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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2019

(Mechanical Engineering)

(Thermal Engineering)

03ME 6002 PRINCIPLES OF TURBOMACHINERY

Max. Marks: 60 **Time: 3Hrs**

PART-A (5 x 4 =20Marks)

1. Define the following efficiencies of a power absorbing machine.

   (i) Total-to-total efficiency (ii) Static-to-static efficiency

2. Show reversible and irreversible process in the diffuser blade ring of a turbo-compressor on enthalpy-entropy coordinates and proves that

$$\eta_D = \frac{\text{static pressure rise}}{\text{Change in dynamic pressure}}$$

3. Describe briefly the various losses occurring in an inward flow radial turbine stage.

4. Draw sketched of the three types of impellers and the velocity triangles at their entries and exits.

PART B (10 x 4 =40 marks)

5. In a three stage turbine, the pressure ration of each stage is 2.0 and the stage efficiency is 75%. Calculate the overall efficiency and the power developed if air initially at a temperature of 600^{o}C flows through it at the rate of 25kg/s. Also find the reheat factor.

OR

6. The stagnation pressure ratio across a gas turbine stage is 2.0 and the initial and final stagnation temperatures of the gas are 600^{o}C and 500^{o}C respectively. The absolute velocity of the gas both at entry and exit is 120 m/s. Determine: (a) the total-to-toal efficiency, (b) The total-to-static efficiency, (c) work done per kg of the gas, and (d) mass flow rate of the gas to develop 10 MW.

7. Determine Euler, isentropic and actual values of work from the following data of an inward flow reaction turbine. Speed: 24000 rpm, Outer diameter of the rotor: 30 cm, Inner diameter of the rotor: 15 cm, Rotor blade angle at entry: 70°, Rotor blade angle at exit: 25°, Actual air angle at entry: 75°, Actual air angle at exit: 35°, Radial velocity at entry and exit: 100 m/s, Stage efficiency: 91%.

OR

8. Enumerate and explain the different cascade losses.

9. Explain with a neat sketch the enthalpy-entropy diagram for an axial turbine stage and hence prove that

$$h_{02,rel} = h_{03,rel}$$

OR

10. How is the degree of reaction(R) of an IFR turbine stage defined? Prove that

$$R = 1 - \frac{C_{\theta 2}}{u_2} = 1 - \frac{1}{2}(1 - \varphi_2 \, cot\beta_2) = 1 - \frac{\psi}{2}$$

11. An axial compressor with 50% degree of reaction has the following data: Temperature and pressure at entry: 30^{o}C, 1.05 bar, Mean blade ring diameter: 40cm, Rotational speed: 20000rpm, Blade height at entry: 5cm, Air angles at rotor and stator exit: 26°, Axial velocity: 250m/s, Work done factor: 0.8, Stage efficiency: 90%, Mechanical efficiency: 98%, Determine: (i) Air angles at rotor and stator entry, (ii) the mass flow rate of air, (iii) Power required to drive the compressor, (iv) the loading coefficient.

OR

12. (a) What is "slip factor: What is its effect on the flow and the pressure ratio in the stage? (5 marks)

(b) A centrifugal impeller has 17 radial blades in the impeller of 45 cm diameter. The tip diameter of the eye is 25 cm. Determine the slip factor by (a) Stodola's equation, (b) Stanitz's equation, and (iii) Balje's equation. (5marks)

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