B.E. MECHANICAL ENGINEERING THIRD YEAR FIRST SEMESTER - 2019

Subject: **Fluid Machinery - II**

Time: Three hours Full Marks: 100

Answer any five questions.

Use suitable data and condition, if necessary.

1. a) With a neat diagram, explain how the performance test of a centrifugal pump can be carried out in the Hydraulics Laboratory and show that the total head development by a pump **'H'** may be expressed as:

$$H = H_s + H_d + [(V_d)^2 - (V_s)^2]/(2.g),$$ where symbols have their usual meanings.

b) The head-discharge relationship for a centrifugal pump is given by: $H = 40 + 52.Q - 775.Q^2$, where **'H'** is the total head generated by the pump in meters and **'Q'** is the discharge in m^3/s. The pump is to deliver water through a pipeline 1000 m long, 35 cm diameter, the static lift being 25 m. Taking friction coefficient f = 0.032, calculate the operating head, discharge and power required to drive the pump. Assume pump efficiency 75% at the operating point. **[10 + 10]**

2. a) The discharge **Q** for a Roto-dynamic machine depends on the coefficient of viscosity **μ**, the mass density of the fluid **ρ**, the diameter of the impeller **D**, the rotational speed of the impeller **N**, the total head **H** and the acceleration due to gravity **g**. Establish the functional relation as given below and hence deduce the expression for the 'Specific Speed' of a Roto-dynamic pump.

$$Q/(ND^3) = f(gH/N^2D^2, \rho ND^2/\mu)$$

b) A six stage centrifugal pump delivers 7.5 m^3/min of water against a net pressure rise of 5 MPa. Determine the specific speed of the pump if it runs at 1440 rpm and comment upon the type of impeller. **[14 + 6]**

3. a) What is Cavitation? Where and why cavitation may occur in a pump? What are the factors which limit the suction head of a pump? How Thoma's Cavitation factor helps in maintaining a cavitation free operation of a centrifugal pump – discuss in the light of 'Available Net Positive Suction Head'.

b) A centrifugal pump was tested for cavitation initiation. The pump was placed above the sump level and the total head development of the pump was 45 m and the flow rate was 0.06 m^3/s. Cavitation started when the net head available at the suction side (Taking care of suction lift and friction) was 3.5 m. The atmospheric pressure was 760 mm of Hg and the vapour pressure at this temperature was 2.5 kPa. Calculate the cavitation parameter.

It was proposed to install the pump where the atmospheric pressure is 680 mm Hg and the vapour pressure at the location Hg is 1.0 kPa. If the pump develops the same total head and flow rate, can the pump be placed at the same height above the sump level as the laboratory setup? **[12 + 8]**

4. a) Why and how centrifugal pumps are used in combination? Discuss, in the light of 'system curve' and 'combined characteristics of pumps', how operating point in combination is dependent on the individual pump characteristics?

b) The head-discharge characteristics relationship for a centrifugal pump is given by:

$$H = 40 - 200.Q^2.$$

What will be the equation for the combined characteristics (head-discharge), if two such identical pumps operate in parallel and series? **[10 + 10]**

5. a) What are unit quantities in reference to hydraulic turbine? How can you get the expression for unit speed and unit discharge?

   b) Discuss the main or constant head characteristics of Pelton and Francis Turbine with comments. What is Muschel curve? Explain in reference to a hydraulic turbine. **[8 + 12]**

6. a) What is the purpose of a draft tube? Why draft tube is not required for a Impulse turbine? What are the different types of a draft tube employed for reaction turbine?

   b) Show that draft tube with divergent section helps in contributing higher power development in a reaction turbine. **[12 + 8]**

7. a) Derive an expression for the rise in pressure for sudden closure of the valve on the basis of Elastic water column theory.

   b) What is rapid and slow valve closure in reference to transient flow in pipeline? With a neat diagram, enumerate the propagation of pressure waves for instantaneous closure of valve for flow from a reservoir to a pipeline with valve at its end. **[10 + 10]**

8. Write short notes on any two of the following: **[2 x 10]**
   a) Fluid coupling.
   b) Governing of a Pelton Turbine.
   c) Torque converter.
   d) Degree of reaction.

----------*******----------