CBCS SCHEME

USN | | | | | | | | | | |

18MR55

Fifth Semester B.E. Degree Examination, July/August 2022
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. Differentiate between a Turbo machine and Positive displacement machines. **(05 Marks)**

b. What is Specific Speed of a pump? Derive an expression for the same. **(05 Marks)**

c. A Francis turbine is built as a model to a scale 1 : 5. The data for model is P = 4kW , N = 350 rpm , H = 2m and for prototype H = 6m. Assume that the overall efficiency of the model is 70%. Calculate i) Speed of prototype ii) Power of prototype. **(10 Marks)**

OR

2 a. Show that for a turbine polytropic efficiency is given by

$$\eta_p = \left(\frac{n-1}{n}\right)\left(\frac{\gamma}{\gamma-1}\right).$$ **(10 Marks)**

b. Air flows through an air turbine where its stagnation pressure is reduced in the ratio 5 : 1. The total – to - total efficiency is 80%. The air flow is 5 kg/s. If the total power output is 500kW, find i) Inlet total temperature ii) Actual exit total temperature iii) Actual exit static temperature if the velocity is 100 m/s. iv) Total – to - static efficiency. **(10 Marks)**

Module-2

3 a. Obtain the relationship between Degree of reaction and Utilization factor. **(10 Marks)**

b. A turbine with 50% reaction , the tangential speed of blade is 98.5 m/s. The steam velocity at the nozzle exit is 155 m/s and the nozzle angle is 18°. Assuming symmetric inlet and outlet velocity triangles, compute the inlet blade angle for the rotor and the power developed by the stages for a flow rate of 10kg/s. Also find the utilization factor. **(10 Marks)**

OR

4 a. For an axial flow compressor, show that

$$R = \frac{V_f}{2u}\left[\frac{\tan\beta_1 + \tan\beta_2}{\tan\beta_1 . \tan\beta_2}\right].$$ **(10 Marks)**

b. In a certain turbomachine, the inlet whirl velocity is 15m/s , inlet flow velocity is 10m/s , blade speeds are 30m/s and 8m/s respectively. Discharge is radial with an absolute velocity of 15m/s. If water is the working fluid , flowing at a rate of 1500 liters/s, calculate i) Power in kW ii) Change in total pressure (bar) iii) Degree of reaction iv) Utilization factor. **(10 Marks)**

Module-3

5 a. Prove that maximum blade efficiency of a single stage impulse turbine is given by $\eta_{b\,max} = \cos^2 \alpha_1$. **(10 Marks)**

b. Steam issues from the nozzle of a D – Laval turbine with a velocity of 1200m/s. The nozzle angle is 20° and mean blade velocity is 400 m/s. Inlet and outlet blade angles are equal. Mass of steam flowing through the turbine is 900 kg/hr. Calculate i) Blade angles ii) Relative velocity of steam entering the blade iii) Tangential force on blades iv) Power developed v) Blade efficiency. Assume K = 0.8. **(10 Marks)**

OR

6 a. With neat sketches, explain :
i) Velocity compounding ii) Pressure – Velocity compounding. **(08 Marks)**

b. The following data refers to the compound impulse turbine having two rows of moving blade and one row of fixed blades in between them.
Velocity of steam leaving nozzle = 600m/s , Blade speed = 125 m/s , Nozzle angle = 20° , First moving blade discharge angle = 25° , Second moving blade discharge angle = 30° , Fixed blade discharge angle = 30° , Friction loss in each ring = 10% of relative velocity.
Find i) Diagram efficiency ii) Power developed for a steam flow of 6 kg/s. **(12 Marks)**

Module-4

7 a. Derive the condition for maximum hydraulic efficiency and expression for maximum hydraulic efficiency of a Pelton wheel. **(10 Marks)**

b. In a power plant, a Pelton wheel produces 15,000 kW under a head of 350m, while running at 500 rpm. Assume a turbine efficiency of 0.84, coefficient of velocity for nozzle as 0.98, speed ratio 0.46 and bucket velocity coefficient 0.86. Calculate i) Number of jets ii) Diameter of each jet iii) Tangential force excerted in the buckets if the bucket deflects the jet through 165°. **(10 Marks)**

OR

8 a. Define Draft tube efficiency. Derive an expression for inlet pressure head of the draft tube and its efficiency. **(08 Marks)**

b. An inward flow reaction turbine works under a head of 110m. The inlet and outlet diameters of the runner are 1.5m and 1.0m respectively. The width of runner is constant throughout as 150mm ; the blade angle at outlet is 15°. The hydraulic efficiency is 0.9. Calculate
i) Speed of the tissue ii) Blade angles iii) The power produced when the discharge velocity is 6m/s. **(12 Marks)**

Module-5

9 a. Derive an expression for minimum starting speed of a centrifugal pumps. **(08 Marks)**

b. Outer diameter of a pump is 50cm and inner diameter is 25cm and runs at 1000 rpm against a head of 40m. Velocity of flow is constant and equal to 2.5m/s. Vanes are set back at an angle of 40° at the outlet. Width at outlet is 5cm. Find i) Vane angle at inlet ii) Work done by impeller iii) Manometric efficiency **(12 Marks)**

OR

10 a. Define the following : i) Suction head ii) Delivery head iii) Manometric head iv) Net Positive Suction Head (NPSH) v) Manometric efficiency vi) Mechanical efficiency. **(10 Marks)**

b. A three stage centrifugal pump has impeller of 40cm diameter and 2.5cm wide at outlet. The vanes are curved back at outlet at 30° and reduces the circumferential area by 15%. η_{max} = 88% , η_0 = 75%. Determine the head generated by the pump when running at 1200 rpm and discharges 0.06 m^3/s. Find power at the shaft of the impeller. **(10 Marks)**

* * * * *