USN | | | | | | | | | |

10CV45

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

PART – A

1 a. What is dimensional analysis? State the uses of dimensional analysis. **(06 Marks)**

b. The discharge Q of a centrifugal pump depends upon the mass density ρ of fluid, pump speed N, the diameter of impeller D, the pressure P and viscosity of the fluid μ. Using Buckingham's method, show that

$$Q = ND^3\phi\left[\frac{gH}{N^2D^2}, \frac{\gamma}{ND^2}\right]$$

where, γ = kinematic viscosity of fluid
H = Head. **(10 Marks)**

c. The discharge over the weir is $1.5m^3/sec$. Find the discharge over the model of the weir if horizontal scale ratio = $\frac{1}{50}$ and vertical scale ratio = $\frac{1}{10}$. **(04 Marks)**

2 a. Derive the conditions for most economical circular channel for maximum velocity condition. **(06 Marks)**

b. Find the discharge in a circular sewer of diameter 2m laid at a slope of 1:2000 when the depth of water is 1.5m. Take valve of Manning's n = 0.020. **(06 Marks)**

c. Calculate the dimension of the section which will require minimum lining for canal having a trapezoidal section with one side vertical and other sloping at 60° with horizontal. It has to carry $24m^3/sec$ of water at a mean velocity of 1.2m/sec. **(08 Marks)**

3 a. Define specific energy and with a neat sketch explain specific energy diagram. **(06 Marks)**

b. Derive an expression for loss of energy due to hydraulic jump in rectangular channel. **(06 Marks)**

c. In a rectangular channel 1.5m wide, if the observed depths before and after the jump are 0.2m and 1m respectively determine the discharge flowing through the channel. Also determine critical depth, minimum specific energy and power lost due to hydraulic jump. **(08 Marks)**

4 a. Show that the efficiency of a jet striking normally on a series of flat plates mounted on the periphery of wheel is 50%. **(06 Marks)**

b. A jet of water of diameter 50mm strikes a flat plate moving with a velocity 8m/sec in such a way that the normal to the plate makes an angle of 30° with the axis of the jet. The force exerted in the direction of the jet is 1471.5N. Calculate the velocity of the jet. **(06 Marks)**

c. A jet of water of diameter 25mm strikes a 200mm × 200mm square plate of uniform thickness with a velocity of 10m/sec at 50mm below the c.g. of the plate. The plate is suspended vertically by a hinge on its top horizontal edge. The weight of the plate is 98.1N. What force must be applied at the lower edge of the plate so that the plate is kept vertical? If the plate is allowed to swing freely, what will be the inclination of the plate with the vertical? **(08 Marks)**

PART – B

5 a. Derive an expression for resultant force exerted by a jet striking an unsymmetrical stationary curved vane tangentially at one of its tips. **(08 Marks)**

b. A jet of water of diameter 50mm having a velocity of 15m/sec strikes a curved vane which is moving with a velocity of 5m/sec. The vane is symmetrical and is so shaped that the jet is deflected through 120°. Find the angle of the jet at inlet. What is the absolute velocity of the jet at outlet in magnitude and direction? Also calculate the efficiency of the jet. **(12 Marks)**

6 a. Explain the classification of turbines. **(06 Marks)**

b. Define: hydraulic efficiency, mechanical efficiency and overall efficiency. Derive the relationship between them. **(06 Marks)**

c. The penstock supplies water from a reservoir to a Pelton wheel with a gross head of 500m. One third of the gross head is lost in friction in the penstock. The rate of flow of water through the nozzle fitted at the end of the penstock is $2m^3/sec$. The angle of deflection of the jet is 165°. Determine the power given by the water to the runner and hydraulic efficiency. Take speed ratio equal to 0.45 and $c_v = 0.98$. **(08 Marks)**

7 a. Define draft tube. State its functions. **(06 Marks)**

b. Derive an expression for specific speed for a turbine. **(06 Marks)**

c. A Kaplan turbine develops 24650kW at a head of 40m. Assuming a speed ratio of 2, flow ratio of 0.6, diameter of boss equal to 0.35 times the diameter of runner and an overall efficiency of 90%, calculate diameter, speed and specific speed of the turbine. **(08 Marks)**

8 a. What is centrifugal pump? Explain its working with a neat sketch. **(08 Marks)**

b. A centrifugal pump impeller has diameters 360mm and 720mm at inlet and outlet respectively. Flow velocity at outlet is 2.4m/sec and the vanes are set back at an angle of 45° at outlet. If manometric efficiency $\eta_{mano} = 70\%$, determine the minimum starting speed of the pump. **(08 Marks)**

c. Find the number of pumps required to take water from a deep well under a total head of 95m. All the pumps are identical and are running at 800rpm. Specific speed of each pump is 25 while the rated capacity of each pump is $0.18m^3/sec$. **(04 Marks)**

* * * * *