Solutions to Open Channel Flow Problems

1. **Problem 1:** A rectangular channel 3 m wide carries a flow of 10 m^3/s. Determine the flow velocity if the flow depth is 1.5 m.

   Solution: The flow velocity v can be calculated using the formula $v = \frac{Q}{A}$, where Q is the discharge and A is the cross-sectional area. Here, $A = width \times depth = 3\,m \times 1.5\,m = 4.5\,m^2$. Thus, $v = \frac{10\,m^3/s}{4.5\,m^2} = 2.22\,m/s$.

   Video Solution: `https://www.youtube.com/watch?v=zutPyDrI7Sg`

2. **Problem 2:** A trapezoidal channel has a bottom width of 4 m and side slopes of 2:1 (horizontal: vertical). If the depth of flow is 2 m, determine the wetted perimeter.

   Solution: The wetted perimeter P is the sum of the bottom width and the lengths of the two side slopes. Each side slope length can be found using the Pythagorean theorem: $sidelength = \sqrt{(2 \times depth)^2 + (depth)^2} = \sqrt{(4\,m)^2 + (2\,m)^2} = \sqrt{16 + 4} = \sqrt{20} = 4.47\,m$. Therefore, $P = 4\,m + 2 \times 4.47\,m = 12.94\,m$.

   Video Solution: `https://www.youtube.com/watch?v=1tAhMkfYfEA`

3. **Problem 3:** A 2.5 m wide rectangular channel has a discharge of 8 m^3/s. Compute the critical depth.

   Solution: The critical depth y_c in a rectangular channel can be calculated using the formula $y_c = \left(\frac{Q^2}{gb^2}\right)^{1/3}$, where Q is the discharge, g is the acceleration due to gravity, and b is the width of the channel. Substituting the given values: $y_c = \left(\frac{(8)^2}{9.81 \times (2.5)^2}\right)^{1/3} = \left(\frac{64}{61.3125}\right)^{1/3} = (1.044)^{1/3} = 1.02\,m$.

   Video Solution: `https://www.youtube.com/watch?v=LMHj7JkxbHc`

4. **Problem 4:** A channel has a flow velocity of 3 m/s and a depth of 1.8 m. Determine the specific energy of the flow.

   Solution: The specific energy E is given by $E = y + \frac{v^2}{2g}$, where y is the flow depth, v is the flow velocity, and g is the acceleration due to gravity. Substituting the given values: $E = 1.8\,m + \frac{(3\,m/s)^2}{2 \times 9.81\,m/s^2} = 1.8 + \frac{9}{19.62} = 1.8 + 0.459 = 2.259\,m$.

   Video Solution: `https://www.youtube.com/watch?v=Z8eBjKpC9J4`

5. **Problem 5:** A rectangular channel with a width of 5 m carries a flow of 20 m^3/s with a depth of 2 m. Compute the Froude number and classify the flow as subcritical, critical, or supercritical.

   Solution: The Froude number Fr is calculated using $Fr = \frac{v}{\sqrt{gy}}$, where v is the flow velocity, g is the acceleration due to gravity, and y is the flow depth. First, calculate the velocity: $v = \frac{Q}{A} = \frac{20\,m^3/s}{5\,m \times 2\,m} = 2\,m/s$.

Then, $Fr = \frac{2}{\sqrt{9.81 \times 2}} = \frac{2}{\sqrt{19.62}} = \frac{2}{4.43} = 0.45$. Since $Fr < 1$, the flow is subcritical.

Video Solution: `https://www.youtube.com/watch?v=XnM6fCJ6C8w`