PETE 4241 — Mechanical Earth Modeling (Spring 2019)

Homework #1:

Instructions: Homework should be submitted as a zipped folder named "PETE4241_19A_FIRSTNAME_LASTNAME". That zipped folder should contain a PDF write up with the same name, to obtain a grade. Your Excel file or Python code showing the details of your calculations should also be included in the zipped folder.

The given density Barnett shale and GOM well logs do not start from the surface. For the Barnett shale well, assume a density of 1.9 g/cc for the sediments above the first given data point. For the GOM data, the sea floor is at 1000 ft, and we have sediments with a density of 1.75 g/cc above the first given data point. Assume that the acceleration due to gravity is 9.8 m/s^2.

1. Using the given density log data for the Barnett shale well and Gulf of Mexico (GOM) offshore well, compute the following quantities for each given depth:
   i. Vertical stress in MPa (10%)
   ii. Hydrostatic pressure in MPa (10%)
   iii. Gradient of vertical stress in MPa/km (10%)
   iv. Porosity (10%)

2. Create the following plots for the Barnett and GOM wells (with the x-axis above and have depth increase downwards on the y-axis)
   i. A plot of depth versus density (5%)
   ii. A plot of depth versus **vertical stress** and **hydrostatic pressure** (5%)
   iii. A plot of depth versus the gradient of vertical stress in MPa/km (5%)
   iv. A plot of depth versus porosity. Assume that the rock is completely saturated with water, and that the matrix (sedimentary) rock density is 2.7 g/cc, while the density of water is 1 g/cc. (5%)

3. i. Divide the density profile in 2(i) into 5 blocks using the variations in the bulk density values. (5%)
   ii. Within each of these blocks, compute the average density and plot depth versus the blocked density for both the Barnett and GOM wells. (10%)
   iii. Is there any value in blocking the continuous density profile this way? What could we possibly achieve in a MEM by using the blocked density profile instead of the continuous density profile? (5%)

4. i. What is the overburden stress (in MPa) in the Barnett shale well at 5,000 ft? (1%)
   ii. What is the pore pressure (in MPa) in the Barnett shale well at 5,000 ft? (1%)
   iii. What is the overburden stress (in MPa) in the GOM well at 5,000 ft? (1%)
   iv. What is the pore pressure(in MPa) in the GOM well at 5,000 ft? (1%)
   v. What is the overburden stress gradient (in MPa/km) in the Barnett shale well at 5,000 ft? (1%)
   vi. What is the overburden stress gradient (in MPa/km) in the GOM well at 5,000 ft? (1%)
   vii. What is the porosity in the Barnett shale well at 2,500 ft? (1%)
   viii. What is the porosity in the GOM well at 10,000 ft? (1%)

ix. What is the bulk density (in g/cc) in the Barnett shale well at 5,000 ft? (1%)
x. What is the bulk density (in g/cc) in the GOM well at 5,000 ft? (1%)

5. For your assigned well in the Volve field:
   i. Perform all four calculations in question 1 above. Make reasonable assumptions for any missing input values and state those assupmtions. (4%)
   ii. Perform all four calculations in question 2 above. Make reasonable assumptions for any missing input values and state those assupmtions. (4%)
   iii. Perform all four calculations in question 3(i) and (ii) above. **Note that you can divide the density into any reasonable number of blocks.** Make reasonable assumptions for any missing input values and state those assupmtions. (4%)