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BIME-013

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

00046

Term-End Examination

June, 2015

BIME-013 : TURBO MACHINES

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any **five** questions. All questions carry equal marks. Use of steam tables is allowed. Use of scientific calculator is permitted.*

1. (a) State the Buckingham's π theorem and explain the technique of dimensional analysis of grouping the variables to form non-dimensional parameters. 7

(b) An agitator of diameter D rotates at a speed N in a liquid of density ρ and viscosity μ.

Show that the power P required to mix the liquid is expressed by a functional form

$$\frac{P}{\rho N^3 D^5} = f\left(\frac{\rho N D^2}{\mu}, \frac{N^2 D}{g}\right).$$ 7

2. (a) What are hydraulic turbines ? How do impulse turbines differ from reaction turbines ? 7

(b) The penstock supplies water from a reservoir to the Pelton wheel with a gross head of 500 m. One-third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is 2·0 m^3/sec. The angle of deflection of the jet is 165°. Determine the power given by the water to the runner and also hydraulic efficiency of the Pelton wheel.

Take speed ratio = 0·45 and C_v = 1·0. 7

3. (a) Describe with neat sketches, the construction and working of a Kaplan turbine. Why is a draft tube used in reaction turbine ? 7

(b) A centrifugal pump is to discharge 0·118 m^3/sec at a speed of 1450 rpm against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller. 7

4. (a) What is a centrifugal compressor ? How does it differ from an axial flow compressor ? 7

(b) A centrifugal compressor running at 10,000 rpm delivers 660 m^3/min of free air. The air is compressed from 1 bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 82%. Blades are radial at outlet of impeller and flow velocity of 62 m/sec may be assumed throughout constant. The outer radius of impeller is twice the inner and the slip factor may be assumed as 0·9. The blade area coefficient may be assumed to be 0·9 at inlet.

Calculate :

(i) Final temperature of air

(ii) Theoretical power

(iii) Impeller diameter at inlet and outlet

(iv) Breadth of impeller at inlet

(v) Impeller blade angle at inlet

(vi) Diffuser blade angle at inlet 7

5. (a) Discuss the advantages and disadvantages of steam turbine as compared to steam engine. 7

(b) Steam issues from the nozzle of a De Laval turbine with a velocity of 1,200 m/sec. The nozzle angle is 20°, the mean velocity is 400 m/sec and the inlet and outlet angles of blade are equal. The rate of mass flow through the turbine is 900 kg/hr.

Calculate the :

(i) blade angle

(ii) relative velocity of steam entering the blade

(iii) tangential force on the blade

(iv) axial force on the blade

(v) power developed

(vi) blade efficiency

(vii) energy lost due to friction in blade per kg of steam.

Assume blade velocity co-efficient as 0·8. 7

6. (a) Describe with a neat sketch the working of a simple constant pressure open cycle gas turbine. 7

(b) A gas turbine unit has a pressure ratio of 6 : 1 and maximum cycle temperature of 610°C. The isentropic efficiencies of the compressor and turbine are 0·80 and 0·82 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine. When the air enters the compressor at 15°C at the rate of 16 kg/sec. Take C_p = 1·005 kJ/(kg K) and γ = 1·4 for the compression process, and take C_p = 1·11 kJ/(kg K) and γ = 1·333 for the expansion process. 7

7. Write short notes on any ***four*** of the following : $4 \times 3\frac{1}{2} = 14$

(a) Hydraulic Similitude

(b) Cavitation

(c) Diagram Efficiency

(d) Francis Turbine

(e) Priming in Centrifugal Pumps