Problem I:

A rectangular concrete channel is a 3 m wide and 2 m high. The water in the channel is 1.5m deep and is flowing at a rate of 30m3/s. Determine the flow area, wetted perimeter, and hydraulic radius. Is the flow laminar or turbulent?

Solution:

- Flow Area: 4.5 m^2
- Wetted Perimeter: 6 m
- Hydraulic Radius: 0.75 m
- To determine whether the flow is turbulent or laminar we should calculate the Reynolds number:

$$Re = \frac{4VR}{\nu}$$

where Re = Reynolds number (unitless)
V = average velocity (m/s, ft/s)
R = hydraulic radius (m, ft)
ν = kinematic viscosity (m^2/s, ft^2/s)

V= 6.67 m/s

v= $10^{\wedge -6}$

Re= 20,010,000 m^2/s > 4,000 m^2/s Then the flow is turbulent

Problem III:

A concrete trapezoidal channel has a bottom width of 4m and 45-degree side slopes. If the channel is 1-percent slope and is flowing at a depth of 1 m throughout its length, how much flow is being carried (use Manning's equation)? How much flow would the same channel carry if it were a rectangular channel 4 m wide?

Solution:

Trapezoidal channel Flow: 31.25 m^3/s

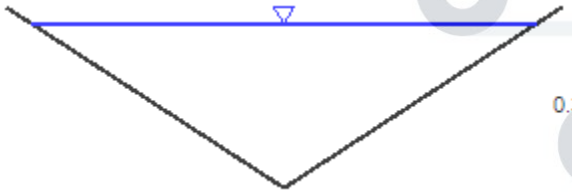
Rectangular channel Flow: 23.48 m^3/s

Problem IV:

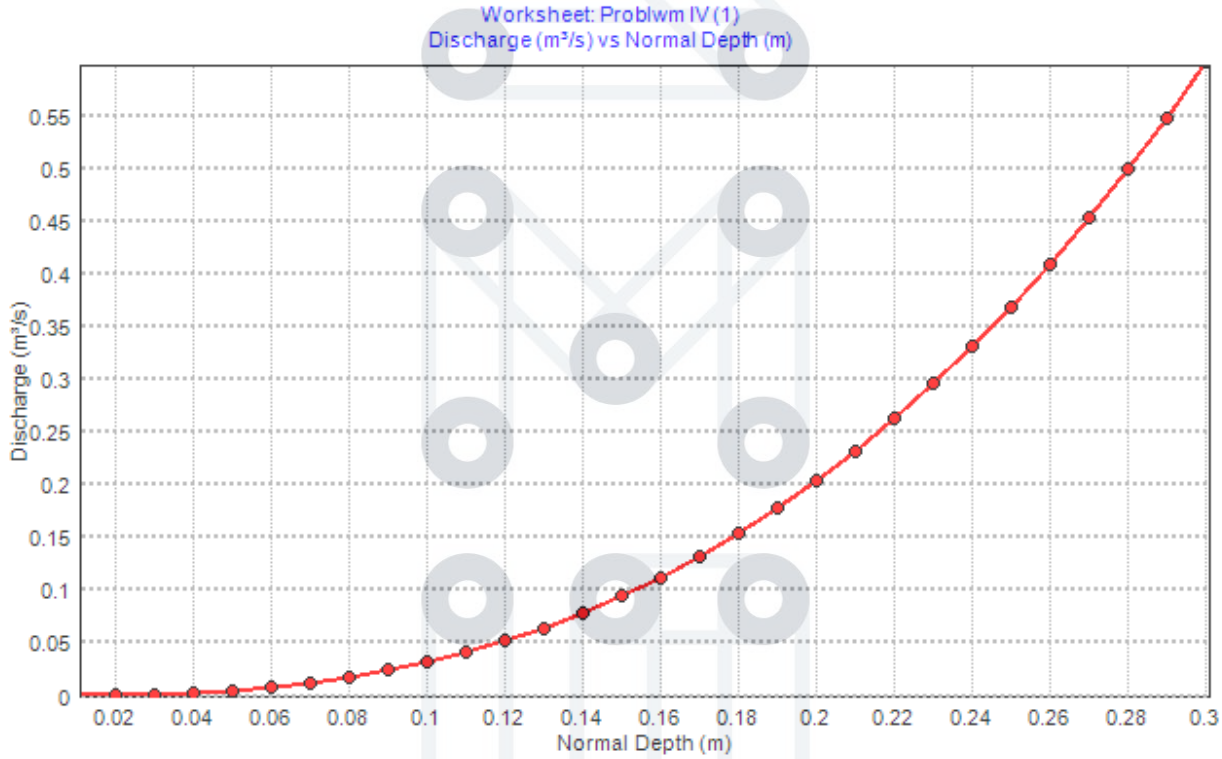
Using Manning's equation, design a triangular channel with equal side slopes, a longitudinal slope of 5%, a peak flow capacity of 0.6 m^3/s, and a maximum depth of 0.3. Also, design a concrete trapezoidal channel with equal side slopes and a base width of 0.2 that meets the same criteria. Create a cross-section of each channel and a curve of discharge versus depth for each channel. Assume the water is at 20˚C.

