CBCS SCHEME

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18AE46

Fourth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic data hand book is permitted.***

Module-1

1 a. Define the following dimensionless numbers, write relevant equations and mention at least one significance of each them.
i) Reynolds Numbers ii) Prandtl number iii) Grashoff Number iv) Nusselt Number. **(10 Marks)**

b. Define a turbomachine. How different is a turbomachine compared to positive displacement machines with regard to i) Action ii) Operation iii) Conversion efficiency iv) Mechanical features, mention in brief and only up to the point. **(10 Marks)**

OR

2 a. Derive Euler turbine equation. State the assumptions made. Further, arrive at the alternate form of the equation, mention each component with significance. **(10 Marks)**

b. Two geometrically similar pumps, when tested were found to rotate at 1000 rpm. One of them has 0.3 m impeller diameter, discharges at 20 ℓps against a head of 15 m. Determine the impeller diameter and head of the other pump, if it has half the discharge capacity of the first. **(10 Marks)**

Module-2

3 a. Represent a compression process on a T-S or P-V diagram. Derive an expression for pre-heat factor. **(10 Marks)**

b. A high speed compressor is designed to compress air at 1.0 bar and 32°C to three times its initial pressure. If the compressor efficiency is 75%, determine the polytropic efficiency. **(10 Marks)**

OR

4 a. Mention which device you choose for an expansion process, a compressor or a turbine? Define: i) Stage efficiency ii) Overall efficiency iii) Polytropic efficiency for an expansion process, and represent them on a T-S or P-V plot. **(10 Marks)**

b. It is required to design a two-stage expansion device to operate with an overall pressure ratio of 10 and with an efficiency of 86%. Determine the i) temperature ratio ii) temperature rise per stage, assuming an inlet temperature of 1199K and temperature rise in each stage is constant. **(10 Marks)**

Module-3

5 a. Sketch and explain :
i) Backward ii) forward iii) radial tip impellers of a centrifugal compressor. Represent the exit velocity triangles for each one of them. **(10 Marks)**

b. Explain the phenomenon of surging and choking in a centrifugal compressor. Draw the characteristic curves. **(10 Marks)**

OR

6 a. An axial flow compressor with 50% degree of reaction has 45° and 10°, inlet and exit blade angles respectively measured in axial direction, respectively. The blade speed and the axial velocity are constant, while the pressure ratio is 6 and overall efficiency is 85%, if the workdone factor is 0.75, blade speed is 200 m/s, and inlet static temperature is 37°C, determine the number of stages. **(10 Marks)**

b. Sketch and explain the working of an axial compressor stage, indicating the major components. **(10 Marks)**

Module-4

7 a. A 50% degree of reaction axial flow turbine has an axial component of fluid velocity at nozzle exit, equal to 180 m/s that matches the blades speed. If the nozzle is inclined at 27° to the direction of rotation, determine the rotor blade angles, construct the inlet and exit velocity triangles. **(10 Marks)**

b. With suitable block diagrams briefly explain : i) subsonic ii) supersonic turbines. **(10 Marks)**

OR

8 a. Explain different losses in a radial flow turbine. **(08 Marks)**

b. With a neat sketch, explain the concept of multi-staging in axial flow turbine. **(08 Marks)**

c. Discuss briefly on radial turbine characteristics. **(04 Marks)**

Module-5

9 a. Define and explain the following terms with reference to a centrifugal pump. i) Manometric head ii) Hydraulic efficiency iii) Suction and delivery heads iv) Overall efficiency. **(10 Marks)**

b. A centrifugal pump discharges $2m^3/s$ at 200 rpm at 6 m height. The exit blade angle tangent to the rotor is 26°, and the radial velcoity is 2.5 m/s. The impeller inlet and outlet diameters are 0.6m and 1.2 m respectively. Determine its manometric efficiency. Construct the velocity triangles (Not to scale) **(10 Marks)**

OR

10 a. Sketch and explain the working of a Kaplan turbine. What are its major components? **(10 Marks)**

b. A Pelton wheel installed in a hydro plant generates 15mW, working under a head of 350 m, running at 500 rpm. The turbine operates at 84% efficiency, with coefficient of velocity of 0.98. Find : i) number of jets ii) diameter at each jet assuming discharge from each jet as $1.2\ m^3/s$ **(10 Marks)**

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