ONE TIME EXIT SCHEME

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10ME56

Fifth Semester B.E. Degree Examination, April 2018
Turbomachines

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of steam tables is permitted.

PART – A

1 a. Define Turbomachine and classify turbomachines. **(05 Marks)**

b. Explain any five major differences between turbomachines and positive displacement machines. **(05 Marks)**

c. A ¼th scale turbine model is tested under a head of 30 m. The full-scale turbine is required to work under a head of 130 m and to run at 450 rpm. Calculate
(i) The speed of model, if it produces 130 kW when discharge is 0.6 m^3/s.
(ii) The power produced by the prototypes if its efficiency is 6% more than that of model. **(10 Marks)**

2 a. Define and differentiate between static and stagnation conditions in flow through turbomachine. **(06 Marks)**

b. With the help of T-S diagram, explain the process of
(i) Isentropic static compression
(ii) Isentropic stagnation compression
(iii) Adiabatic static compression
(iv) Adiabatic stagnation compression **(04 Marks)**

c. An air compressor has six stages of equal pressure ratio 1.4. The mass flow rate is 45 kg/s. The overall isentropic efficiency is 84%. Entry pressure 1 bar and entry temperature is 40°C. Calculate
(i) the state of the air at the exit
(ii) polytropic efficiency
(iii) each stage efficiency
(iv) power required to drive the compressor.
Assume overall efficiency of drive = 0.9. **(10 Marks)**

3 a. Derive an alternate form of Euler's turbine equation and explain significance of each energy component. **(10 Marks)**

b. Define degree of reaction. Derive an expression for utilization factor in terms of degree of reaction for an axial flow turbine. **(10 Marks)**

4 a. Explain (i) backward curved vane (ii) radial vane and (iii) forward curved vane of a centrifugal pump with the help of velocity diagrams, neat sketches of vanes and plot of variation of head with varying discharge. **(10 Marks)**

b. The impeller of a centrifugal pump has an outer diameter of 1.5m. It lifts water at a rate of 2000 lit/s. The blade is making an angle of 145° with the direction of motion at outlet and the speed being 300 rpm. Radial velocity of flow is 3 m/s. Find the power required to drive the impeller. **(10 Marks)**

PART – B

5 a. Explain the working principle of velocity compounded steam turbine with the help of nea diagrams. **(08 Marks**

b. Steam flows through the nozzle with a velocity of 450 m/s at an angle of 20° to the tangen of blade. Steam exits the moving blade with a velocity of 100 m/s. The exit angle of stean is 120° with the direction of blade motion. Assume that blades are equiangular. The mas flow rate of steam is 7.5 kg/s. calculate (i) the power developed (ii) the power lost due t friction. **(12 Marks**

6 a. Show that for Pelton wheel, the maximum hydraulic efficiency is given by

$$\frac{1+C_b\cos(\beta_2)}{2},$$

where C_b = ratio of relative velocities at outlet to inlet and β_2 = blade at outlet. **(10 Marks**

b. A Francis turbine works under a head of 60 m and develops 294 kW while running a 700 rpm. Outer diameter of the runner is twice the inner diameter. Overall efficiency is 84% Hydraulic efficiency is 93%, flow ratio is 0.2. breadth ratio is 0.1. The thickness of vane occupy 5% of the circumferential area of the runner. Velocity of flow is constant from inl to outlet and the flow is radial at outlet. Determine (i) Guide blade angle (ii) runner van angle at inlet and outlet (iii) diameter of runner at inlet and outlet and (iv) width of runn at inlet. **(10 Mark**

7 a. Derive pressure rise expression for centrifugal pump. **(10 Mark**

b. A centrifugal pump having outer diameter equal to twice the inner diameter and running 1200 rpm, works against a head of 75m. The velocity of flow through the impeller constant and is equal to 3 m/s. The blades are set at an angle of 30° at outlet. If the outl diameter of impeller is 60cm and width at outlet is 5cm, determine (i) Vane angle at inl (ii) Work done per second by the impeller and (iii) manometric efficiency. **(10 Mark**

8 a. Differentiate between centrifugal compressor and axial flow compressor. **(05 Mark**

b. Explain the principle of surging and stalling in centrifugal compressor. **(05 Mark**

c. Air at a temperature of 290 K flows in a centrifugal compressor running at 20,000 rpm, sl factor = 0.8, η_{t-t} = 0.8, d_2 = 0.6m. Assume that the absolute velocities at inlet and outlet a same. Calculate (i) the temperature rise of air passing through the compressor a (ii) the stage pressure ratio. **(10 Mark**

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