CBCS SCHEME

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17ME53

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Turbomachines

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define the following for turbomachine:
(i) Specific speed (ii) Flow coefficient
(iii) Energy coefficient (iv) Speed ratio **(10 Marks)**

b. An output of 10 KW was recorded on a turbine, 0.5 diameter, revolving at a speed of 800 rpm, under a head of 20 m. What is the diameter and output of another turbine which works under a head of 180 m at a speed of 200 rpm when their efficiencies are same? Find the specific speed and name the turbine can be used. **(10 Marks)**

OR

2 a. Define polytropic efficiency of turbine. Show that the polytropic efficiency during expansion process is given by:

$$\eta_p = \frac{\ell_n\left[\frac{T_2}{T_1}\right]}{\frac{\gamma-1}{\gamma}\ell n\left[\frac{p_2}{p_1}\right]}$$ **(10 Marks)**

b. A nine stage centrifugal compressor has an overall pressure ratio of 2.82. Air enters the compressor at a pressure of 1 bar and 17°C the stage efficiency is 0.9. Determine:
(i) Pre heat factor (ii) Overall efficiency (iii) Polytropic efficiency **(10 Marks)**

Module-2

3 a. Derive an expression for the alternative form of Euler's turbine equation. **(10 Marks)**

b. Obtain an expression for utilization factor of a turbomachine interms of inlet and outlet absolute velocity of the fluid and degree of reaction. **(10 Marks)**

OR

4 a. Derive an expression for maximum utilization factor for axial flow type of impulse turbine and 50% reaction turbine. **(10 Marks)**

b. Draw the inlet and outlet triangles for an axial flow compressor for which given :
(i) Degree of reaction = 0.5
(ii) Inlet blade angle = 40°
(iii) Axial velocity of flow which is constant throughout = 125 m/s
(iv) RPM = 6500
(v) Radius 0.2 m
Calculate the power required in KW at an air flow rate of 15 kg/s. Find fluid angles at inlet and outlet. Assume blade speed is same at inlet and outlet. **(10 Marks)**

Module-3

5 a. Name the different compounding methods and explain any one. **(10 Marks)**

b. A single stage impulse turbine has a diameter of 1.5 m and running at 3000 rpm. The nozzle angle is 20°, speed ratio is 0.45. Ratio of relative velocity at the outlet to that at inlet is 0.9. The outlet angle of the blade is 3° less than inlet angle. Steam flow rate is 6 kg/s. Draw the velocity triangles and find the following:

(i) Velocity of whirl (ii) Axial thrust

(iii) Blade angles (iv) Power developed **(10 Marks)**

OR

6 a. Explain the following:

(i) Nozzle efficiency (ii) Diagram efficiency

(iii) Stage efficiency (iv) Axial thrust **(10 Marks)**

b. Derive an expression for maximum blade efficiency in an impulse steam turbine. **(10 Marks)**

Module-4

7 a. Show that for maximum utilization the speed ratio is 0.5 for pelton wheel. **(10 Marks)**

b. Define the following with reference to hydraulic turbines:

(i) Overall efficiency (ii) Hydraulic efficiency

(iii) Mechanical efficiency (iv) Volumetric efficiency **(10 Marks)**

OR

8 a. Draw a neat sketch of Francis turbine. Explain different types of draft tube. Draw typical velocity triangles for Francis turbine. **(10 Marks)**

b. A double jet pelton wheel is required to generate 7500 KW under a head of 400 m. The deflection of jet is 165° and the relative velocity of the jet is reduced by 15% in passing over the buckets. Find:

(i) The diameter of each jet

(ii) Total flow

(iii) Force exerted by the jets in the tangential direction.

Assume generator efficiency is 95%, η_0 = 80%, speed ratio = 0.47. **(10 Marks)**

Module-5

9 a. Explain the following with reference to centrifugal pump:

(i) Manometric efficiency (ii) Cavitation (iii) Need of priming

(iv) Pumps in series (v) Mechanical efficiency **(10 Marks)**

b. Derive an expression of pressure rise in the impeller of centrifugal pump. **(10 Marks)**

OR

10 a. Define the following:

(i) Pre whirl (ii) Surging (iii) Slip factor (iv) Choking **(10 Marks)**

b. An air compressor has eight stages of equal pressure ratio of 1.35. The flow rate and overall efficiency are 50 kg/s and 82% respectively if the conditions of air at entry are 1 bar and 40°C, determine:

(i) The state of air at the compressor exit

(ii) Polytropic efficiency

(iii) Efficiency of each stage **(10 Marks)**

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