Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

V SEMESTER B. TECH (MECHANICAL ENGG.) END SEMESTER EXAMINATIONS, NOVEMBER 2018

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.

1A. Derive the expressions for specific speed of turbines and pumps. **05**

1B. A radial outward flow turbo machine has no inlet whirl. The blade speed at the exit is twice that at the inlet. If the inlet blade angle is 45° and radial velocity is constant throughout, show that $R = \frac{2+\cot\beta_2}{4}$ where R is degree of reaction and β_2 is exit blade angle. Given that $\beta_2 < 90^0$. **05**

2A. Show that with the help of velocity triangles for maximum utilization and same amount of energy transfer in impulse and reaction axial flow turbines with no axial thrust, **05**

$$U_R = \sqrt{2}U_I$$

where U_R = rotor speed of 50% reaction turbine and U_I = rotor speed of impulse turbine.

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) Temperature of air at compressor exit, (ii) polytropic efficiency, (iii) stage efficiency and (iv) power required to drive the compressor. **05**

3A. The impeller of a centrifugal pump has backward swept blades inclined at 30° to the tangent at impeller exit. The blade width at the outlet is 20mm. The impeller is 250mm in diameter at the outlet and rotates at 1450RPM. The flow rate through the pump is 28LPS and a slip factor of 0.77 may be assumed. Determine the head developed by this pump in meter. Also calculate the number of impeller blades. **05**

3B. With the help of velocity triangles, derive an expression for stage stagnation pressure rise in a centrifugal compressor. **05**

4A. Each stage of an axial flow compressor of 50% reaction has the same mean blade speed and same outlet blade angle of 30° relative to the axial direction. The mean flow coefficient is 0.5 and remains constant. At entry to the first stage the stagnation condition of air is 101.3kPa and 278K and static pressure is 87.3kPa and flow area is 0.372m^2. Find (I) Flow velocity, (ii) Mean mass flow rate (iii) Shaft power for 6 stages with a mechanical efficiency of 90%. **05**

4B. Derive an expression for hydraulic efficiency of a pelton turbine in terms of blade speed ratio and exit blade angle. Also draw the velocity triangles. **05**

5A. An Inward flow reaction turbine is required to develop 3000kW when operating under a net head of 25m at a dimensioned specific speed of 300. Taking the inlet guide blade angle at full gate opening as 30°, the hydraulic efficiency and overall efficiency as 95% and 87% respectively, flow coefficient at inlet as 0.6, blade thickness factor as 0.95, Compute (i) RPM of the Turbine, (ii) Diameter and width of wheel at inlet. Assume radial discharge at exit of the runner. **05**

5B. With the help of velocity triangles derive an expression for utilization factor in terms of inlet flow angle and blade speed ratio for a curtis impulse turbine. **05**