Code No: 5221AF **R15**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M.Tech I Semester Examinations, February - 2017**
**TURBO MACHINES**
**(Thermal Engineering)**

**Time: 3hrs** **Max.Marks:75**

**Note:** This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

**PART -A**

**5 × 5 Marks = 25**

1.a) Explain stagnation pressure and stagnation temperature. [5]
b) What are the losses, which occur within the steam turbine and describe them briefly? [5]
c) Define slip factor in a centrifugal compressor and derive an expression for the same. [5]
d) With a suitable sketch explain the working principle of an axial flow compressor. [5]
e) Explain briefly the cascade analysis of an axial flow turbine. [5]

**PART - B**

**5 × 10 Marks = 50**

2.a) How do you differentiate between a turbine rotor and compressor rotor from the point of view of energy transfer.
b) Discuss the physical meaning of the Euler's energy equation. [6+4]

**OR**

3. The internal and external diameters of the impeller of a centrifugal pump are 20 cm and 40 cm respectively. The pump is running at 1200 rpm. The vane angle of impeller at inlet is 20°. The fluid enters the impeller radially and the velocity of flow is constant. Calculate the work done by the impeller per kg of fluid for the following three cases: a) $\beta_2 = 30^\circ$, b) $\beta_2 = 90^\circ$ and c) $\beta_2 = 100^\circ$. [10]

4. Dry saturated steam at 10 bar is expanded in a nozzle to 0.4 bar. The throat area is 7 cm and inlet velocity is negligible. Estimate the mass flow and exit area. Assume isentropic flow and take the index n = 1.135 for dry saturated steam. [10]

**OR**

5.a) Explain how we can reduce rotor speed in case of a impulse turbine. Describe various ways.
b) Sketch the velocity diagram of a single stage impulse turbine and determine the expression for force, work done and diagram efficiency. [5+5]

6.a) A centrifugal compressor delivers 2 kg/s of air at a pressure of 2 bar when compressing from 1 bar and 15 °C. If the temperature of air delivered is 97 °C and no heat is added to the air from external sources during compression, determine the efficiency of the compressor relative to ideal adiabatic compression and estimate the power absorbed.
b) Explain the phenomenon of surging and choking in rotary compressor. [7+3]

**OR**

7.a) Describe with a neat sketch the working of a centrifugal compressor. How pressure changes take place in impeller and diffuser?

b) Explain Super sonic flow and oblique shock waves. [7+3]

8. The mass flow rate of a multistage axial flow compressor is 20 kg/s of air. The stage efficiency is 0.9. The inlet conditions are 1 bar and 300 K. The stage pressure ratio is constant and the temperature rise in the first stage is 20 °C. The temperature at the end of isentropic compression is 500 K. Calculate a) the delivery pressure at the end of last stage, b) the total pressure ratio and the number of stages. [10]

**OR**

9.a) What are the factors that effect the performance of an axial flow compressor?

b) Draw the velocity triangles for hub, mean and tip radius for i) free vertex conditions and ii) for constant reaction. [5+5]

10.a) Show that the maximum value of utilization factor for an axial flow impulse flow is (single stage) $\varepsilon_{max} = \cos^2\alpha_1$ where $\alpha_1$ is the nozzle angle at inlet.

b) What are the forces the blades are subjected to? Explain. [7+3]

**OR**

11. An axial flow gas turbine has axial velocity of 250 m/s, which is constant. The mass flow rate of gas is 15 kg/s. Blade speed is 350 m/s. The nozzle inlet angle is 30 ° and the gas exit angle is 75 °. Calculate a) the blade angles b) the degree of reaction c) the blade loading coefficient and d) the power output. [10]

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