CBCS Scheme

USN | | | | | | | | | | | **15ME53**

Fifth Semester B.E. Degree Examination, June/July 2018
Turbo Machines

Time: 3 hrs.   Max. Marks: 80

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

Module-1

1 a. Define with appropriate expressions: i) flow coefficient ii) head coefficient iii) power coefficient iv) specific speed. **(08 Marks)**

b. A model of a centrifugal pump absorbs 5 KW at a speed of 1500 rpm, pumping water against a head of 6m. The large prototype pump is required to pump water to a head of 30 m. The scale ratio of diameter is 4. Assume same efficiency and similarities. Find: (i) Speed (ii) Power of prototype (iii) The ratio of discharge of prototype and model. **(08 Marks)**

OR

2 a. Show that polytropic efficiency for compressor is given by $\eta_p = \left(\frac{\gamma - 1}{\gamma}\right) \times \left(\frac{n}{n-1}\right)$. **(08 Marks)**

b. Air enters a compressor at a static pressure of 1.5 bar, a static temperature of 15°C and a flow velocity of 15 m/s. At the exit the static pressure is 3 bar the static temperature is 100°C and the flow velocity is 100 m/s. The outlet is 1 m above the inlet. Evaluate :

i) The isentropic change in enthalpy

ii) The actual change in enthalpy and efficiency of the compressor. **(08 Marks)**

Module-2

3 a. Define utilization factor and write the expression. Derive relation between degree of reaction and utilization factor. **(08 Marks)**

b. The following data refers to a turbomachine. Inlet velocity of whirl = 16 m/s, velocity of flow = 10 m/s, blade speed = 33 m/s, outlet blade speed = 8 m/s. Discharge is radial with an absolute velocity of 16 m/s. If water is the working fluid flowing at the rate of 1 m^3/s. Calculate the following:

i) Power in KW

ii) Change in total pressure in kN/m^2

iii) Degree of reaction

iv) Utilization factor **(08 Marks)**

OR

4 a. Derive theoretical head capacity relation in case of centrifugal pumps.

$$H = \frac{u_2^2}{g_c} - \frac{u_2^2 Q \cot\beta_2}{A_2 g_c}$$

where β_2 discharge blade angle with respect to tangential direction. **(08 Marks)**

b. A hydraulic reaction turbine of the radial inward flow type works under a head of 160 m of water. At the point of fluid entry, the rotor blade angle is 119° and diameter of the runner is 3.65 m. At the exit, the runner diameter is 2.45 m. If the absolute velocity of the wheel outlet is radially directed with a magnitude of 15.5 m/s and the radial component of velocity at the inlet is 10.3 m/s. Find the power developed by the machine, assuming that the 88% of the available head of the machine is converted into work and the flow rate is 110 m^3/s. Find also the degree of reaction and the utilization factor. **(08 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. Define compounding. List different types of compounding. Explain any one method of compounding with neat sketch showing variations of pressure and velocity of steam. **(08 Marks)**

b. The following particulars refer to a stage of a parsons steam turbine. Mean diameter of blade ring = 70 cm, steam velocity at inlet of moving blades = 160 m/s, outlet blade angles of moving blade $\beta_2 = 20°$. Steam flow through the blades = 7 kg/s and speed 1500 rpm, $\eta = 0.8$. Draw the velocity diagram and find the following: i) Blade inlet angle ii) Power developed in the stage iii) Available isentropic enthalpy drop. **(08 Marks)**

OR

6 a. Derive the condition for maximum efficiency of an impulse steam turbine and show that the maximum efficiency is $\cos^2 \alpha_1$. **(08 Marks)**

b. In a stage of an impulse turbine provided with single row wheel, the mean diameter of the blade ring is 80 cm and speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is 20°. The rotor blades are equiangular and blade velocity coefficient is 0.85. What is the power developed in the blades when the axial thrust on the blade is 140 N. **(08 Marks)**

Module-4

7 a. Show that for a maximum efficiency of peltan wheel, the bucket velocity is equal to half of the jet velocity. **(08 Marks)**

b. A double over hung peltan wheel unit is to produce 30000 KW at the generator under an effective head of 300 m at base of the nozzle. Find the size of the jet, mean diameter of the runner, speed and specific speed of the each peltan turbine. Assume generator efficiency = 93%, peltan wheel efficiency = 0.85, speed ratio = 0.46, jet velocity coefficient = 0.97 and jet ratio 12. **(08 Marks)**

OR

8 a. Show that pressure at the exit of the reaction turbine with draft tube is less than atmospheric pressure. **(08 Marks)**

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: i) Turbine efficiency ii) Specific speed of the turbine iii) Speed ratio (based on tip diameter) iv) Flow ratio. **(08 Marks)**

Module-5

9 a. Show that pressure rise in impeller of a centrifugal pump when the frictional and other losses in impeller are neglected is given by $\frac{1}{2g}\left[v_{f_1}^2 + u_2^2 - v_{f_2}^2 \operatorname{cosec}^2\beta_2\right]$ where v_{f_1} and v_{f_2} are flow velocities at inlet and outlet of the impeller. u_2 = tangential speed of impeller at exit, β_2 = exit blade angle. **(08 Marks)**

b. A centrifugal pump has its impeller diameter 30 cm and a constant area of flow 210 cm^2. The pump runs at 1440 rpm and delivers 90 LPS against a head of 25 m. If there is no whirl velocity at entry, compute the rise in pressure head across the impeller and hydraulic efficiency of pump. **(08 Marks)**

OR

10 a. Explain the working principle of the axial flow compressor along with a neat sketch of compressor with inlet guide vane. **(08 Marks)**

b. A 4 stage centrifugal pump has 4 identical impellers keyed to the same shaft. Speed of the shaft is 500 rpm. Total manometric head developed from 4 impellers is 50 m. The width at exit is 5 cm and diameter at exit is 60 cm. Whirl velocity at exit is 10 m/s, radial flow velocity at exit is 2 m/s. Calculate: i) Discharge ii) Exit vane angle iii) Manometric efficiency. **(08 Marks)**