Determine the following:

1) Starting from dry condition, what is the cumulative infiltration depth for a silty loam after 10 minutes? 
\[ F = 1.4 \text{ cm} \]
\[ F(t) = k t + \frac{P_o - P_e}{\ln\left(1 + \frac{k t}{P_o - P_e}\right)} \]
\[ P_o - P_e (1-e^{-k t}) = 0.42 \]
\[ k = \frac{1.09 \text{ cm}}{h} \]

2) Calculate the 50-year runoff coefficient for a 25 acre watershed. The watershed is composed of 35% concrete, 15% is poor grass areas with flat slopes, 35% is pasture area with average slope and the remaining 15% is forested lands with average slopes?
\[ C = 0.61 \]
\[ C = 0.35 (0.92) + 0.15 (0.44) + 0.35 (0.45) + 0.15 (0.43) = 0.61 \]

3) Determine the 100-year rainfall intensity for a 12 hour rainfall event?
\[ I_{100} = 8.5 \text{ mm/h} \]

4) From 4 and 5 above, estimate the 50-yr discharge for a drainage area of 1 square kilometer:
\[ Q = 51 \text{ cfs} \]
\[ Q = C I A = 0.61 \times 8.5 \text{ mm/h} \times 1 \text{ km}^2 \times 10^6 \text{ m}^2 \text{ km}^{-2} \times \frac{1}{h} \]
\[ \text{m}^3 \text{ km}^{-1} \times \frac{35.3 \text{ ft}^3}{	ext{m}^3} \]
\[ Q = 50.9 \text{ ft}^3/\text{s} \]
Problem #2 (20%) Open channel hydraulics

Consider a wide-rectangular stream with a critical depth of 0.5 m over the entire profile sketched below. Sketch the water surface profile next page given normal depth at both ends of the channel and determine the following from the information on the sketch:

5) What is the normal depth of Reach 2

\[ h_n = \left( \frac{mg}{g} \right)^{3/5} = \left( \frac{0.015 \times 1.107}{20 \times 10^{-5}} \right)^{4} = 1.1 \text{ m} \]

6) How much can you raise a sill in Reach 2 without choking the flow;

\[ E = h_n^2 + \frac{q^2}{2g h_n^2} = 1.1 + \frac{(1.1)^2}{2 \times 9.81 \times (1.1)^2} = 1.15 \]

\[ \Delta z = E - E_{\text{min}} = 1.15 - \frac{3}{2} h_c = 1.15 - \frac{3}{2} \times 0.5 = 0.4 \text{ m} \]

7) What is the shear stress of the second reach at normal depth;

\[ \tau_2 = 2.15 \text{ Pa} \]

8) What is the laminar sub-layer thickness for Reach 1.

\[ \delta_1 = 0.07 \times 10^{-3} \text{ mm} \]

\[ \delta = \frac{11.6 \sqrt{g h S}}{u} = \frac{11.6 \times 1 \times 1 \times 10^{-6}}{5 \times 0.015} = 0.07 \text{ m}^{-1} \]

Reach 1
- \( S_0 = 1000 \text{ cm/km} \)
- \( h_n = 0.25 \text{ m} \)
- \( n = 0.025 \)

\[ u = \sqrt{ghS} = \sqrt{9.81 \times 0.25 \times 1 \times 10^{-2}} = 0.156 \text{ m/s} \]

Reach 2
- \( S_0 = 20 \text{ cm/km} \)
- \( h_n = ? \)
- \( n = 0.015 \)
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Problem #3 (40%) Sedimentation and River Engineering

Consider a natural channel with a width of 60m, flow depth of 4 m, velocity of 1 m/s, Manning n 0.025, and uniform bed grain size of 0.2 mm. Determine:

9) the settling velocity for 0.2mm sand?

\[ \omega = \sqrt{\frac{gD_o^2}{18\pi \mu}} \]

10) the critical Shields parameter for 0.2 mm sand?

\[ \tau_c = \frac{gD_o^2}{18\mu} \]

11) Sediment discharge from Eng.-Hansen

\[ Q_{de-h} = \frac{50000}{2.65}(\frac{V}{1.65})^{0.5} \left[ \frac{h_s}{(4.5\sqrt{D_o})^{0.5}} \right] \]

12) The mid depth concentration of a 10 m deep channel is \( C_{0.5} = 10 \text{ mg/l} \). If the Rouse number is 2, estimate the concentration 10 cm above the bed.

\[ C_{0.01} = \frac{98100}{2} \text{ mg/l} \]

13) Design the riprap for this channel with side slopes of 1V:3H. Determine the median particle diameter

\[ d_{50} = 1.2 \text{ in} \]

14) Determine the riprap gradation:

\[ d_{20} = 0.6 \text{ in} \quad d_{100} = 2.5 \text{ in} \]

15) Estimate the pier scour depth around a rectangular pier 12 ft long 2 ft wide:

\[ F_a = \frac{V}{\sqrt{g h n}} = 0.16 \quad K_1 = 1.1, \quad K_2 = 1 \]

\[ \Delta z = \frac{2.80}{0.80} \text{ ft} \]

16) Estimate the spillthrough abutment scour depth for a 10 m long abutment

\[ \Delta z = \frac{28.7 \times \text{ft}}{3.28 \times \text{ft/m}} \]

\[ y_s = y \times 4 \times F_2 \]

\[ 0.45 = 4 \times 4 \times 0.16 \times 0.33 \times 0.55 = 8.7 \times 3.78 \times 28 \times \text{ft} \]
Problem #4 (20%) Class Discussion

With reference to the in-class discussion about the Peligre Dam in Haiti, describe in the space below your plan to improve the integrated development of water resources in this country. Please also attach the discussion sheet that you developed with your teammates from the class discussion.