Solution 125 B

HW 1

Pb 1 (30)

$$w = \frac{V_p}{V_t} = \frac{V_t - 9V_c}{V_t} = 1 - \frac{9V_c}{V_t}$$

w: Total Porousity
V_p: Volume of voids
V_c: Volume of Cylinder
V_t: Total Volume

$$w = 1 - 9 \times \frac{\pi \times (10/6)^2 \times 10 \text{ cm}^3}{10 \times 10 \times 10 \text{ cm}^3} = 1 - 9 \times \frac{\pi}{36} = 1 - \frac{\pi}{4} = 0.2146$$

Pb 2 (30)

w: Total Porousity ε: Void ratio

$$w = \frac{V_p \text{ (Volume of the voids}}{V_t \text{ (Total volume of the medium)}}$$

$$\varepsilon = \frac{V_p \text{ (Volume of the voids)}}{V_s \text{ (Volume of the solid)}}$$

$$V_t = V_p + V_s$$

$$w = \frac{V_p}{V_t} = \frac{V_p}{V_p + V_s} = \frac{V_p/V_s}{(V_p+V_s)/V_s} = \frac{\varepsilon}{\varepsilon + 1} = \frac{\varepsilon}{1+\varepsilon}$$

Pb 3 (10)

μ: Dynamic viscosity $\Rightarrow$ $\nu = \frac{\mu}{\rho}$ ρ: density

ν: Kinematic viscosity

$$Re = \frac{\rho v D}{\mu}$$

Re : unitless

$$[\mu] = \left[\frac{kg}{m^3}\right]\left[\frac{m}{s}\right][m] = \left[\frac{kg}{m\text{-}s}\right]$$

$$[\nu] = \left[\frac{kg}{m\text{-}s}\right] / \left[\frac{kg}{m^3}\right] = \left[\frac{m^2}{s}\right]$$

Pb4

$$\underline{q} = -\underline{\underline{K}}\,\nabla h$$

$$\begin{pmatrix} q_1 \\ q_2 \\ q_3 \end{pmatrix} = -\begin{pmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{pmatrix} \begin{pmatrix} \frac{\partial h_e}{\partial x_1} \\ \frac{\partial h_e}{\partial x_2} \\ \frac{\partial h_e}{\partial x_3} \end{pmatrix} = -\begin{pmatrix} K_{11}\frac{\partial h_e}{\partial x_1} + K_{12}\frac{\partial h_e}{\partial x_2} + K_{13}\frac{\partial h_e}{\partial x_3} \\ K_{21}\frac{\partial h_e}{\partial x_1} + K_{22}\frac{\partial h_e}{\partial x_2} + K_{23}\frac{\partial h_e}{\partial x_3} \\ K_{31}\frac{\partial h_e}{\partial x_1} + K_{32}\frac{\partial h_e}{\partial x_2} + K_{33}\frac{\partial h_e}{\partial x_3} \end{pmatrix}$$