Code No: NR312003 **NR**

III B.Tech I Semester Supplementary Examinations, November 2005
TURBO MACHINERY
(Production Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Explain the following terms: [3+3+3+3+2+2]
   (a) Eulers's Turbine equation
   (b) Concept of boundary layers
   (c) Flow pattern in converging and diverging passage
   (d) Difference between impulse and reaction principles
   (e) Stage efficiency and overall efficiency
   (f) Mach cone

2. (a) Explain the terms slip factor and power input factor as applied to centrifugal compressor. [4]
   (b) The free air delivered by a centrifugal compressor is 20kg/min. The suction condition is 1bar and 20^0C. The velocity of air at the inlet is 60m/s. The isentropic efficiency of the compressor is 0.68. If the total head pressure ratio of compressor is 3. Determine
      i. The total nead temperature of air at the exit of the compressor and
      ii. Power required to run the compressor assuming mechanical efficiency of 96%.

   [12]

3. (a) Discuss breifly aero foil theory. [4]
   (b) Air at a temperature of 290K enters a ten stage axial flow compressor at the rate of 3kg/s. The pressure ratio is 6.5 and the isentropic efficiency is 90%. The compression process being adiabatic. The compressor has symmetrical blades. The axial velocity of 110m/s is uniform across the stage and mean blade speed of each stage is 180 m/s.

   Determine the direction of the air at entry to and exit from the rotor and the stator blades and also the power given to the air. Assume C_p=1.005 kJ/kg^0K and γ=1.4.

   [12]

4. (a) With neat sketch explain a single stage velocity traingle and derive an expression for the work output of gas turbine. [8]
   (b) Gas at 7bar and 300^0C expands to 3bar in an impulse turbine stage, The nozzle angle is 20^0 with referemce to the plane of rotation. The rotor baldes haveequal inlet and outlet angles and the stage operates with the optimum

blade speed ratio. Assuming that the isentropic efficiency of the nozzle is 0.9 and that the velocity at entry to the stage is negligble, deduce the blade angle used and the mass flow required for this stage to produce 75kW. [8]

5. (a) Show that the maximum dischange of steam through the nozzle takes place when the ratio of steam pressure at the throat to the inlet pressure is given by

   $\frac{p_2}{p_1} = \left(\frac{2}{\eta+1}\right)^{\frac{\eta}{\eta+1}}$ is the index of expansion.

   (b) Super saturated expansion occurs in a nozzle supplied with steam at 2 Mn/m^2 and 325^0C. The law is p$v^{1.3}$=constant and exit pressure is 0.36 MN/m^2 . For a flow rate of 450 kg/min. Determine

      i. the throat and the exit area and
      ii. the degree of under cooling at the exit. [8+8]

6. (a) What are the different methods of compounding of steam turbine stages. List the advantages and limitations of velocity compounding. [6]

   (b) The following data refers to one stage of an impulse turbine. [10]

   Isentropic nozzle heat drop = 185kJ/kg.

   Reheat of steam due to blade friction =10% of isentropic drop

   Nozzle angle = 20^0

   Ratio of blade speed to whirl component speed =0.5

   Velocity coefficient for the baldes=0.95

   Take its velocity of steam at the entry of the nozzle=30m/s

   Determine

      i. blade angles if the steam leaves axialy
      ii. work done per kg
      iii. friction loss over the blades and
      iv. kinetic energy loss

7. (a) Distinguish between turbo-prop, turbo-jet and Rocket engines. [6]

   (b) Air enters a turbo Jet engine at a rate of 12×10^4 kg/h at 15^0C and 1.03 bar and is compressed adiabatically to 182^0C and four times the pressure. Products of combustion enter the turbine at 815^0C and leaves it at 650^0C to enter the nozzle. Calculate the isentropic efficiency of the compressor, the power required to drive the compressor. The exit speed of gases and thrust developed when flying at 800 km/h. Assume isentropic efficiency of compressor is same as that of the turbine and the nozzle efficiency is 90%. [10]

8. Write short notes on the following : [4x4]

   (a) Pressure distribution around a cambered aerofoil blade.
   (b) Stalling and surging in compression.
   (c) C.F.C characteristics curves.

(d) Methods of flame stabilization

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