Birla Institute of Technology and Science, Pilani

ME F341 Prime Movers & Fluid Machines

Mid Sem (Open Book)

Time: 90 minutes Weightage: 25% Date: 15/ 03 / 2022

Note: State clearly the assumptions you make.

Underline the answers and the assumptions you make.

Q.1. A double overhung (i.e., two runners keyed on the two ends of the generator shaft) Pelton wheel is coupled to an electric generator operating under a net head of 400 m at maximum practical efficiency. The discharge through a runner is 18,000 liters per minute, and the jet is deflected by 165°. The velocity coefficient and blade velocity coefficient are 0.97 and 0.90, respectively. The diameter of the runner is 4 m, volumetric efficiency is 0.99, mechanical efficiency is 0.92.

Draw the velocity triangles and calculate the (i) hydraulic efficiency, (ii) total power produced by the generator, if the generator efficiency is 95%, (iii) synchronous speed, synchronous speed = $60f/p$, where frequency f = 50 cycles/sec and p is the number of pairs of poles in the generator and (iv) modified diameter of the runner. [14]

Q.2. Determine the power developed by Francis turbine when running at 500 rpm under a head of 190 m. The blade angle and guide vane angle at the inlet are 50^{o} and $20^{o,}$ respectively, while the peripheral speed of the runner at the inlet is 35 m/s and discharge is nine m^3/s. Also, determine the runner diameter and width at the inlet and hydraulic efficiency of the turbine. Draw the velocity triangles. [10]

Q.3 You are in charge of a hydroelectric with a Pelton wheel. Due to some emergency, you have to stop the generating power immediately. What will be your course of action, and why? Discuss with consequences. [4]

Q.4 A propeller turbine has a speed of 30 rpm. The inlet guide vane angle is 30^{O}. The inlet and the outlet runner blade angles are 90^{O} and 25^{O}, respectively, to the direction of motion of the vanes. The mean diameter of runner blades is 4m, and the flow area is $30m^2$. The velocity at the outlet is not kept minimum. Assuming that the flow velocity is constant throughout, draw velocity triangles and calculate a) discharge, b) power produced, c) hydraulic efficiency, and d) specific speed. [12]

Q.5. Name the turbines used in BASPA-II and KARCHAM-WANGTOO hydroelectric power plants as discussed in class. If you exchange the turbines of both the plants, what kind of problems you will face. Elaborate each point for both the power plants. [6]

Q.6 Is it possible to have actual discharge in a reciprocating pump to be greater than the theoretical discharge? Justify your answer with a neat sketch. [4]

*****BEST LUCK******