CBCS SCHEME

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17AE46

Fourth Semester B.E. Degree Examination, July/August 2021
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Define Turbomachines. Explain the parts of turbomachines, with useful sketch. **(10 Marks)**

b. Obtain a general expression for degree of reaction for Axial machines. **(10 Marks)**

2 a. Using Buckingham's π theorem, derive an expression for incompressible flow machines and its physical significance. **(12 Marks)**

b. With the help of useful sketch, express a relation for ideal energy transfer (Euler equation) of turbomachines. **(08 Marks)**

3 a. Derive an expression for overall isentropic efficiency of compressors, with help of h – s diagram. **(08 Marks)**

b. A gas turbine engine has the following data : Inlet pressure and temperature $P_1 = 5$ bars , $T_1 = 500K$, Exit pressure = 1.2 bar , Overall turbine efficiency $\eta_T = 0.90$, Mass flow rate of the gas m = 20kg/s. Determine the polytropic efficiency of expansion and the power developed. Take $C_p = 1.005kJ/kg$, K , $\gamma = 1.4$. **(12 Marks)**

4 a. Discuss the effect of Reheat factor for expansion process. **(08 Marks)**

b. An air compressor has eight stages of equal pressure ratio 1.35. The flow rate through the compressor and its overall efficiencies are 50kg/s and 82%. If the conditions of air at entry are 1 bar and 40^0C , determine :

i) The state of air at compressor exit.
ii) Polytropic or small stage efficiency.
iii) Efficiency of each stage.
iv) Power required to drive the compressor assuming overall efficiency of the drive as 90%. **(12 Marks)**

5 a. Determine the pressure ratio developed and the power required to drive a centrifugal air compressor (Impeller diameter = 45cm) , Running at 7200 rpm. Assume zero swirl at the entry and $T_{01} = 288K$. **(10 Marks)**

b. With the help of velocity triangle, explain the flow through the induced section with and without inlet guide vanes. **(10 Marks)**

6 a. Elucidate the effect of surging and choking on performance of Axial flow compressors. **(08 Marks)**

b. An axial compressor stage has a mean diameter of 60cm and runs 15000 rpm. If the actual temperature rise and pressure ratio developed are 30^0C and 1.4 respectively. Determine

i) Power required to derive compressor while delivering 57kg/s of air. Assume mechanical efficiency 86.0% and initial temperature of 35^0C.
ii) The stage loading coefficient.
iii) The stage efficiency. **(12 Marks)**

7 a. Draw the velocity triangles for a 50% reaction stage turbine and give suitable relations. **(08 Marks)**

b. Gas at 7 bar and 300 ^{0}C expands to 3 bar in an impulse turbine stage. The nozzle angle is 70^0 with reference to the exit direction. The rotor blades have equal inlet and outlet angles and the stage operates with optimum blade speed ratio. Assuming that the isentropic efficiencies of the nozzles is 0.9 and that the velocity at entry to the stage is negligible. Deduce the blade angle used and the mass flow required for this stage to produce 75kW. Take C_p = 1.15 kJ/kg K. **(12 Marks)**

8 a. Describe the aerodynamic losses occurs in radial flow turbines. **(10 Marks)**

b. Draw the sketch of a 90^0 inward flow radial turbine stage with relevant equations. **(10 Marks)**

9 a. With the help of neat sketch, explain the working principle of centrifugal pumps. **(10 Marks)**

b. Describe the following :

i) Manometric head ii) Suction head.

iii) Delivery head iv) Static head. **(10 Marks)**

10 a. Briefly classify the Hydraulic turbines and explain it. **(10 Marks)**

b. Enlight the role of Draft tubes in hydraulic turbine and its functions. **(10 Marks)**

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