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2005 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

III B.TECH I SEMESTER SUPPLEMENTARY EXAMINATIONS

TURBO MACHINERY

(PRODUCTION ENGINEERING)

NOVEMBER 2005

TIME – 3 HOUR
MARK - 80

Answer any FIVE Questions
All Questions carry equal marks

1. Explain the following terms:

(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 [3*4+2+2]

2. (a) Explain the terms slip factor and power input factor as applied to centrifugal compressor.

(b) The free air delivered by a centrifugal compressor is 20kg/min. The suction condition is 1bar and 200C. 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%. [5+11]

3. (a) Discuss breifly aero foil theory.

(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 Cp=1.005 kJ/kg0K and =1.4. [7+9]

4. (a) With neat sketch explain a single stage velocity traingle and derive an expression for the work output of gas turbine.

(b) Gas at 7bar and 3000C expands to 3bar in an impulse turbine stage, The nozzle angle is 200 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. [10+6]

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
p2

p1
= □ 2
□ +1□
□
□ +1
is the index of expansion.

(b) Super saturated expansion occurs in a nozzle supplied with steam at 2 Mn/m2 and 3250C. The law is p 1.3=constant and exit pressure is 0.36 MN/m2 . 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.

(b) The following data refers to one stage of an impulse turbine. Isentropic nozzle heat drop = 185kJ/kg. Reheat of steam due to blade friction =10% of isentropic drop Nozzle angle = 200 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 [4+12]

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

(b) Air enters a turbo Jet engine at a rate of 12 × 104 kg/h at 150C and 1.03 bar and is compressed adiabatically to 1820C and four times the pressure. Products of combustion enter the turbine at 8150C and leaves it at 6500C 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+6]

8. Write short notes on the following :

(a) Pessure distribution around a cambered aerofoil blade.

(b) Stalling and surging in compression.

(c) C.F.C characteristics curves.

(d) Methods of flame stabilization [4*4]