CBCS SCHEME

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18AE46

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.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. With a neat sketch, explain the major components of a turbomachine. **(06 Marks)**

b. Distinguish between a turbomachine and a positive displacement machine. **(04 Marks)**

c. A model of Francis turbine of 1:5 scale ratio is tested under a head 1.5m. It develops 3kW at 360rpm. Determine the speed and power developed under a head of 6m. Also find its specific speed. **(10 Marks)**

OR

2 a. Derive an expression for Euler Turbine equation in alternate form and explain each term with significance involved in it. **(10 Marks)**

b. A turbine has following data : water in directed at an angle of 30° to the tangent. Degree of reactions 0.45, utilization factor is 0.895. The absolute velocity at exit is axial; water enters the rotor with a static pressure 500KPa and stagnation pressure of 750KPa. Calculate : i) the inlet blade angle and ii) Work output for a mass flow rate of 10Kg/s **(10 Marks)**

Module-2

3 a. With reference to a compression process, define : i) stage efficiency ii) overall efficiency. Represent the same an a T-S diagram. **(10 Marks)**

b. A two stage gas turbine develops 22mW at the shaft. The inlet temperature is 1500k. The pressure ratio of the turbine is 8 and the isentropic expansion efficiency 0.9. Assume that the pressure ratio of each stage is same. Calculate : i) the pressure ratio of each stage ii) polytropic efficiency iii) mass flow rate and iv) efficiency and power of each stage. Assume r = 1.4, C_p = 1.005 kJ/Kg.K, overall drive efficiency = 0.9. **(10 Marks)**

OR

4 a. With the help of a T-S diagram define 'reheat' factor in a turbine. Why reheat factor is greater than unity? Explain. **(05 Marks)**

b. A jet of gas has the following data. Temperature = 593K, R = 1.3, R = 469J/Kg-K, Mach number 1.2. Calculate for static and stagnation conditions, i) Velocity of sound ii) Enthalpy. **(07 Marks)**

c. Air flows through an air turbine, where it stagnation pressure is decreased in the ratio 5:1. The total to total efficiency is 0.8 and the air flow rate is 5Kg/s. The inlet total temperature is 280K. Calculate: i) Actual power output ii) Actual exit total temperature. **(08 Marks)**

Module-3

5 a. What is a diffuser? Explain with a neat sketch. **(06 Marks)**

b. Explain the phenomenon of surging and choking in a compressor. **(08 Marks)**

c. Free air delivered by a compressor is 20Kg/min. The inlet conditions are 1 bar and 20°C, static. The velocity of air at the inlet is 60m/s. the isentropic efficiency of the compressor is 0.7. The total head pressure ratio is 3. Determine the total head temperature at the exit. **(06 Marks)**

OR

6 a. With the help of a schematic diagram, explain the working of an axial flow compressor. **(10 Marks)**

b. A centrifugal compressor develops a pressure ratio of 5 and an air consumption of 30Kg/s. The inlet temperature and pressure are 15°C and bar respectively. Isentropic efficiency 0.85. Calculate: i) Workdone ii) Exit total temperature iii) Power required. **(10 Marks)**

Module-4

7 a. What are the different types of losses in a radial flow turbine and define nozzle loss coefficient. **(10 Marks)**

b. Show that the overall isentropic turbine efficiency is greater than the stage efficiency for an expression process. **(10 Marks)**

OR

8 a. Explain subsonic, transonic and supersonic turbines with reference to flow passage. **(10 Marks)**

b. The output of a 3 stage gas turbine is 30mW at the shaft coupling at an entry temperature of 1500K. The overall pressure ratio across the turbine is 11 and efficiency 88%. If the pressure ratio of each stage is same, determine:

i) Pressure ratio of each stage
ii) Polytropic efficiency
iii) Mass flow rate
iv) Efficiency and power of each stage. **(10 Marks)**

Assume r = 1.4, C_p= 1.005kJ/Kg.K, drive efficiency 91%.

Module-5

9 a. Explain the working of a centrifugal pump with a neat sketch. **(10 Marks)**

b. A centrifugal pump delivered water against a head of 20m at the rate of 100 l/s, at the speed of 1500 rpm. The impeller diameter is 25cm and width at outlet is 5cm. the manometric efficiency is 75%. Determine the blade angle at the outer periphery of the impeller. **(10 Marks)**

OR

10 a. Formulate an expression for the maximum hydraulic efficiency of a pelton wheel turbine. Also draw the inlet and outlet velocity triangle. **(10 Marks)**

b. The external and internal diameter of an inward flow reaction turbine are 2m and 1m respectively. The head on the turbine is 6m. The width of the vane at inlet and outlet are same and equal to 0.25m. The runner vanes are radial at inlet and the discharge is radial at outlet. The speed is 200rpm, and the discharge is $6m^3/s$. Determine : i) The vane angle at outlet and inlet of the runner ii) the hydraulic efficiency. **(10 Marks)**

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