Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. Sem. - V - Examination – June- 2011

Subject code: 150102

Subject Name: Fundamentals of Turbomachines

Date:22/06/2011 **Time: 10:30 am – 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)** Explain geometry and working principles of axial flow compressor **07**

(b) With the help of diagram, explain the various components of centrifugal compressor. Also explain role of various components described. **07**

Q.2 **(a)** Explain rotary machines and positive displacement machines. **07**

(b) What are the various assumptions involves in general matching trend and in determining operating lines? **07**

OR

(b) Explain radial turbine stage with stage velocity triangle for radial turbine **07**

Q.3 **(a)** Explain choking of centrifugal flow compressor stage at inlet, impeller and diffuser. **07**

(b) An aircraft engine is fitted with a single-sided centrifugal compressor. The aircraft flies with a speed of 850 km/hr at an altitude where pressure is 0.23 bar and temperature 217 K. The inlet duct of the impeller eye contains fixed vanes which gives the air pre-whirl of 25º at all radii. The inner and outer diameters of the eye are 180 and 330 mm respectively, the diameter of the impeller tip is 540 mm and the rotational speed 16000 r.p.m. Estimate the stagnation pressure at the compressor outlet when the mass flow is 216 kg/min. Neglect losses in inlet duct and fixed vanes, and assume that the isentropic efficiency of the compressor is 0.8. Take the slip factor as 0.9 and the power input factor as 1.04 **07**

OR

Q.3 **(a)** Show that the area ratio of a diffuser can be increased by increasing the diameter ratio, width ratio, by decreasing the leading edge vane angle and various combination of above parameters **07**

(b) Derive an expression for Mach number in terms of blade angle and flow coefficient at the diffuser entry **07**

Q.4 **(a)** Explain Stalling of an axial flow compressor. What is rotating stall? **07**

(b) An axial flow compressor takes in 1000 m^3/min of free air at 0.7 kgf/cm^2 and 5º. The blades are of airfoil type, having chord area and blade length as 19.25cm2 and 6.75cm respectively. Blade ring mean diameter is 60 cm and rotational speed is 6000 r.p.m. On each blade ring there are 50 blades and the blade occupy 10% of the axial flow area of flow. Values of C_L and C_D are 0.6 and 0.05 respectively, at zero angle of incidence. Assuming isentropic compression, calculate the pressure rise per blade ring and the theoretical h.p/stage. Assume axial entry. **07**

OR

Q.4	**(a)**	Explain the stage losses in centrifugal compressor	**07**
	(b)	The first stage of an axial flow compressor is designed on free vortex principle, with no inlet guide vanes. The rotational speed is 6000 r. p. m. and stagnation temperature rise is 20 K. The hub-tip ratio is 0.6, the work done factor is 0.93 and the isentropic efficiency of the stage is 0.89. assuming an inlet velocity of 140 m/s and ambient conditions of 1.01 bar and 288 K, compute: (a) The tip radius and corresponding rotor air angles, if the Mach number relative to tip speed is limited to 0.95 (b) The mass flow entering the stage (c) The stage stagnation pressure ratio and (d) power requiured	**07**
Q.5	**(a)**	Define "Solidity" and "Aspect ratio" and explain their significance in the design of axial flow compressors.	**07**
	(b)	The design point data for an axial compressor stage are as follows. Axial velocity = 180 m/s, mean blade ring diameter = 36 cm, rotational speed = 18000 r.p.m, air angles at rotor and stator exit = 25º. Calculate the design point flow and loading coefficients. From these compute the loading coefficients at ϕ = 0.2, 0.4, 0.6 and 0.8. Plot $\phi - \psi$ curve.	**07**

OR

Q.5	**(a)**	Explain general matching procedure of components	**07**
	(b)	What is equilibrium diagram and explain with sketches the method of finding the equilibrium points.	**07**

****