CBCS SCHEME

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18ME54

Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
Turbo Machines

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Compare turbo machines and positive displacement machines. **(06 Marks)**

b. Define the following for a trubomachine.
i) Flow coefficient ii) Power coefficient iii) Capacity coefficient **(06 Marks)**

c. A turbine model wolking under a head of 2m runs at 170 rpm and has a diameter of 1m. A prototype turbine develops 22 MW under a head of 250 m with a specific speed of 100. Calculate: i) Scale ratio ii) Power development by the model. **(08 Marks)**

OR

2 a. Define total to total, total-to-static, static-to-static and static-total efficiencies for power generator and power absolving turbo machine with the help of T-S diagram. **(10 Marks)**

b. Air flows through an air turbine where its stagnation pressure is decreasing in the ratio 5:1. Total to total efficiency is 0.8 and air flow rate is 5 Kg/s. The inlet total temperature is 280K. Calculate :
i) Actual power output
ii) Actual exit total temperature
iii) Actual exit static temperature if the exit flow velocity is 100 m/s and
iv) Total-to-static efficiency of the device. **(10 Marks)**

Module-2

3 a. Derive an expression for maximum utilization factor in an axial flow type :
i) Impulse turbine and ii) 50% Reaction turbine. Draw also the velocity triangles. **(10 Marks)**

b. In an radial inward flow turbine, the degree of reaction is 0.8 and utilization factor is 0.9. The tangential speeds of wheel at the inlet and outlet are 11m/s and 5.5 m/s. Draw the velocity triangle at inlet and outlet assuming radial velocity is constant and equal to 5 m/s. Flow is radial at exit. Find the power output for a volumetric flow rate 2 m^3/s of water per second. **(10 Marks)**

OR

4 a. A radial outward flow machine has no inlet whirl. The blade speed at the exit is twice that at inlet. Radial velocity is constant throughout. Taking the inlet blade angle as 45 degree show that degree of action, $R = \frac{2+\cot\beta_2}{4}$. Where β_2 is the blade angle at exit with respect to tangential direction. **(10 Marks)**

b. The mean rotor blade speed of an axial flow turbine with 50% reaction is 210 m/s. Steam emerges from the nozzle inclined at 28° to the plane of wheel with axial component equal to blade speed. Assuming symmetrical inlet and outlet velocity triangle, find :
   i) Rotor blade angles
   ii) ii) Utilization factor. Find also
   iii) Degree of reaction to make the utilization factor maximum, if the axial velocity blade speeds as well as nozzle angle remains constant. **(10 Marks)**

Module-3

5 a. Define compounding. Explain any two types of compounding with a neat sketch, showing variations of pressure and velocity of the stream. **(10 Marks)**

b. Steam emerges from a nozzle to an impulse De-Laval turbine with a velocity of 1000m/s. The nozzle angle is 20°. The mean blade speed is 400 m/s. The blades are symmetrical. The mass flow rate of steam is 1000 Kg/hr. Friction factor is 0.8. Calculate the following – i) Blade angles ii) Axial thrust iii) Work done per Kg of steam iv) Power developed. **(10 Marks)**

OR

6 a. Derive the expression for maximum efficiency of impulse steam turbine and show that maximum efficiency is $[\cos^2 \alpha_1]$. **(10 Marks)**

b. The following data refers to a particular stage of a Parson's reaction turbine. Speed of the turbine = 1500 rpm. Mean diameter of rotor = 1m, Stage efficiency = 0.8, blade outlet angle = 20°. Speed ratio = 0.7. Determine the available isentropic enthalpy drop in the stage. **(10 Marks)**

Module-4

7 a. Derive an expression for maximum hydraulic efficiency of pelton wheel. **(10 Marks)**

b. A double jet pelton wheel is required to generate 7500 KW when the available head at the base of the nozzle is 400 m. The jet is deflected through 165° and the relative velocity of the jet is reduced by 15% in passing over the buckets. Determine the i) Diameter of each jet ii) Total flow iii) Force exerted by the jets in the tangential direction. Assume generator efficiency is 95%, overall efficiency = 80% and speed ratio = 0.47. **(10 Marks)**

OR

8 a. Define the following :
   i) Functions of draft tube ii) Hydraulic efficiency iii) Overall efficiency
   iv) Mechanical efficiency v) Volumetric efficiency. **(10 Marks)**

b. Following data are given for a Francis turbine net head = 60m, speed = 700 rpm, Power at the shaft = 294.3 KW, Overall efficiency = 84%, hydraulic efficiency = 93%, flow ratio = 0.2, width ratio = 0.1, outer diameter to inner diameter ratio = 2. Thickness of vane occupy 5% of circumference area of runner velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine :
   i) Guide blade angle ii) Runner vane angles iii) diameter of runner at inlet and outlet iv) width of wheel at inlet. **(10 Marks)**

Module-5

9 a. Define :
   i) Manometric efficiency
   ii) Manometric head (04 Marks)

b. Derive an expression for minimum starting speed of pump. (06 Marks)

c. A centrifugal pump runs 950 rpm. its outer and inner diameter are 500 mm and 250 mm. The vanes are set back at 35° to the wheel rim. If the radial velocity of water through the impeller is constant at 4 m/s, find
i) vane angle at inlet ii) velocity of water at outlet iii) Direction of water at outlet and iv) work done per kg of water. Entry of water at inlet is radial. (10 Marks)

OR

10 a. Define :
i) Slip factor ii) Power input factor. (04 Marks)

b. Explain: i) Surging ii) Choking iii) Pre notation. (06 Marks)

c. A centrifugal compressor running at 6000 rpm having an impeller tip diameter of 101 cm has the following test data :
   i) Mass flow rate = 25 Kg/s
   ii) Static pressure ratio = 2.12
   iii) Pressure at inlet = 100 KPa, temperature at inlet = 28°C
   iv) Mechanical efficiency = 0.97.

Find :
   i) Slip coefficient
   ii) Temperature of air at exit
   iii) Power input
   iv) Power coefficient (10 Marks)

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