CBCS SCHEME

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17AE46

Fourth Semester B.E. Degree Examination, Jan./Feb. 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. Compare the properties of positive displacement machine and turbomachines. **(06 Marks)**
   b. Prove that the discharge of centrigufal pump is given as

   $$Q = ND^3\phi\left[\frac{gH}{N^2D^2}, \frac{\mu}{ND^2\rho}\right]$$

   Where the discharge 'Q' depends on speed of pump 'N' in rpm, diameter of impeller 'Λ', acceleration due to gravity 'g', manometric head 'H', dynamic viscosity of fluid 'μ' and density of fluid 'ρ'. **(08 Marks)**
   c. Write and give the expressions for following :
   i) Reynold's law of similitude
   ii) Froude's law of similitude. **(06 Marks)**

OR

2 a. Derive the expression of energy transfer in the alternate form Euler's turbine equation and explain significance of each term. **(10 Marks)**
   b. Obtain the relation between degree of reaction and utilization factor for turbines. **(04 Marks)**
   c. Air flows axially in a axial flow turbine with a mean radius of 0.2m. If the tangential component of absolute velocity reduced by 20m/s during passage through rotor. Find the power developed by turbine if mass flow rate is 100m³/s where the pressure and temperature are 1 bar and 27°C. Rotational speed of rotor is 3000 rpm. **(06 Marks)**

Module-2

3 a. Using h-s diagram define and write the expression for following term for compression process :
   i)   Total – total efficiency
   ii) Static – static efficiency
   iii) Polytropic efficiency
   iv) Pre heat factor. **(12 Marks)**
   b. Air enters a compressor at a static pressure of 1.5 bar, static temperature of 15°C and flow velocity of 50m/s. At the exit static pressure is 3 bar, static temperature is 100°C and the flow velocity is 100m/s. Outlet is placed 1m above the inlet level. Evaluate :
   i)   Isentropic change in enthalphy
   ii) Actual change in enthalphy
   iii) Efficiency of compressor. **(08 Marks)**

OR

4 a. Define polytropic efficiency for turbine and obtain the expression for polytropic efficiency interms of overall efficiency. **(12 Marks)**

b. The overall pressure ratio across three stages gas turbine is 11 and its efficiency is 88%. If the pressure ratio of each stage is same and Inlet temperature is 1500K. Take $C_P = 1.005kJ/kg\text{-}k$, $\gamma = 1.4$, $m = 50kg/s$. Determine :
   i)   Pressure ratio in each stage
   ii) Ploytropic efficiency
   iii) Stage efficiency
   iv) Reheat factor
   v)   Exit temperature
   vi) Total power. **(08 Marks)**

Module-3

5 a. Draw and explain the important elements of centrifugal compressor and its working principle. **(10 Marks)**

b. Draw and explain the different vane shape and their characteristics with H-Q diagram. **(06 Marks)**

c. Explain the phenomenon of surging and choking. **(04 Marks)**

OR

6 a. Draw and explain the effect of reaction ratio on velocity triangles for the following condition. i) R > 1 ii) R = 1 iii) 0.5 < R < 1 iv) R = 0.5 v) 0 < R < 0.5 vi) R = 0. **(12 Marks)**

b. An air compressor has eight stages of equal pressure ratio 1.35. The flow rate through the compressor and its overall efficiency are 50kg/s and 82% respectively. If the conditions of the air at entry are 1 bar and 40°C, determine :
   i)   Pressure and temperature at exit
   ii) Polytropic efficiency
   iii) Stage efficiency
   iv) Power required if $\eta_m = 0.9$. **(08 Marks)**

Module-4

7 a. Write about types of losses in turbines. **(08 Marks)**

b. A fluid flows through one stage of turbomachine. From the Fig.Q7(b), Find :
   i)   Is this power generating
   ii) Power absorbing machine
   iii) Change in total enthaphy
   iv) Degree of reaction
   v)   Utilization factor.

Fig.Q7(b) **(12 Marks)**

OR

8 a. Draw and explain the working of 90° Inward flow radial turbine. (10 Marks)
   b. Discuss about aerodynamic losses occurs in radial turbine. (10 Marks)

Module-5

9 a. Explain about parts of the centrifugal pump and various heads in the centrifugal pump. (10 Marks)

   b. Draw and explain about the following :
       i) Pumps in series
       ii) Pumps in parallel
       iii) Priming. (10 Marks)

OR

10 a. Discuss the classification of hydraulic turbines based various parameters. (10 Marks)
   b. A Pelton wheel produces 15456KW under a head of 335m running at a speed of 500rpm overall efficiency of turbine is 0.84, coefficient of jet velocity is 0.98 and speed ratio 0.46. If the buckets defect the incoming Jet through an angle of 165°. Determine :
       i)   Number of Jets
       ii) Diameter of each jet
       iii) Tangential force exerted by Jets on Buckets. (10 Marks)

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