for compressor pressure p_2. where p_2 = $f(p_1,D,m,N,\rho)$ **07**

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