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# P.E.S. College of Engineering, Mandya - 571 401

*(An Autonomous Institution affiliated to VTU, Belagavi)*

**Fifth Semester, B.E. - Mechanical Engineering**

**Semester End Examination; February / March - 2023**

**Tubromachines**

*Time: 3 hrs* *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

## UNIT - I

1 a. Derive Eulers turbine equation and obtain alternate form of Euler turbine equation. 10

b. At a stage of an impulse turbine the mean blade dia is 0.75 m, its rotational speed being 3500 rpm. The absolute velocity of fluid discharging from a nozzle inclined at 20° to the plane of wheel is 275 m/s. If the utilization factor is 0.9 and the relative velocity at rotor exit is 0.9 times that at the inlet, find the inlet and exit rotor angle. Also determine the power output from the stage for a mass flow rate of 2 kg/s and axial thrust on the shaft. 10

2 a. Define Turbomachine. Briefly explain the calcification of Turbomachine. 7

b. Show that with the help of velocity triangle for maximum utilization factor and the same amount of energy transfer in impulse and 50% reaction axial flow turbine. $U_R = \sqrt{2U_I^2}$ 7

Where $U_R$ is blade speed of 50% reaction turbine and $U_I$ is the blade speed of impulse turbine.

c. An inward flow reaction turbine has outer and inner diameter of the wheel as 1 m and 0.5 m respectively. The names are radial at inlet and the discharge is radial at outlet and water enters the vanes at an angle of 10°. Assuming the velocity of flow to be constant and equal to 3 m/s. Find; 6

i) The speed of wheel

ii) The vane angle at outlet

iii) Degree of reaction

## UNIT - II

3 a. Draw the neat sketch of Pelton wheel and explain the main components 10

b. Design a pelton wheel for a head of 60 mts and speed 200 rpm. The pelton wheel develops 100 kW. Take $C_V$ = 0.98, speed ratio = 0.45 and overall efficiency = 85%. 10

4 a. Explain the following with respect to hydraulic turbine:

i) Mechanical efficiency ii) Hydraulic efficiency 10

iii) Overall efficiency iv) Volumetric efficiency

Contd….2

b. A Pelton wheel produces 7000 kW under a head 250 m. The overall efficiency is 85% and speed is 200 rpm. Calculate;

i) The unit discharge ii) Unit power iii) Unit speed

Assuming peripheral coefficient = 0.46. If the head on the same turbine falls during the summer season to 150 m, calculate; 10

iv) The discharge v) The power vi) The speed for this head

## UNIT - III

5 a. Draw neat sketch of Kaplan turbine and indicate all its parts with brief explanation. 10

b. The following data pertains to Francis turbine; shaft power = 1000 kW, head = 200 m, overall efficiency = 85%, speed = 540 rpm velocity of flow at inlet = 9 m/s. The ratio of width to diameter of wheel at inlet = 1/10, hydraulic efficiency = 87%, area occupied by thickness of blades = 7.5%. Find; 10

i) The area of flow ii) The angle of entry

iii) The tangential velocity iv) The velocity of whirl at the inlet if the discharge is radial

6 a. What is the purpose of draft tube? Explain different types of draft tube. 10

b. A Kaplan turbine produces 30000 kW under a head of 9.6 m, while running at 65.2 rpm. The discharge through the turbine is 350 $m^3/s$. The tip diameter of the runner is 7.4 m. The hub diameter is 0.432 times the tip diameter. Calculate; 10

i) The turbine efficiency ii) The specific speed

iii) The speed ratio (based on tip diameter) iv) The flow ratio

## UNIT - IV

7 a. Explain the need for compounding and explain velocity pressure compounding of reaction turbine. 10

b. The mean diameter of the blades of an Impulse turbine is 85 cm and the speed is 3200 rpm. The nozzle angle is 20° and the ratio of blade speed to steam speed is 0.45. The blade velocity coefficient is 0.85. The outlet angle of blades is 2° less than the blade angle at the inlet. The steam flow is 9 kg/s. Draw the velocity triangles and determine the following: 10

i) Tangential and axial thrust on the blades

ii) Resultant thrust on the blades

iii) Power developed and blade efficiency

8 a. Derive the condition for maximum blade efficiency of an Impulse turbine. Also deduce the expression for maximum efficiency.

$$\eta_{b\max} = \frac{\cos^2 \alpha_1}{2}[KC + 1]$$ 10

Where, $c = \frac{\cos \beta_2}{\cos \beta_1}$ and $K = \frac{Vr_2}{Vr_1}$

Contd....3

b. The following data refers to an axial flow turbine. Steam speed at the exit at fixed blade = 150 $m/s$, The Ratio $= \frac{Vf_1}{u} = 0.75, \frac{Vf_2}{u} = 0.78, M_s = 2.8\ kg/s$,

Discharge blade angles for both stator and rotor = 20° calculate; 10

i) The inlet rotor blade angle

ii) The power developed

iii)The degree of reaction

## UNIT - V

9 a. Draw the neat sketch of centrifugal pump and explain the main parts of a centrifugal pump. 10

b. A centrifugal pump of 1.2 m diameter runs at 250 rpm and pumps 1880 litre/s, the average lift being 6 M. The angle which the Vane makes at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5 m/s. Determine the useful power and the efficiency. Find also the least speed to start pumping against a head of 6 m, the inner diameter of the impeller being 0.6 m. 10

10 a. Explain briefly with neat sketches;

i) Volute casing 10

ii) Vortex casing

b. A centrifugal pump impeller has a diameter of 1.2 m, speed 210 rpm, area at the outer periphery 0.65 $m^2$, angle of vane at outlet 25°, and ratio of external to internal diameter 2:1 calculate;

i) The hydraulic efficiency 10

ii) Power

iii) Minimum speed to lift water against a head of 6.2 m. Assume that the pump discharge is 1550 litre/s

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