CBCS SCHEME

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17AE46

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

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. List out the differences between turbomachines and positive displacement machines. **(10 Marks)**

b. Obtain an expression for (i) flow coefficient (ii) head coefficient (iii) Power coefficient of a turbomachine using Buckingham - π theorem. **(10 Marks)**

OR

2 a. Derive alternate form of Euler's turbine equation and explain the significance of each energy component. **(10 Marks)**

b. Define a specific speed of a pump. Derive the expression for specific speed for a pump. **(05 Marks)**

c. Explain with a neat sketch, the principal components of a turbomachine. **(05 Marks)**

Module-2

3 a. Define the following with the help of h-s diagram for the power absorbing turbomachines.
(i) Total-to-total efficiency
(ii) Static-to-Static efficiency **(10 Marks)**

b. Show that the overall efficiency in a multistage compressor is given by

$$\eta_0 = \frac{P_r^{K\left(\frac{\gamma-1}{\gamma}\right)} - 1}{\left[\left(1 + \frac{P_r^{\frac{\gamma-1}{\gamma}} - 1}{\eta_s}\right) - 1\right]}$$

where η_s and K are stage efficiency and number of stages. **(10 Marks)**

OR

4 a. The overall pressure ratio across a three stages gas turbine is 11 and its efficiency is 88%. If the pressure ratio of each stage is the same assn inlet temperature is 1500 K determine
(i) Pressure ratio in each stage, (ii) Polytropic efficiency (iii) Stage efficiency
(iv)Reheat factor (v)Exit temperature (vi)Total power output for a mass flow rate of 50 kg/s.
Assume for the gas, $C_p = 1.005$ kJ/kg-K and $\gamma = 1.4$. **(12 Marks)**

b. A compressor develops a pressure of 1600mm WG. If the air enters the compressor at 1.20 bar, 303K and leaves at 320K, compute compressor and infinitesimal stage efficiency. In another compressor, air compresses from 1.02 bar, 303K to a final pressure of 2.5 bar with a compressor efficiency of 75%. Determine the infinitesimal stage efficiency. Comment on the results. **(08 Marks)**

Module-3

5 a. For axial flow compressor show that

$$E = V_{fu}\left[\frac{\tan\beta_2 - \tan\beta_1}{\tan\beta_1 \tan\beta_2}\right]$$ **(10 Marks)**

b. With a neat sketch, explain the parts of centrifugal compressors. **(10 Marks)**

OR

6 a. For an axial flow compressor, draw velocity triangles at inlet and at exit for the following values of R :
(i) R = 50% (ii) R > 50% (iii) R < 50%. **(10 Marks)**

b. Obtain the expression of overall pressure ratio developed by the centrifugal compressor in terms of ϕ_s , ϕ_w and ϕ_p . **(10 Marks)**

Module-4

7 a. How do you differentiate between an impulse and a reaction turbine? With a neat sketch explain the working of an impulse and a reaction stage. **(10 Marks)**

b. An inward flow radial turbine has nozzle angle α_1 and rotor blades are radial at entry. The radial velocity is constant and there is no whirl velocity at discharge. Show that utilization factor is equal to

$$\in = \frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$$ **(10 Marks)**

OR

8 a. With a neat sketch, explain
(i) Velocity compounding (ii) Pressure compounding **(10 Marks)**

b. Obtain general relation between degree of reaction and utilization factor for axial flow turbines. **(10 Marks)**

Module-5

9 a. Define the following with a mathematical expression:
(i) Manometric efficiency (ii) Mechanical efficiency
(iii) Overall efficiency (iv) Volumetric efficiency **(08 Marks)**

b. Write short notes on:
(i) Pumps in series
(ii) Pumps in parallel
(iii) Cavitations in pump. **(12 Marks)**

OR

10 a. Design a Pelton wheel for a head of 80m and speed 300 rpm. The Pelton wheel develops 103 kW shaft power. Take $C_v = 0.98$, Speed ratio = 0.45, $\eta_0 = 0.80$. **(10 Marks)**

b. With a simple sketch explain different types of draft tubes. **(10 Marks)**

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