

V SEMESTER B.TECH (MECHANICAL ENGG) END SEMESTER

MAKE UP EXAMINATIONS, DECEMBER 2017

SUBJECT: TURBO MACHINES [MME 3101]

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitably assumed.
- Use of Thermodynamic data hand book is permitted
- **1A.** Obtain the expressions for flow coefficient, head coefficient and power **05** coefficient as applicable to an incompressible flow turbomachine using Buckingham's π theorem.
- 1B. An inward flow reaction turbine has outer and inner diameter of the wheel as 1m and 0.5m respectively. The blades are radial at inlet. Water enters the turbine with a flow angle of 10°. Assuming the flow velocity as constant and is equal to 3m/s, find speed of the wheel at the exit, exit blade angle and degree of reaction. Assume maximum utilization condition.
- **2A.** Discuss the effect of exit blade angle on the performance of a centrifugal **05** compressor. Draw the velocity triangles for each case.
- 2B. An air compressor has eight stages of equal pressure ratio of 1.35. The flow rate through the compressor and its overall efficiency are 50 kg/s and 82% respectively. If the condition of air at entry are 1 bar and 40°C, determine (i) the state of air at compressor exit (ii) polytropic efficiency (c) efficiency of each stage and (iv) power required to drive the compressor.
- 3A. A multi stage centrifugal pump is discharging 45,000 liters of water per minute against a total manometric head of 60 m. There are four identical impellers keyed to the same shaft which is running at 350 RPM. The vanes are curved backward at an angle of 60° to the tangent at outer periphery. The velocity of flow at outlet is 0.27 times the corresponding peripheral velocity and is constant along the radial direction to avoid radial thrust. The hydraulic loss in the impeller is one-third of the kinetic head at exit of the impeller, Find: (a) Diameter of the impeller and (b) Manometric efficiency.
- **3B.** With the help of velocity diagrams, derive the expression for degree of **05** reaction of an axial flow compressor in terms of inlet and exit blade angles.
- 4A. A centrifugal compressor compresses air at ambient stagnation temperature and pressure of 288 K and 101.3 kPa respectively. The impeller tip speed is MME 3101
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365 m/s, the radial flow velocity at the exit of the impeller is 30 m/s, and the slip factor is 0.9. Calculate the Mach number of the flow at the impeller tip. If the isentropic total-total efficiency is 90 % and the flow area at the impeller exit is 0.1 m², find the mass flow rate of air. Assume zero inlet whirl and that the blades are radial at exit.

- **4B.** For a reaction hydraulic turbine mounted on a draft tube, show that the static **05** pressure at the exit of the runner is always less than atmospheric pressure.
- 5A. A Pelton Turbine produces 15.5 MW under a head of 300 m. The turbine produces 15.5 MW under a head of 300 m. The turbine speed is 440 rpm. Assuming a turbine efficiency of 85%, the coefficient of jet as 0.96, blade Speed ratio of 0.46, a bucket coefficient of 0.90, a jet ratio of 10, and assuming the deflection angle of the jet over the bucket as 165°, Compute the number of jets required and the diameter of each jet. Also determine the tangential force exerted by each jet on the bucket.
- 5B. Explain the need of compounding in impulse steam turbines. Explain velocity 05 compounding with the help of pressure velocity diagrams and velocity triangles for Curtis two stages.