Ex/EE/ME/T/216/2018

**B.E. ELECTRICAL ENGINEERING 2nd YEAR 1st SEMESTER EXAM 2018**

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 A. Note that Q1 carries 20 marks and each of other questions carries 15 marks.*

1. Briefly answer any **four** questions. [5+5+5+5]
   a) Distinguish between dynamic and kinematic viscosity?
   b) Explain the operations of a U-tube manometer.
   c) Discuss friction factors and Moody's diagram.
   d) Explain Hydraulic grade line and Energy line.
   e) Explain Streamline, Stream tube and Continuity Equation.
   f) Discuss the role of a draft tube in a reaction turbine.
   g) Draw a schematic of a hydraulic turbine installation.

2. a) A 90N rectangular block is towed upward along a 300 inclined plane by a 90N force. The plane is lubricated by a 3mm thick oil film of viscosity 0.8 Pa-s. If the area being lubricated is $0.3m^2$, find the velocity of slide of the block. [7]

   b) A rectangular plate 1.0m ×2.0m is submerged in water and makes an angle of $60^o$ with the horizontal – the 1.0m sides being horizontal. Calculate the magnitude of the force on one face and the position of the center of pressure when the top edge of the plane is 0.8m below the water surface [8]

3. a) What are the assumptions in the derivation of the *Hagen-Poiseuille Equation*? Derive the expression for head loss in a pipe in terms of discharge for fully developed laminar flow. [3+8]

   b) In a smooth pipe of 250mm in diameter, a pressure of 50kPa was observed at Section 1, which was at elevation of 10m. At another Section 2 at an elevation of 12m, the pressure was 20kPa and velocity 1.25m/s. Determine the direction of water flow in the pipe and head loss between the sections. [2+2]

4. a) Oil of absolute viscosity 0.15Pa-s and relative density 0.85 flows through a 30cm diameter pipe. If the head loss in 300m length of pipe is 20m, estimate the shear stress at a radial distance of 10cm from the pipe axis. Check whether the flow is laminar and determine the friction factor $f$ of the pipe. [7]

   b) A powerhouse is equipped with impulse turbines of Pelton type. Each turbine delivers a power of 14MW when working under a head of 900m and running at 600rpm. Find the diameter of the jet and the mean diameter of the wheel. Assume that the overall efficiency is 89%, the coefficient of velocity of the nozzle is 0.98 and the speed ratio is 0.46. [8]

5. a) Derive an expression for wheel efficiency of a Pelton turbine and show its variation with speed ratio. [8]

   b) Derive the expression for discharge equation for flow through a V-notch. [7]

**B.E. ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER - 2018**

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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) | What is over expanded nozzle? | 3 |
| (b) | What are the basic reasons for selecting an aero-foil type blade in steam turbines? | 2 |
| (c) | What is metastable flow in steam nozzles? | 3 |
| (d) | What is specific output? | 2 |
| | | |
| 2 (a) | For an actual flow in nozzles, derive the expansion index. Write the assumptions to be considered for establishing the above mathematical relationship. | 12 |
| (b) | Develop the maximum blade efficiency for a half degree reaction turbine. | 8 |
| | | |
| 3 (a) | When is compounding of steam turbine necessary? Show mathematically that the optimum blade speed ratio for a Curtis turbine diminishes with the increase in number of rows of moving blades. | 12 |
| (b) | The exit velocity of steam from the nozzles of a single wheel impulse turbine is 700 m/s. The nozzle is $20^0$ to the plane of wheel. The blade speed is 3000 rpm and the mean blade radius is 60 cm. The axial velocity of the steam at exit from the blades is 160 m/s and the blades are symmetrical. Calculate (i) the blade angles, (ii) the diagram work, (iii) the diagram efficiency, (iv) the blade velocity coefficient and (v) the resultant axial thrust on the blades and its direction. | 8 |
| | | |
| 4 (a) | Dry and saturated steam is supplied to a deLaval turbine at 8 bar at the rate of 200 kg/h, exhausting at 0.5 bar. The efficiency of expansion is 80%. The nozzle angle is $20^0$ and the blade velocity coefficient is 0.85. The blade speed is 180 m/s. The power 1.0 KW is vanished due to disc friction and windage. If there is no end thrust on the shaft, determine the net power at shaft coupling and the dryness fraction of steam at the blade exit. | 12 |
| (b) | The following details were noted in a test on a four cylinder, four-stroke petrol engine, diameter=100 mm, stroke=120 mm, speed of the engine=1600 rpm, fuel consumption=0.2 kg/min, calorific value of fuel=44000 kJ/kg, difference in tension on either side of the brake pulley=40 kg, brake circumference is 300 cm. If the mechanical efficiency is 80%, calculate (i) brake thermal efficiency, (ii) indicated thermal efficiency, (iii) indicated mean effective pressure, and (iv) brake specific fuel consumption. | 8 |