Solution:

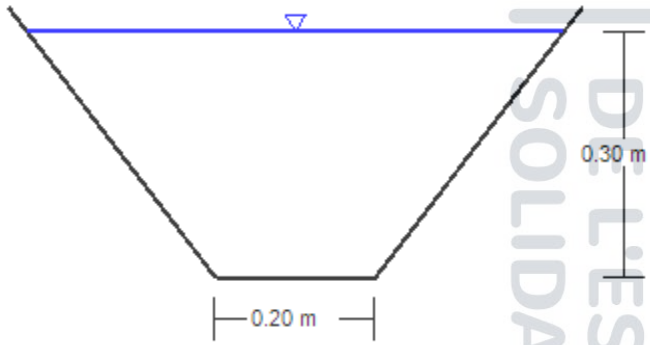
Triangular channel:



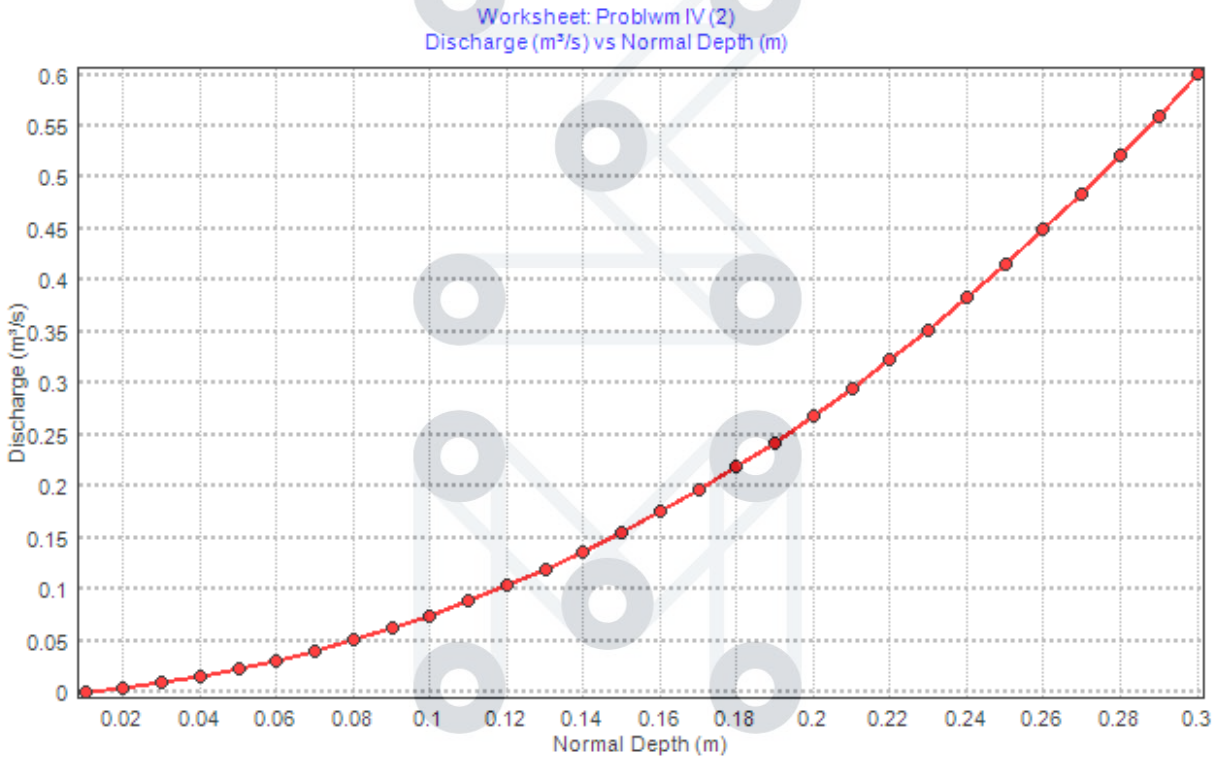
Equal side slopes: 1.54 m/m (H: V)



Trapezoidal channel:



Equal side slopes: 0.8 m/m (H: V)



Problem V:

A channel with the cross-section shown in the flowing figure has a Manning's coefficient of 0.040 from station 0 to station 3 and 0.054 from station 3 to station 8.

The flow through the channel is 13 m^3/s, and the water surface is 1.7m high. Find the following:

a- Weighted Manning's coefficient

b- Slope of the channel

c- Top width

d- Wetted perimeter

e- Flow regime (supercritical or subcritical)

Solution:

a. 0.049
b. 1.26046 %
c. 7.1 m
d. 8.65 m
e. Subcritical Flow