**In The Name of Allah**
**Flow of Fluids through Porous Media**
**HW # 3**
**Due 1398.08.04**

1. From the definition of porosity, show that if a sample of porous material of volume $V_T$ having porosity $\emptyset_T$ is cut into $n$ pieces having volumes $V_i$ , $i = 1,2,\dots,n,$ then

$$\emptyset_T = \frac{1}{V_T}\sum_{i=1}^{n} V_i \emptyset_i$$

Where $\emptyset_i$ , $i = 1,2,\dots,n,$ are the porosities of the pieces. Also consider the case in which the $V_i$ are all equal.

2. A vertical column of sandstone with lateral surface sealed is filled with dilute salt water; permeable electrodes are placed over the ends. Write the equation for the electrical potential difference between electrodes which will prevent the water from draining from the column.

3. Show that if Darcy had performed his experiments in columns sloped at an angle rather than in a vertical column, he still would have obtained the result as that given by its current form.

4. A porous medium is made up of grain particles with a density of 2.65 g/cc, water with a density of 1.0 g/cc, and air. A 1 cc sample taken from the medium has a mass of 2.05 g. If the porosity of the sample is 0.3, determine the water saturation and the water content.

5. Show that if the porous medium is itself compressible, the equation of continuity for mass flow has the form

$$-\nabla \cdot (\rho \hat{v}) + G = \emptyset \left(1 - \frac{c_\emptyset}{c}\right)\frac{\partial \rho}{\partial t}$$

Where $c_\emptyset$ is the pore compressibility and $c$ is the compressibility of the fluid.