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BIME-013

B.Tech. – VIEP – MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

00035

December, 2014

BIME-013 : TURBO MACHINES

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any* ***seven*** *questions. All questions carry equal marks. Use of scientific calculator is permitted.*

1. (a) Describe with the help of a neat sketch a combustion chamber for internal combustion gas turbine. *5*

(b) What are the advantages of gas turbine over reciprocating engines ? Discuss their scope and fields of application. *5*

2. What is the influence of the following variables on the thermal efficiency of an open cycle gas turbine at different pressure ratios : *10*

(a) Turbine inlet temperature

(b) Compressor inlet temperature

(c) Compressor efficiency

(d) Turbine efficiency

3. The resistance R, to the motion of a supersonic aircraft of length L, moving with a velocity V in air of density ρ, depends on the viscosity μ and bulk modulus of elasticity K of air. Obtain by dimension analysis, the following expression for the resistance R : *10*

$$R = (\rho L^2 V^2)\, \phi \left[\left(\frac{\mu}{\rho LV} \right), \left(\frac{K}{\rho V^2} \right) \right]$$

4. A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of 750 litres per second under a head of 35 m. If the bucket deflects the jet through an angle of 160°, find the power developed by the turbine and its hydraulic efficiency. Take the coefficients of velocity as 0·98. Neglect friction in the bucket. Also determine the overall efficiency of the turbine if its mechanical efficiency is 80%. *10*

5. A centrifugal compressor delivers 16·5 kg/s of air with a total head pressure ratio of 4 : 1. The speed of the compressor is 1500 rpm. Inlet total head temperature is 20°C, slip factor 0·9, power input factor 1·04 and isentropic efficiency is 80%. Calculate : *10*

(a) Overall diameter of the impeller

(b) Power input

6. (a) Describe briefly an axial-flow compressor. *5*

(b) What do you mean by 'Surging' and 'Choking' ? *5*

7. Find the required air-fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80% respectively. Maximum cycle temperature is 875°C. The working fluid can be taken as air (C_p = 1·0 kJ/kg K, γ = 1·4) which enters the compressor at 1 bar and 27°C. The pressure ratio is 4. The fuel used has calorific value of 42,000 kJ/kg. There is a loss of 10% of the calorific value in the combustion chamber. *10*

8. In an air-standard regenerative gas turbine cycle the pressure ratio is 5. Air enters the compressor at 1 bar, 300 K, and leaves at 490 K. The maximum temperature in the cycle is 1000 K. Calculate the cycle efficiency, given that the efficiency of the regenerator and the adiabatic efficiency of the turbine are each 80%. Assume for air, the ratio of specific heats is 1·4.

Also, show the cycle on a T – S diagram. *10*

9. 300 kg/min of steam (2 bar, 0·98 dry) flows through a given stage of a reaction turbine. The exit angle of the fixed blades as well as the moving blades is 20° and 3·68 kW of power is developed. If the rotor speed is 360 rpm, and tip leakage is 5 percent, calculate the mean drum diameter and the blade height. The axial-flow velocity is 0·8 times the blade velocity. *10*

10. (a) Explain the difference between an impulse turbine and a reaction turbine. *5*

(b) What do you mean by compounding of steam turbines ? List down the various methods of compounding of steam turbines. *5*