Hydraulics

A. Fluid Properties - γ, ρ and μ

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

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

1. Continuity Equation: $\rho_1 v_1 A_1 = \rho_2 v_2 A_2$ for no energy losses/additions
2. Momentum balance: $F + (P_1A_1 - P_2A_2) = \rho\, Q(v_2 - v_1)$
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 $\mathbf{R} = \frac{\rho\, v\, D}{\mu}$ 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 - θ, ϕ, ρ_b, ρ_s etc. from block diagtram of M's and V's

B. Darcy Equation

$$q = \text{darcy flux} = \frac{Q}{A} = -K\,\frac{\Delta H}{\Delta \ell}$$

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

$-\frac{\Delta H}{\Delta \ell}$ = 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

$$Q = \frac{\Psi_{source} - \Psi_{leaves}}{Resist_{source\ to\ sink}}$$

know concept of component potentials