CBCS SCHEME

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18AE46

Fourth Semester B.E. Degree Examination, June/July 2023
Turbomachines

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Write a descriptive note on the classification of turbomachines. Give specific examples for each case. **(10 Marks)**

b. The thrust (T) of a propeller is assumed to depend on the axial velocity of the fluid V, the density ρ, and viscosity μ of fluid, the speed N in RPM and the diameter D. Find the relationship of 'T' by dimensional analysis. **(10 Marks)**

OR

2 a. Derive an expression for maximum utilization factor for axial flow type of impulse turbine and 50% reaction turbine. Draw also the velocity triangles. **(10 Marks)**

b. At a stage of a impulse turbine the mean blade dia is 0.75 m, its rotational speed being 3500 rpm. The absolute velocity of fluid discharging from a nozzle inclined at 20° to the plane of the wheel is 275 m/s. If the utilization factor is 0.9 and the relative velocity at the rotor exit is 0.9 times that at the inlet find the inlet and exit rotor angle. Also find the power output from the stage for a mass flow rate 2 kg/s and axial thrust on the shaft. **(10 Marks)**

Module-2

3 a. Define the following with the help of h-s diagram for the power absorbing turbomachines:
(i) Total-to-total efficiency (ii) Static to static efficiency **(10 Marks)**

b. What do you mean by infinitesimal stage efficiency? Derive an expression for polytropic efficiency for a compression process and hence express for the stage efficiency in terms of polytropic efficiency. **(10 Marks)**

OR

4 a. What is reheat factor in turbine? Show that the reheat factor is greater than the unity in multistage compressor. **(10 Marks)**

b. A compressor develops a pressure of 1600 mm WG. If the air enters the compressor at 1.02 bar, 303K and leaves at 320 K, compute compressor and infinitesimal stage efficiency.

In another compressor, air compresses from 1.02 bar, 303 K to a final pressure of 2.5 bar with a compressor efficiency of 75%. Determine the infinitesimal efficiency. Comment on the results. **(10 Marks)**

Module-3

5 a. Draw the outlet velocity triangles for the impeller of : (i) Froward curved vane type (ii) Radial type and (iii) Back curved vane type. Derive an expression for H-Q characteristics curve and discuss the effect of outlet blade angle on energy transfer. **(10 Marks)**

b. A centrifugal compressor rotor has inlet radius of 30 cm and exit radius of 60 cm. Entry is radial with a component of m/s which is constant throughout. The compressor requires 700 KW of power to handle 20 kg of air per second. Find the blade angles at inlet and outlet if the compressor runs at 5100 rpm. Calculate the width at inlet and outlet if the specific volumes at inlet and outlet are respectively, 0.85 m^3/kg and 0.71 m^3/kg. What is the degree of reaction? **(10 Marks)**

OR

6 a. Explain the work done and efficiencies of axial flow compressor. **(10 Marks)**

b. Draw a sketch of an axial flow compressor with inlet guide vanes and explain the working principle of the compressor. **(10 Marks)**

Module-4

7 a. Explain the enthalpy and entropy diagram of axial flow turbines. **(12 Marks)**

b. Air enters in an axial flow turbine with a tangential component of the absolute velocity equal to 600 m/s in the direction of rotation. At the rotor exit, the tangential component of the absolute velocity is 100 m/s in a direction opposite to that of rotational speed. The tangential blade speed is 250 m/s. Evaluate:

(i) The change in total enthalpy of air between the inlet and outlet of the rotor.

(ii) The power in KW, if the mass flow rate is 10 kg/s.

(iii) The change in total temperature across the rotor. **(08 Marks)**

OR

8 a. Explain the types of inward flow radial turbines with a neat sketch. **(10 Marks)**

b. Explain the thermodynamics of radial flow turbines. **(10 Marks)**

Module-5

9 a. Define an expression for maximum efficiency of a pelton wheel interms of blade angle at the exit. **(10 Marks)**

b. A Kaplan turbine working under a head of 15 m developed 7250 KW. The outer diameter of the runner is 4m and hub diameter = 2m. The guide blade angle at the extreme edge of runner is 30°. The hydraulic and the overall efficiency of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at outlet, determine:

(i) Runner vane angle at inlet and outlet at the extreme edge of the runner

(ii) Speed of the turbine. **(10 Marks)**

OR

10 a. Define the following terms as referred to the centrifugal pump:

(i) Suction head (ii) Static head (iii) Manometric efficiency

(iv) Hydraulic efficiency (v) Volumetric efficiency (vi) Mechanical efficiency

(vii) Overall efficiency (viii) Manometric heat **(08 Marks)**

b. Discuss the different types of casing with a neat sketch. **(12 Marks)**

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