CBCS SCHEME

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15AE46

Fourth Semester B.E. Degree Examination, July/August 2022
Turbomachines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. With reference to (i) operation (ii) action (iii) efficiency of conversion (iv) mechanical features, make a comparison of a turbo-machine with a positive displacement machine. **(08 Marks)**

b. Two geometrically similar pumps are running at the same speed of 1000 rpm. One pump with an impeller of 0.3 m diameter lifts water at 20 lps against a head of 15 m. What is the head and impeller diameter of the other pump to deliver half the discharge? **(08 Marks)**

OR

2 a. Derive Euler's turbine equation and also express in its alternate form. Name all the components of it. **(10 Marks)**

b. In a lawn sprinkler, water leaves the jet with an absolute velocity of 3 m/s. The sprinkler has 0.2 m long arm and rotates at 120 rpm. Find the ideal and actual work input. **(06 Marks)**

Module-2

3 a. Derive an expression for pre-heat factor. Represent on a P-V or T-S diagram. **(08 Marks)**

b. Determine the polytropic efficiency of a high pressure compressor, compressing air at 1.01 bar and 32°C to 3 bar. Assume compressor efficiency of 75%. **(08 Marks)**

OR

4 a. Define: (i) Stage efficiency (ii) Overall efficiency (iii) Polytropic efficiency for an expansion process with suitable representation on a P-V or T-S diagram. **(08 Marks)**

b. A two stage gas turbine operates with an overall pressure ratio of 10 and with an efficiency of 86%. Assuming temperature rise in each stage as constant, find the (i) pressure ratio (ii) stage efficiency, if the inlet temperature is 1199 K. **(08 Marks)**

Module-3

5 a. Define with reference to a centrifugal compression, explain the phenomenon of surging and choking. **(08 Marks)**

b. Define slip factor and slip. Represent the same using velocity triangle and discuss in detail about them. **(08 Marks)**

OR

6 a. Sketch and explain the different types of impellers used in a centrifugal compressor. Represent the exit velocity triangles for each of them. **(08 Marks)**

b. An axial flow compressor is designed for the following conditions:
50% degree of reaction with an overall efficiency of 85%; inlet and outlet blade angles with respect to axial direction = 45° and 10° respectively; pressure ratio = 6, blade speed = 200 m/s; inlet static temperature = 37°C. Assuming constant blade speed and axial velocity, find the number of stages of the workdone factor is unity. **(08 Marks)**

Module-4

7 a. In an axial flow turbine the air velocity at the exit in the axial direction is 180 m/s. The nozzle is inclined at 27° to the direction of rotation. If the blade speed is 180 m/s and the degree of reaction is 50%, find the rotor blade angles. **(08 Marks)**

b. Explain the following types of turbines:
(i) Subsonic (ii) Transonic (iii) Supersonic turbines **(08 Marks)**

OR

8 a. The inner and outer diameter of the impeller of an inward radial flow turbine rotating at 34000 rpm, are 8 cm and 20 cm respectively. The fluid entry is axial at the impeller with a radial velocity of 293 m/s. The turbine generates 180 KW of power. Determine:
(i) The mass flow rate
(ii) The percentage energy transfer due to change of radius **(10 Marks)**

b. What are the different losses in a radial flow turbine? Discuss. **(06 Marks)**

Module-5

9 a. With reference to a centrifugal pump, define the following terms and write appropriate relations:
(i) Manometric head
(ii) Manometric efficiency
(iii) Volumetric efficiency
(iv) Net positive suction head **(08 Marks)**

b. A centrifugal pump running at 200 rpm discharges 2 m^3/s, lifting the fluid to an average height of 6m. If the exit vane angle tangent to the impeller is 26°, and the radial velocity is 2.5 m/s, determine its manometric efficiency. The impeller outlet diameter is 1.2 m while the inlet diameter is half the outlet diameter. **(08 Marks)**

OR

10 a. Sketch and explain the working of a Pelton turbine. Describe its major components. Also draw the velocity angle. **(10 Marks)**

b. A pelton wheel generates 15 MW against a head of 350 m, at 500 rpm. Assuming turbine efficiency of 84%, coefficient of velocity for nozzle as 0.98, determine: (i) Number of jets (ii) Diameter of each jet, assuming discharge from each jet as 1.3 m^3/s. **(06 Marks)**

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