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10ME56

Fifth Semester B.E. Degree Examination, June/July 2014

Turbomachines

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamics data book is permitted.***
3. ***Assume any missing data suitably.***

PART – A

1 a. Define turbomachine. Classify them on basis of work transfer. **(04 Marks)**

b. Define the following efficiencies of power absorbing turbomachines:
i) Total-to-total efficiency
ii) Static-to-static efficiency **(06 Marks)**

c. Explain specific speed and specific power. **(04 Marks)**

d. A model turbine 1 m in diameter acting under a head of 2 m runs at 150 rpm. Estimate the scale ratio if the prototype develops 20 MW under a head of 225 m with a specific speed of 100. **(06 Marks)**

2 a. Define polytropic efficiency of a compressor. **(04 Marks)**

b. What is reheat factor in a multistage turbine? Prove that R.F is greater than unity. **(08 Marks)**

c. In a three stage turbine the pressure ratio of each stage is 2 and the stage efficiency is 75%. Calculate the overall efficiency and reheat factor. **(08 Marks)**

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

b. At a 50% reaction stage axial flow turbine, the mean blade diameter is 0.60 mtr. The maximum utilization factor is 0.85 and steam flow rate is 12 kg/s. Calculate the inlet and outlet absolute velocities and power developed if the speed is 2500 rpm. **(10 Marks)**

4 a. Derive an expression of theoretical head capacity relationship of radial outward flow devices (centrifugal machines). **(10 Marks)**

b. An inward flow reaction turbine has outer and inner diameter wheel as 1 m and 0.5 m respectively. The vanes are radial at inlet and discharge is radial at outlet and fluid inters the vanes at an angle of 10°. Assuming the velocity of flow to be constant and equal to 3 m/sec. Find: i) Speed of wheel, ii) Vane angle at outlet, iii) Degree of reaction. **(10 Marks)**

PART – B

5 a. What is compounding or staging? Name the different compounding methods. **(04 Marks)**

b. The data pertaining to an impulse turbine is as follows:
Steam velocity = 500 m/sec, blade speed = 200 m/sec, exit angle at moving blade = 25° measured from tangential direction, nozzle angle = 20°. Neglecting the effect of friction when passing through blade passages. Calculate:
i) Inlet angle of moving blade
ii) Exit velocity and direction
iii) Work done per kg of steam
iv) Power developed
v) Diagram efficiency **(16 Marks)**

6 a. Obtain an expression for the workdone per second by water on the runner a pelton Wheel and Hydraulic efficiency. **(10 Marks)**

b. A Kaplan turbine has an outer diameter of 8m and inner diameter as 3m and developing 30,000 KW at 80 rpm under a head of 12 m. The discharge through the runner is 300 m^3/sec. If the hydraulic efficiency is 95%, determine:

i) Inlet and outlet blade angles
ii) Mechanical efficiency
iii) Overall efficiency **(10 Marks)**

7 a. Derive the expression for the minimum speed for starting a centrifugal pump. **(12 Marks)**

b. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1200 rpm, works against a total head of 75 m. The velocity of flow through the impeller is constant and equal to 3m/sec. The vanes are setback at an angle of 30° at outlet. If the outlet diameter of the impeller is 60 cm and width at outlet is 5 cm, determine:

i) Vane angle at inlet
ii) Workdone per second by impeller
iii) Manometric efficiency **(08 Marks)**

8 a. Explain the phenomena of surging, stalling and chocking in centrifugal compressor stage. **(06 Marks)**

b. Draw velocity triangles at the entry and exit for the axial compressor stage. **(06 Marks)**

c. An axial compressor/blower supplies air to furnace at the rate of 3 kg/sec. The atmospheric conditions being 100 kPa and 310 K. the blower efficiency is 80% and mechanical efficiency is 85%. The power supplied to 30 kW. Estimate the overall efficiency and pressure developed in mm W.G. **(08 Marks)**

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