CBCS SCHEME

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18MR55

Fifth Semester B.E. Degree Examination, June/July 2024
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Turbomachine. Classify them on basis of work transfer and working fluid. **(06 Marks)**

b. Define the specific speed of a turbine. Obtain an expression for the same in terms of power, speed and head. **(06 Marks)**

c. The quantity of water available for a hydroelectric power station is $280 m^3/s$. The head developed is 1.5m. If the speed of the turbine is 60rpm and the efficiency 85%, find the number of turbines. Assume specific speed to be 750. **(08 Marks)**

OR

2 a. Define the static and stagnation state of fluid. **(04 Marks)**

b. Define the following with the help of h-s diagram for power absorbing machine:
i) Total to total efficiency
ii) Total to static efficiency
iii) Static to total efficiency
iv) Static to static efficiency. **(08 Marks)**

c. Air enters a straight axis symmetric duct at 300K 3.5 bar and 150m/s and leaves it at 275K, 2.2 bar and 270 m/s. The area of cross section at entry is $550 cm^2$. Assume adiabatic flow, $\gamma = 1.4$, R = 287.03/kgK. Calculate :
i) The stagnation temperature
ii) The mass flow rate
iii) The area of cross section at exit. **(08 Marks)**

Module-2

3 a. Considering the elements of energy transfer. Derive an alternate form of Euler Turbine equation. **(10 Marks)**

b. At a stage of 50% reaction axial flow turbine running at 3000rpm, the mean blade diameter is 68.5cm. If the maximum utilization factor for the stage is 0.915, calculate: i) The inlet and outlet absolute velocities ii) The power output, also find the power developed for a steam flow rate of 1.5kg/s. **(10 Marks)**

OR

4 a. Show that the degree of reaction for axial flow compressor with constant velocity of flow is given by

$$R = \frac{Va}{2u}\left(\frac{\tan\beta_2 + \tan\beta_1}{\tan\beta_1 \tan\beta_2}\right) = \frac{Va}{2u}\cot\beta_n$$ **(10 Marks)**

b. An axial flow compressor has the following data entry condition 1 bar and 20°C degree of reaction 50% mean blade ring diameter 36cm blade height 0.06m rotational speed 18,000rpm. The angle at stator exit 65°. Axial velocity Va = 180m/s and mechanical efficiency 96.7%. Determine: i) Blade angle at inlet ii) The power required to drive the compressor. **(10 Marks)**

Module-3

5 a. Define the following with respect to steam turbine i) Tangential force ii) Axial thrust iii) Blade efficiency iv) Stage efficiency. **(08 Marks)**

b. A De Laval turbine has a mean rotor diameter of 0.55m and runs at 3300 rpm. The speed ratio is 0.45 and the nozzle angle at the rotor inlet is 20°. The blade velocity coefficient is 0.91. Assuming equiangular blades, find the rotor blade angles at the inlet and outlet. If m = 10kg/s, find the power output and the axial thrust. **(12 Marks)**

OR

6 The following data refers to a velocity compounded impulse steam turbine having two rows of moving blades and a fixed row between them, velocity of steam leaving the nozzle is 1200m/s, nozzle angle is 20°, blade speed is 250m/s, blade angles of first moving row are equiangular, blade outlet angle of the fixed blade is 25°. Blade outlet angles of the second moving row is 30°. Friction factor for all the rows is 0.9. Draw the velocity diagrams for a suitable scale and calculate the power developed, axial thrust, diagram efficiency for steam flow rate of 5000kg/hr. **(20 Marks)**

Module-4

7 a. With a neat sketch explain the principle and working of Pelton wheel. **(08 Marks)**

b. A dam power house is proposed to be built for which a Francis turbine is required to be designed. The design head is 16m, and the design flow rate is $8m^3/s$. The speed is to be 250rpm. An overall efficiency of 0.9, hydraulic efficiency of 0.95, a speed ratio of 0.76 and flow ratio of 0.35 may be assumed. Obtain all the salient dimensions (outer, inner, diameters, width), blade angles and guide vane angles. The inner diameter is half the outer diameter and the discharge does not have any whirl component. Neglect vane thickness. **(12 Marks)**

OR

8 a. With a neat sketch, explain the principle and working of Francis turbine, along with the help of velocity triangle. **(10 Marks)**

b. The penstock supplies water from a reservoir to the pelton wheel with a gross heat of 500m. (1/3) 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 penstock is $2m^3/s$. 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 $C_V = 1$. **(10 Marks)**

Module-5

9 a. With the help of a neat sketch, explain the parts and working principle of a centrifugal pump. **(10 Marks)**

b. Briefly explain the following for a centrifugal pump:

i) Manometric head
ii) Suction and delivery head
iii) Manometric efficiency
iv) Mechanical efficiency
v) Hydraulic efficiency
vi) Volumetric efficiency
vii) Overall efficiency. **(10 Marks)**

OR

10 a. Write a note on type of casing in centrifugal pump. **(06 Marks)**

b. Following data refers to a centrifugal pump. Outer diameter of the impeller = 0.75m, discharge = $1.5m^3/s$, total head = 0.85m, speed = 1000rpm, width of outlet = 0.8m. The leakage loss is 4% of the discharge, mechanical losses 8.5kW and hydraulic efficiency 80%. Calculate: i) The vane exit angle ii) The power at shaft of the motor iii) The overall efficiency iv) The mechanical efficiency v) The volumetric efficiency. **(14 Marks)**