

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BE - SEMESTER-V • EXAMINATION – WINTER 2013**

**Subject Code: 150102****Date: 29-11-2013****Subject Name: Fundamentals of Turbomachines****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) A centrifugal compressor has an inlet eye of 15 cm diameter. The impeller revolves at 20000 rpm and the inlet air has an axial velocity of 107m/s, inlet stagnation temperature 294K and inlet pressure 1bar. Determine theoretical angle of the blade at this point and Mach number of the flow at the tip of the eye. **07**
- (b) With a neat sketch explain the essential parts of centrifugal compressor. **07**
- Q.2** (a) With a neat sketch explain the inlet and exit velocity triangles for various types of blades for the centrifugal compressor rotor. **07**
- (b) A 10 stage axial flow compressor provides an overall pressure ratio of 5:14 with an overall efficiency of 0.87. The temperature of air at inlet is 288K. The work is equally divided between the stages. A fifty percent reaction is used with a blade speed of 210m/s and a constant axial velocity of 170m/s. estimate the blade angles. Assume a work done factor is 1. **07**
- OR**
- (b) A centrifugal compressor compresses 30Kg of air per second at a rotational speed of 15000 rpm. The air enters the compressor axially, and the conditions at the exit sections are radius 0.3m, relative velocity of air at the tip 100m/s at an angle of 80° with respect to plane of rotation. Calculate the pressure ratio of the compressor and the power required to drive the compressor. The conditions at entry to compressor are 1bar and 300K. **07**
- Q.3** (a) Draw the complete h-s diagram for the axial compressor stage. **07**
- (b) With a suitable sketch explain the working principle of an axial compressor stage. **07**
- OR**
- Q.3** (a) Define degree of reaction and derive the expressions for the same for the axial compressor. **07**
- (b) Explain the phenomena of surging and stalling in an axial flow compressor. **07**
- Q.4** (a) With a neat sketch explain the single stage velocity triangle for an axial turbine and derive an expression for the work output. **07**
- (b) Explain zero percent reaction stage, fifty percent reaction stage and hundred percent reaction stage for the axial turbine stage. **07**
- OR**
- Q.4** (a) Write a short note on losses in turbomachines. **07**
- (b) Explain the velocity compounded multistage turbines. **07**

- Q.5 (a)** A multistage gas turbine is to be designed with impulse stages, and is to operate with an inlet pressure and temperature of 6bar and 900K and an outlet pressure of 1bar. The efficiency of the turbine is 0.85. All the stages are to have a nozzle outlet angle of  $75^\circ$  and equal inlet and outlet angles, Mean baled speed of 250m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages required. Blade to gas speed ratio is optimum. **07**
- (b)** Draw and explain the sketch of a ninety degree inward flow radial turbine stage with an exit diffuser showing its main components. Give its applications. **07**
- OR**
- Q.5 (a)** Draw the entry and exit velocity triangles for a general inward flow radial turbine stage and for the ninety degree IFR turbine stage. **07**
- (b)** Define turbomachine and classify the same. **07**

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