CBCS SCHEME

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

17AE46

Fourth Semester B.E. Degree Examination, Aug./Sept. 2020
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 positive displacements machine and turbo machines. **(08 Marks)**

b. The thrust (T) of a propeller is assumed to depend on the axial velocity of the fluid V, the density ρ and viscosity μ of fluid, the speed N in RPM and the diameter D. Find the relationship of T by dimensional analysis. **(12 Marks)**

OR

2 a. Derive an expression for Euler's energy for a turbomachines. **(10 Marks)**

b. Define degree of reaction, derive a general expression for degree of reaction of turbomachine. **(10 Marks)**

Module-2

3 a. Define polytropic efficiency. Derive an expression for polytropic efficiency of a compression. **(10 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 total enthalpy (ii) The actual change in total enthalpy (iii) Efficiency of the compressor. **(10 Marks)**

OR

4 a. Derive an expression for total to static efficiency of a turbine. **(08 Marks)**

b. In a three stage turbine the pressure ratio of each stage and stage efficiency are 2 and 75% respectively. Calculate overall efficiency and power developed if air initially at a temperature of 600°C flows through it at a rate of 25 kg/s. Also find reheat factor. **(12 Marks)**

Module-3

5 a. Explain (i) Slip and slip factor (ii) Choking (iii) Surging. **(08 Marks)**

b. A centrifugal compressor running at 5950 RPM having an impeller tip diameter = 100 cm. Mass flow rate of air is 30 kg/s, total pressure ratio = 2.125, pressure at inlet is 1 bar and temperature is 25° C, Slip co-efficient μ = 0.9 and $\eta_{mech} = 0.97$, find (i) Total efficiency (ii) Temperature of air at exit (iii) Power input needed (iv) Pressure co-efficient. **(12 Marks)**

OR

6 a. Explain the effect of reaction ratio on velocity triangles. **(08 Marks)**

b. An air compressor has eight stages of equal pressure ratio 1.35 the flow rate through the compressor and its overall efficiency an 50 kg/s and 82% respectively. If the conditions of air at entry are 1.0 bar and 40°C, determine (i) the state of air at the compressor exit (ii) Polytropic efficiency (iii) Efficiency of each stage (iv) Power required to drive the compressor assuming overall efficiency of the drive as 90%. **(12 Marks)**

Module-4

7 a. What is turbine cooling? Explain different methods utilized to cool the turbine. **(08 Marks)**

b. In an slow speed inward flow radial turbine, degree of reaction is R and utilization factor is $\in$. Assuming the radial velocity component is constant throughout and there is no tangential component of absolute velocity at outlet. Show $\alpha_1 = \cot^{-1}\sqrt{\left(\frac{1-R}{1-\in}\right)\in}$ **(12 Marks)**

OR

8 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 taking inlet blade angle 45°. Show that. $R = \frac{2+\cot\beta_2}{4}$. **(10 Marks)**

b. A hydraulic reaction turbine of the radial inward flow types works under a head of 160 m of water. At the point of fluid entry the t rotor blade angle is 119° and the diameter of the runner is 3.65 m. At the exit the runner diameter is 2.45 m. If the absolute velocity at 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. Determine (i) Power developed for flow rate of 110 m^3/s. (ii) Degree of reaction (iii) Utilization factor. **(10 Marks)**

Module-5

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

b. A centrifugal pump delivers 50 lit/s of water against a head of 24 m, running at 1500 rpm. The velocity of flow 2.4 m/s is constant and the blades are set back to 30°. The inner diameter as half the outer dia. If manometric efficiency is 80% from the blade angle at inlet and power required to drive the pump. **(12 Marks)**

OR

10 a. Velocity triangle and workdone by the pelton wheel expression for maximum utilization factor of hydraulic turbine. **(10 Marks)**

b. A furnaces turbine has wheel diameter of 1 m at the entrance and 0.5 m at the exit. The guide vane angle is 15°. The water at exit leaves the vane without any tangential component. The vane angle at the entrance is 90°. The head is 30 m and the radial component of the flow is constant, what would be the speed of the wheel in rpm and vane angle at exit. **(10 Marks)**

* * * * *