Ref. No.: Ex/CON/PE/T/121/2018

B.E. CONSTRUCTION ENGINEERING FIRST YEAR SECOND SEMESTER - 2018

HYDRAULICS

Time: 3 (Three) hours **Full Marks: 100**

Attempt any 5 questions out of 7

Q 1. (a) Derive the equation of continuity. **7 Marks**

(b) A right cylindrical tank (resting on the ground) of height H and radius R is completely filled with water (density ρ). There are two inlets of diameters D_1 and D_2 respectively at the bottom; water enters through the first inlet at a constant rate of m_1 kg/s. The volumetric flow rate through the other inlet varies with time and is given by $Q_2(t) = Q_0(1 - \sin t)$. There is also a small hole of radius r at the top (on the curved i.e. the vertical surface of the tank) through which water-jet comes out of the tank.
Find the minimum and maximum ranges the water jet covers on the ground. (All quantities, if not specified, are in SI units.) **13 Marks**

Q 2. (a) Derive the formula of 'discharge' for a 'Sharp-Crested Rectangular Weir', the 'drawdown', and 'non-zero velocity of the surface must be taken cared of while deriving the formula. **12 Marks**

(b) Derive the formula of 'discharge' through a venturimeter lying horizontally. How does an orificemeter differ from a venturimeter? **8 Marks**

Q 3. Write short notes on: (a) Cavitation (b) Hydraulic jump (c) Reynolds number (d) Froude number. 4×5 **Marks**

Q 4. (a) Water flows through a horizontal pipe of radius R, however the pipe is partially filled, the surface of the water lies at a distance h from the top-most point of the pipe ($h < R$). Is this a 'pipe-flow' or an 'open-channel flow' ? Find the 'hydraulic radius' and 'hydraulic depth'. **8 Marks**

(b) Find the fractional change in 'hydraulic radius' when 'h' changes from its present value by an amount 'Δh'. **6 Marks**

(c) Find the fractional change in 'hudraulic depth' when we take another piipe of

radius $R + \Delta R$; 'h remains the same. **6 Marks**

Q 5. (a) A square surface $3m \times 3m$ lies in a vertical plane. Determine the position of the center of pressure and the total force on the square for the follwing two cases: the upper edge lies in (i) the water surface (ii) $15m$ below the water surface. —- **12 Marks**

(b) What types of water turbines are usually used for (i) high head (ii) moderate head (iii) low head. **3 Marks**

(c) Describe with diagram how the Peltron turbine works. **5 Marks**

Q 6. (a) Derive Euler's momentum equation concerning fluid flow. Clearly state the underlying assumptions. **8 Marks**

(b) Derive the velocity profile for a steady, hydrodynamically fully developed, 1-D viscous flow throug a rectangular conduit of height $2h$ (the width is much larger than the height); a constant axial pressure gradient drives the flow; dynamic viscosity of the fluid is μ; neglect the effect of gravity. Take the orgin at the left of the domain, on the axis. The fluid flows in the z direction; the velocity changes in the y direction only. **12 Marks**

Q 7. (a) Derive Chezy's velocty-formula concerning an open-channel flow. For what particular types of flows we can apply this formula ? **10 Marks**

(b) Determine the rate of flow through a $3m$ wide concrete lined rectangular channel having a slope 1 in $10,000$ when the depth of flow is $1m$. Take Mannings $n = 0.012$. **10 Marks**