Hydraulics

A. Fluid Properties - $\gamma$, $p$, and $\mu$

B. Hydrostatics
   - piezometric head $h = \frac{P}{\gamma} + z$ = constant
   - manometers $p = p(z)$ only

C. Dynamics
   - be sure to correctly identify control volume (pts. 1 & 2)

1. Continuity Equation:
   \[ \rho_1 v_1 A_1 = \rho_2 v_2 A_2 \text{ for no energy losses/additions} \]

2. Momentum balance:
   \[ F + (P_1 A_1 - P_2 A_2) = \rho \frac{Q(v_2 - v_1)}{A} \]

3. Bernoulli (energy) Equation:
   \[ H = \frac{P}{\gamma} + z + \frac{v^2}{2g} \]

4. Head losses 
   - friction losses: $h_f = f \frac{L}{D} \frac{v^2}{2g}$ based on $R = \frac{L}{D} \frac{v}{d}$ and Moody diagram
   - general losses: $H_L = K \frac{v^2}{2g}$

5. Pumps and turbines: Power = $H_p Q \gamma$

Soil-Water

A. Definitions - $\theta$, $\phi$, $\rho_v$, $\rho_s$ etc. from block diagram of M's and V's

B. Darcy Equation
   \[ q = \text{darcy flux} = \frac{Q}{A} = -K \frac{\Delta h}{\Delta x} \]

   - $K = \text{hydraulic conductivity} = \frac{\text{kpg}}{\mu}$ where $k = \text{intrinsic permeability}$
   - a function of porous media isotropy and homogeneity
   - also a function of $h_c$ or $\theta$ in unsaturated soils

   \[ \frac{\Delta H}{\Delta x} = \text{hydraulic head gradient} \]

   \[ \Delta H = \Delta h + \Delta z, \text{ or } \begin{cases} \Delta H = \Delta h \text{ for horizontal flow} \\ \Delta H = \Delta h + 1 \text{ for vertical flow} \\ \Delta H = \Delta h + \sin \alpha \text{ for flow @ angle } \alpha \text{ to horiz.} \end{cases} \]

C. Unsaturated Flow

   - $\theta (h_c)$ relationship
   - $k (h_c)$ relationship

   Seepage from impoundment example

D. Plant - Water Relations - follow points as given in lecture

\[ Q = \frac{\Psi_{\text{source}} - \Psi_{\text{leaves}}}{\text{Resist}_{\text{source to sink}}} \]

know concept of component potentials