# Code No. 2144

## FACULTY OF ENGINEERING

**B.E. 4/4 (Mech.) I-Semester (Main) Examination, November / December 2012**

**Subject : Thermal Turbo Machines**

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

**Note:** Answer **all** questions of Part - A and answer any **five** questions from Part-B. Missing data if any may suitably be assumed. Use of data of book is permitted.

**PART – A (10 x 2 ½ =25 Marks)**

1. Derive the expression for velocity of sound in adiabatic medium.

2. Draw Rayleigh curve on h-s plane and prove that at maximum entropy point, the velocity of fluid is sonic velocity.

3. Define cone angle and express it in terms of Mach number.

4. Express the ratio of stagnation temperature to static pressure in terms of Mach number for isentropic flow.

5. Define stalling of compressor and what are its affects.

6. List out the differences between axial flow compressor and centrifugal compressor.

7. Draw pressure-velocity variations across the blades in three pressure compounded impulse turbine.

8. Define compounding of steam turbine and why it is necessary.

9. Draw the configuration diagram and temperature-entropy diagram for open cycle gas turbine with regeneration.

10. Define propulsive efficiency and thermal efficiency of jet propulsion system.

**PART – B (5x10=50 Marks)**

11. A convergent-divergent nozzle is provided with a pipe of constant cross section at its exit: the exit diameter of the nozzle and that of the pipe is 40 cm. The mean coefficient of friction for the pipe in 0.0025. Stagnation pressure and temperature of air at the nozzle entry are 12 bar and 600K respectively. The flow is isentropic in the nozzle and adiabatic in the pipe the Mach numbers at the entry and exit of pipe are 1.8 and 1.0 respectively. Determine (i) the length of the pipe, (ii) diameter of the nozzle throat, (iii) pressure and temperature at the pipe exit Depict graphically the static and stagnation pressure variation from the nozzle entry to the pipe exit.

12. The ratio of exit to entry area in a subsonic diffuser is 4.0. The Mach number of jet of air approaching of the diffuser at po=1.013 bar, T=290K is 2.2 There is a standing normal shock wave just outside the diffuser entry. The flow in the diffuser is isentropic. Determine the (i) Mach number, temperature and pressure at the exit of the diffuser and (ii) the stagnation pressure loss between the initial and final states of the flow. Depict graphically the static and stagnation pressure variation from the diffuser entry to diffuser exit.

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13. An axial flow compressor having 8 stages and with 50% reaction design compresses air in the pressure ratio of 4:1. The air enters the compressor at 20oC and flows through it with a constant speed of 90 m/s. The compressor rotates with a mean speed of 180 m/s. Assume isentropic of compressor is 82%, γ= 1.4 and Cp=1.005 kJ/kg-K, calculate (i) work done on the compressor and (ii) blade angles.

14. In a Parsons Reaction turbine running at 1500 rpm, the available enthalpy drop of steam for the expansion is 65 kJ/kg. If the mean diameter of the rotor is 1 meter, find the number of the rows of the moving blade required. Assume stage efficiency as 80%, blade outlet vane angle is 20o and speed ratio is 0.7.

15. In an open cycle constant pressure gas turbine, air enters the compressor at 1 bar and 300 K. The pressure ratio is 4:1. The isentropic efficiencies of compressor and turbine are 78% and 85% respectively. The air fuel ratio is 80:1, calculate the power developed and thermal efficiency of the cycle if the flow rate of air is 2.5 kg/sec. Assume Cp=1.005kJ/kg-K, γ=1.4 for air, Cpg=1.147k J/kg,-K, γ= 1.33 for gases, R=0.287k J/kg-K, Calorific value of fuel is 42000 kJ/kg.

16. A centrifugal compressor running at 9000 rpm delivers 600 m3/min of free air. The air is compressed from 1 bar and at 293 K to a pressure of 4 bars with an isentropic efficiency of 82%. Blades are radial at outlet of impellor and the flow velocity of 62 m/s is assumed constant throughout the impellor. The outer radius of impellor is twice the inner radius and slip factor is assumed as 0.9. The blade area coefficient of 0.9 may be assumed at inlet. Determine (i) final temperatures of air (ii) theoretical power required (iii) impellor diameters at inlet and outlet, (iv) breadth of impellor at inlet (v) impellor blade angle at inlet and (vi) diffuser blade angle at inlet.

17.(a) Write short notes on application of rockets along with classification of rockets. (3+3)

 (b) Explain the working principle of Turbo jet with a neat sketch. (4)

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