Sample Problems on Hydraulics

1. You are given the following rectangular channel.

   ![Diagram of rectangular channel with dimensions W = 20 feet and h = 7 feet]

   a. Calculate the hydraulic radius for the given channel.
   b. If the velocity within the channel is measured to be 5 feet/sec determine the discharge and unit discharge.
   c. If the slope is $S = 0.001$, determine Manning $n$.

2. You are given a wide rectangular channel. The channel is a clean, straight, full stage, no rifts or deep pools (Hint uses Table 2.1 in HIRE to determine the Manning $n$). Given the following, $Q = 1000$ cfs, $W = 100$ feet, $S_o = 2$ ft /mile, calculate the following in English units.

   a. Calculate the normal depth. (Hint: check the formula in English units)
   b. Calculate the critical depth
   c. Calculate the minimum specific energy.
   d. Define whether the channel slope is mild or steep.
   e. If the flow depth is 110% of the normal depth, calculate the friction slope.
   f. Determine the Froude number and define whether the flow is critical, supercritical or subcritical.
   g. Calculate the specific energy for the actual flow depth.
   h. If the reach is long describe and draw the water surface profile.
   i. Explain in words how you would solve this problem differently if told that the rectangular channel is not wide.
3. You are given a straight mountain channel with \( ds = 300 \text{ mm} \), \( n = 0.04 \) and a slope of \( S_0 = 0.07 \). Calculate the following in SI at a discharge \( Q = 20 \text{ cms} \) and width \( W = 15 \text{ m} \).

j. Calculate the normal depth.
k. Calculate the critical depth and minimum energy.
l. Define whether the channel is mild or steep.
m. If water flows at normal depth, calculate the hydraulic radius.
n. Determine the Froude number and define whether the flow is critical, supercritical or subcritical.
o. Determine the friction slope.
p. Determine the bed shear stress.
4. You are given the following channel profile. The unit discharge is 10 m$^2$/s and constant throughout the entire reach. Calculate the following in English units:
   a. Determine if the channel segments are mild or steep?
   b. Draw the normal depth along this reach.
   c. Draw the critical depth along the reach.
   d. Identify where the hydraulic control is for each segment and determine the boundary conditions.
   e. Sketch the hydraulic grade line of the entire reach.
   f. Calculate the velocity head and sketch the energy grade line for the entire reach.

Reach 1
So = 0.001
n = 0.013

Reach 2
So = 0.02
n = 0.035

Reach 3
So = 0.005
n = 0.035

h = 4.5 feet