M.E. Mechanical Engineering - First Year - Second Semester, 2019

Subject: **TURBO MACHINERY II**

Time : Three hours   **Full Marks: 100**

Answer any four [4]

1a) With reference to the impeller of a compressor or pump, how do you define slip factor ? 7

b) Using a neat sketch explain the features of actual and hypothetical velocity diagrams at exit from an impeller with back swept vanes. 8

c) A centrifugal pump delivers 0.1 m 3 /s of water at a rotational speed of 1200 rpm. The impeller has seven vanes which lean backwards to the direction of rotation such that the vane tip angle β_2 is 50 0 . The impeller has an external diameter of 0.4 m , an internal diameter of 0.2 m and an axial width of 31.7 mm. Assuming that the diffuser efficiency is 51.5% , that the impeller head losses are 10% of the ideal head rise and that the diffuser exit is 0.15 m in diameter, estimate the slip factor, the manometric head and the hydraulic efficiency. 10

2a) Explain degree of reaction in case of hydraulic turbines. 10

b) Find the blade loading co-efficients for the following three cases with the help of velocity triangles

i. zero reaction, ii. fifty percent reaction, iii. axial leaving velocity 15

3a) Explain 'total to total efficiency' and 'total to static efficiency' of hydraulic turbines. 10

b) With neat diagrams explain camber angle, blade angle and air angle of a hydraulic turbine stage. From the same explain stagger, incidence and deviation angles for the same. 10

c) Write short note on: Hawthorne's correlation 5

4a) Starting from the inlet, outlet and mean velocity triangles and pressure terms, find out the axial thrust co-efficient, lift-efficient and drag-efficient associated to a hydraulic turbine cascade. 15

b) Discuss about different losses associated with a hydraulic turbine cascade. 10

5a) Deduce the equation specifying the optimum conditions for the inlet velocity triangles in terms of hub/tip ratio for a centrifugal compressor or pump. Also obtain the condition for which the suction specific speed , for a centrifugal pump inlet, is maximum. 15

b) The inlet of a centrifugal pump is to be designed for optimum conditions when the flow rate of water is 25 dm^3/s and the impeller rotational speed is 1450 rpm. The maximum suction specific speed Ω_{ss} = 3.0 (rad) and the inlet eye radius ratio is to be 0.3. Determine:

i) the blade cavitation coefficient

ii) the shroud diameter at the eye

iii) the eye axial velocity

iv) The NPSH 10