CBCS SCHEME

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15AE46

Fourth Semester B.E. Degree Examination, July/August 2021
Turbomachines

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions.***

1 a. Classify Turbomachines and explain the important components of Turbomachines. **(06 Marks)**

b. From Non – Dimensional π-term, derive the Relation for specific speed of pump and turbine. **(04 Marks)**

c. The model of turbine built to a scale 1:4 is tested under a head of 10m. The prototype has to work under a head of 50m at 450rpm. Calculate:
   i) Speed of the model if it develops 60kW using $0.9m^3/s$ at this speed.
   ii) Power obtained from prototype if the efficiency is 3% better than model. **(06 Marks)**

2 a. Derive Euler Turbine equation and show the condition for power generating and power Absorbing turbomachines. **(06 Marks)**

b. Define Degree of reaction and utilization factor. Also write the relation between them. **(04 Marks)**

c. For a steam turbine, Nozzle Exit has absolute steam velocity is 300m/s. The rotor speed is 150m/s at a point where nozzle angle is 18°. If the outlet rotor blade angle is 3.5 degree less than inlet blade angle, find:
   i) Power outlet
   ii) Utilization factor, Assume $V_{r1} = V_{r2}$ and mass flow rate of steam is 8.5kg/s. **(06 Marks)**

3 a. Draw the h-s diagram of a compressor and Derive i) Total – Total Efficiency ii) Static – static Efficiency. **(06 Marks)**

b. Derive polytropic efficiency relation for compressor using h-s diagram. **(04 Marks)**

c. An air compressor has six stages at equal pressure Ratio 1.4. The mass flow rate is 45kg/s. The overall Isentropic efficiency is 84%. Entry pressure is 1bar and temperature is 40°C. Find :
   i) Polytropic efficiency
   ii) Each stage efficiency
   iii) Power required to drive compressor if overall efficiency is 0.9. **(06 Marks)**

4 a. For a multistage Turbine. Draw h-s diagram with effect of re-heat and obtain the relation. **(06 Marks)**

b. For 3 stage turbine, overall pressure Ratio is 11 and its efficiency is 88%. If the pressure ratio of each stage is same and inlet temperature is 1500K. Take $C_p = 1.005kJ/Kg\text{-}K$, $\gamma = 1.4$. Determine:
   i) Pressure ratio in each stage
   ii) Polytropic efficiency
   iii) Stage efficiency and Re-heat factor
   iv) Exit temperature
   v) Power output.

   For same work output from each stage, find i) Pressure Ratio and ii) Stage efficiency of each stage. **(10 Marks)**

5 a. Explain the operation of centrifugal compressor with h-s diagram. **(06 Marks)**
b. Obtain the relation for pressure co-efficient in terms of work done factor. **(04 Marks)**
c. Explain the different types of diffuser and volute casing. **(06 Marks)**

6 a. Derive the efficiency and pressure Ratio for an Axial flow compressor. **(08 Marks)**
b. An air compressor has 8 stages of equal pressure ratio 1.35. The flow rate through the compressor is 50kg/s ad overall efficiency is 82%. If the conditions of air at entry are 1bar and 40°C overall efficiency is 90%, Find :
i) State of air at exit
ii) Polytropic Efficiency
iii) Stage efficiency
iv) Power required. **(08 Marks)**

7 a. Define Finite stage efficiency and explain Reheat effect. **(04 Marks)**
b. Derive polytropic efficiency and overall efficiency for multistage turbine. **(08 Marks)**
c. Explain the cooling methods used for turbine blades. **(04 Marks)**

8 a. Draw the 90° Inward flow radial turbine and explain the working procedure. **(08 Marks)**
b. Explain the stage losses occurs in the Radial flow turbines. **(08 Marks)**

9 a. Write the types of efficiencies for centrifugal pump and derive the relation for efficiencies. **(08 Marks)**
b. A centrifugal pump handling water has backward curved vanes. The Impeller tip diameter is 0.5m. The tip angle is 45°. If the radial velocity of flow at the exit is 15m/s, the flow at inlet is radial and $\eta_{t-t} = 0.7$ when the head developed is 68m. Find :
i) Speed of Rotor in rpm
ii) Manometric head assuming 50% of K.E at Impeller exit is wasted and loss of head in the impeller is 5m.
iii) Minimum starting speed of pump if $U_1 = \frac{1}{2} U_2$. **(08 Marks)**

10 a. Write the classification of Hydraulic turbines. **(06 Marks)**
b. Draw and explain working of Francis Turbine. **(04 Marks)**
c. A Kaplan turbine working under a head of 15m developed 7350kW. 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 whirl velocity is zero at outlet. Determine :
i) Runner vane angle at inlet
ii) Runner vane angle at outlet
iii) Speed of the Turbine
iv) Specific speed of Turbine. **(06 Marks)**

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