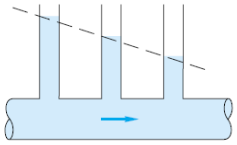
Addis Ababa Institute of Technology

Department of civil and Environmental Engineering

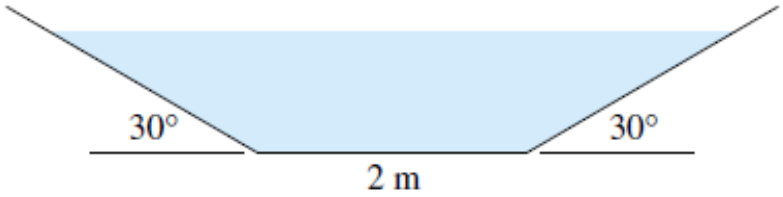
Hydraulics-II (CENG-2162)

Assignment 1(Open Channel Flow)

1) The water-channel flow in Fig. shown below has a free surface in three places. Does it qualify as an open-channel flow? Explain. What does the dashed line represent?



2) The trapezoidal channel of Fig. shown below is made of brickwork and slopes at 1:500. Determine the flow rate if the normal depth is 80 cm.



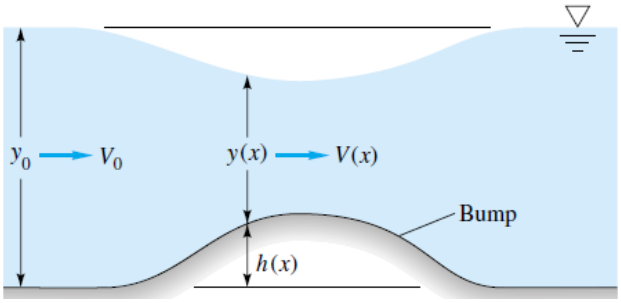
3) A trapezoidal channel is to be excavated at a site where permit restrictions require that the channel have a bottom width of 5 m, side slopes of 1.5:1 (H:V) and a depth of flow of 1.8 m. If the soil material erodes when the shear stress on the perimeter of the channel exceeds 3.5 N/m2, determine the appropriate slope and flow capacity of the channel. Use the Darcy-Weisbach equation and assume that the excavated channel has an equivalent sand roughness of 3 mm

4) A prismatic channel of symmetric trapezoidal section, 1600 mm deep and with top and bottom widths 3 m and 0.6 m respectively carries water at a rate of 2.6 $m^3 s^{-1}$. Manning's *n* may be taken as 0.012 $m^{-1/3}$ s. Find:
   (a) The normal depth at a slope of 1 in 2500;
   (b) The Froude number at the normal depth;
   (c) The critical depth;
   (d) The critical slope.

5) A rectangular channel 5m wide laid to a mild bed slope conveys a discharge of 8 m^3/s at a uniform flow depth of 1.25m.
   A) Determine the critical depth
   B) Neglecting the energy loss, show the height of streamlined sill constructed on the bed affects the depth upstream of the sill and the depth at the crest of the sill.
   C) Show that if the flow at the crest becomes critical the structure can be used as a flow measuring device using only an upstream depth measurement.

6) Consider the flow in a wide channel over a bump, as shown in Fig. below. One can estimate the water-depth change or transition with frictionless flow. Use continuity and the Bernoulli equation to show that

$$\frac{dy}{dx} = -\frac{dh/dx}{1 - V^2/(gy)}$$

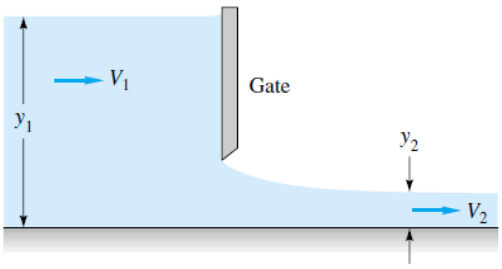


7) A trapezoidal channel has side slopes of 1 horizontal to 2 vertical and the slope of the bed is 1 in 2000. The area of the section is 42 m^2. Find the dimensions of the section if it is most economical. Determine the discharge of the most economical section if C = 60.

8) An undershot sluice controls the flow in a channel of width 1.5 m. If the flow rate is 3 m3 s–1 and the upstream depth is 1.8 m calculate the minimum depth and Froude number just downstream of the sluice if:

a) There is no energy loss;
b) There is a 10% loss in specific energy through the sluice.

9) Given is the flow of a channel of large width b under a sluice gate, as shown in Fig. below. Assuming frictionless steady flow with negligible upstream kinetic energy, derive a formula for the dimensionless flow ratio Q2/(y13b2g) as a function of the ratio y2/y1. Show by differentiation that the maximum flow rate occurs at y2 =2y1/3.



10) A long wide rectangular channel has a slope of 2×10–5, a Manning's n of 0.01 m–1/3 s and a flow rate of 0.5 m3 s–1 per metre width. A broad-crested weir with a height of 0.7 m is placed in the channel. Determine:

(a) The normal depth in the channel;
(b) The depth over the weir;

(c) The depth downstream of the weir assuming that the hydraulic jump occurs well downstream;
(d) The depth upstream of the hydraulic jump, and thus …
(e) The actual position of the hydraulic jump.