CBCS SCHEME

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15MR54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Turbo Machines

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Missing data may be assumed suitably.

Module-1

1 a. Define specific speed of a turbine. Derive an expression for specific speed of a turbine. **(08 Marks)**

b. A Francis turbine model is built to a scale of 1:5. The data for model is P = 4kW, N = 3500 rpm, H = 2m and for prototype, H = 6m. Assume that the overall efficiency of the model as 70%, calculate: i) Speed of the prototype ii) Power of the prototype. Use Moody's equation. **(08 Marks)**

OR

2 a. Explain static and stagnation state for a fluid. **(06 Marks)**

b. A centrifugal pump rotates at 1000rpm, having inlet diameter 100mm and outlet diameter 400mm. The inlet and exit blade angles are 20° and 10° respectively. The blade depth is 60mm. Assuming radial entry and hydraulic efficiency of 90%, Calculate: i) The volume flow rate ii) the static and stagnation pressure rise across the impeller iii) The power transferred to the fluid iv) the input power to the impeller. **(10 Marks)**

Module-2

3 a. With a neat sketch derive an expression for Eulers turbine equation. **(08 Marks)**

b. Following data refers to a 50% reaction turbine, blade speed 250m/s, $\alpha_1 = 18°$, the velocity of flow is constant and is equal to blade speed, determine: i) blade angles ii) energy transfer iii) utilization factor. **(08 Marks)**

OR

4 a. Draw velocity triangular for the following types of vanes of centrifugal pumps i) Backward Vane ii) Radial Vane iii) Forward Vane. **(06 Marks)**

b. Show that the degree of reaction for axial flow compressor is constant velocity of flow is given by $R = \frac{V_a}{2u}\left[\frac{\tan\beta_2 + \tan\beta_1}{\tan\beta_1 \tan\beta_2}\right]$ where $V_a \rightarrow$ Velocity of flow,

$u \rightarrow$ blade speed $u_1 = u_2 = 4$, $v_{f_1} = v_{f_2} = v_a$ **(10 Marks)**

Module-3

5 a. Prove that for maximum blading efficiency for a single stage impulse steam turbine is given by $(\eta_b)_{max} = \cos^2\alpha_1$. **(06 Marks)**

b. The specific enthalpy drop in the nozzles of a simple impulse turbine is 495 kJ/kg. The moving blades are symmetrical, and the blade velocity coefficient is 0.9. Steam leaves the blades in an axial direction. The diagram efficiency is 0.82. Determine each of the following: i) The blade velocity ii) The change in whirl velocity iii) The nozzle angle iv) The blade angle. **(10 Marks)**

OR

6 a. Define degree of reaction. Show that for reaction turbine degree of reaction (R) is given by $R = \frac{V_f}{2u}(\cot\beta_2 - \cot\beta_1)$. **(08 Marks)**

b. In a Parson's turbine running at 1500rpm, the available enthalpy drop for an expansion is 63kJ/kg. If the mean diameter of the rotor is 100cm, find the number of moving rows required. Assume that efficiency of a stage is 0.8, blade outlet angle 20°and speed ratio 0.7. **(08 Marks)**

Module-4

7 a. Prove that the hydraulic efficiency of Pelton wheel is given by $\frac{1+K\cos\beta_2}{2}$ where 'K is the bucket velocity coefficient and β_2 is the runner tip angle. **(08 Marks)**

b. A dam power house is proposed to be built for which a Francis turbine is required to be designed. The design head is 16m, and the design flow rate is $8m^3/s$. The speed is to be 250rpm. An overall efficiency 0.9, hydraulic efficiency of 0.95, a speed ratio of 0.76 and flow ratio of 0.35 may be assumed. Obtain all the salient dimensions, blade angles and guide vane angles. The inner diameter is half the outer diameter and the discharge does not have any whirl component. Neglect vane thickness. **(08 Marks)**

OR

8 a. With a neat sketch, explain the principle and working of Kaplan turbine. **(08 Marks)**

b. A Kaplan turbine develops 1500kW under a head of 6m. The turbine is set 2.5m above the tail race level. A vacuum gauge inserted at the turbine outlet records a section head of 3.2m. If the efficiency is 85%, what will be the efficiency of the draft tube having inlet diameter of 3m. **(08 Marks)**

Module-5

9 a. Define the following with respect to centrifugal pump :

i) Manometric head
ii) Manometric efficiency
iii) Hydraulic efficiency
iv) Cavitation. **(08 Marks)**

b. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000rpm. Works against a total head of 40m. The velocity of flow through the impeller is constant and equal to 2.5m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 50cm and width at outlet is 5cm, determine i) the vane angle at inlet ii) work done per second by the impeller on water iii) manometric efficiency. **(08 Marks)**

OR

10 a. With a neat sketch and working principle, explain centrifugal compressor. **(08 Marks)**

b. Explain the phenomenon of surging in centrifugal compressor. **(04 Marks)**

c. Define the following terms of centrifugal compressor i) over all pressure ratio ii) slip factor. **(04 Marks)**

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