Ex/EE/ME/T/216/2019

B.E. ELECTRICAL ENGINEERING 2nd YEAR 1st SEMESTER EXAM 2019

Subject: Prime Mover for Electrical Systems

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

Use separate answer scripts for Part I and Part II. Maximum number in each part is 50.

Part I – Hydraulics

Answer three questions from Part I.

Answer question no-1 and any two from the rest.

1. Briefly answer any **two** from the following. [2 x5]
   a) Explain Hydraulic grade line and Energy line with an example.
   b) Discuss friction factors and minor losses.
   c) Explain Streamline, Stream tube and Continuity Equation.
   d) Laminar and turbulent flow.
   e) Discuss the role of a draft tube in a reaction turbine.

2. **a)** State and explain Newton's law of viscosity. What are Dynamic and Kinematic viscosities and what are their units in SI system?

   b) A 2.0 cm wide gap between two vertical plane surfaces is filled with an oil of specific gravity 0.85 and dynamic viscosity 2.5 N-s/m^2. A metal plate 1.25 m x 1.25 m x 0.2 cm thick and weighing 30 N is placed midway in the vertical gap. Find the force required, if the plate is to be lifted up with a constant velocity of 0.12 m/s **[20]**

3. **a)** Show that for an inclined submerged plane surface, the centre of pressure (CP) lies below the centre of area.

   b) A circular plate of diameter 1.0 m is submerged in water with an inclination of 45° with free surface. The depth of the top most point of the plate is 0.75 m from the free surface (minimum depth). Calculate the hydrostatic force and the depth of centre of pressure. **[20]**

4. **a)** Stating assumptions, derive Bernoulli's equation of motion from Euler's equation of motion along a stream line.

   b) A conical tube 1.5 m long is fixed vertically with its smaller end upward and it forms a part of pipeline. Water flows down the tube and measurements undicate that velocity is 4.5 m/sec at the smaller end, 1.5 m/sec at the larger end and the pressure head is 10 m of water at the upper end. Assuming that the loss of head is 15% of velocity head difference between inlet and outlet, find the pressure head at the lower end of the conical tube. **[20]**

5. **a)** Derive the expression for discharge equation for flow through a Venturi-meter. **[20]**

6. **a)** Derive an expression for wheel efficiency of a Pelton turbine and show its variation with speed ratio.

   b) A powerhouse is equipped with impulse turbines of Pelton type. Each turbine delivers a power of 15 MW when working under a head of 900 m and running at 600 rpm. Find the diameter of the jet and the mean diameter of the wheel. Assume that the overall efficiency is 88%, the coefficient of velocity of the nozzle is 0.98 and the speed ratio is 0.46. **[20]**

[Turn over

B.E. ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER - 2019

Subject: Prime Movers for Electrical Systems

Time: Three hours — Full marks: 100

Use separate answer scripts for Part-I and Part-II
(50 Marks for each Group)

Part-II

A separate answer script should be used for this Group.
Answer **question no. 1** and **any two questions** from the rest
Use of Steam Table and Mollier Diagram is allowed

1 (a)	Why de-Laval nozzle is commonly used in single-stage impulse turbines?	3
(b)	What are the basic reasons for using the plate type blade in steam turbines?	2
(c)	What is reference condition in nozzle flow?	3
(d)	What is specific steam consumption?	2
2 (a)	Show mathematically that a convergent-divergent passage with a section of minimum area is required to accelerate from subsonic to supersonic speed. This derivation can be made with the help of critical condition.	16
(b)	Write down advantages to use Parson's turbine in comparison to the simple impulse turbines.	4
3 (a)	Why compounding of steam turbine is made? Using schematic diagram to show the variation of absolute pressure in the axial direction in three-row Rateau turbines.	6
(b)	Following are the data for a stage of an impulse-reaction turbine: Blade velocity = 150 m/s. Fixed blade outlet steam velocity = 350 m/s Nozzle angle = 20^0 Relative velocity of steam at moving blade outlet = 1.5 times that of at moving blade inlet. Moving blade outlet angle = 65^0 Carry over coefficient = 0.82 Find out the degree of reaction and resultant force acting on the blades, assuming expansion efficiency = 0.85 for both the fixed and moving blades. Show the direction of the resultant force on the velocity diagram.	14
4 (a)	What do you understand by the term "carry over coefficient"? What parameters are influenced the carry over coefficient? Define the term 'degree of reaction' of an impulse-reaction turbine. Explain its significance.	6
(b)	Draw the velocity diagram for a stage in a impulse turbine with two rows of moving blades for the following particulars: Nozzle angle = 15^0. Nozzle efficiency = 88%. The carry over factor =0.9. Moving blades tip discharge angle = 20^0. Moving blade inlet angle = 25^0. Exit velocity of steam from nozzles= 500 m/s. Final discharge is axial. Find out the followings: (i) blade velocity (ii) diagram power per kg of steam flow (iii) stage efficiency	14