PGE 392K: Numerical Simulation of Reservoirs

Assignment #10 (PROJECT)
Due Tuesday, November 29 (5% penalty for each late day)

1. (20 points). Adapt your code for two phase flow from Assignment #9 to include capillary pressure and gravity. You should have a function file from assignment #1 that computes capillary pressure (drainage, imbibition, and scanning) and the respective derivatives. You may want to adapt that function to make the function finite (but smooth and continuous) near the residual saturations (alternatively you could force a minimum water saturation to like S_{wr} + 001).

   Recall that capillary pressure appears or is important in a few places, for example, (1) a drainage curve is used to initialize the phase pressures and saturations (you did this in assignment, (2) scanning curve capillary pressure appears in the water saturation equation and also in the gravity vector, G, for the pressure equation, (3) results in different potentials of the phases thus affecting upwinding of relative permeability, and (4) derivative of scanning curve effects β_w, although this has no significant impact except near residual saturations. Gravity is important for (1) initializing the phase pressures and saturations, (2) G for the pressure equation and (3) phase potentials for computing upwinding.

2. (30 points) Use the attached ‘Example.yml’ file or adapt your own to validate your code against the 3×3 example problem included in the powerpoint on canvas. The example problem includes capillary pressure and gravity. It also has non-uniform grids; you may “hard code” in the grid locations of the wells, although it is not difficult to expand your well locations code to work for non-uniform grids.

3. (50 points). Use the attached (or adapt your own) ‘Thomas2.yml’ file to run the simulation for this reservoir and make the plots requested on the ppt template. Note:
   a. The reservoir begins under primary recovery with all wells at constant rate producers.
   b. Constant rate wells are converted to constant BHP (producer) wells when the BHP reaches the bubble point
   c. When the field production rate declines to a limit, the deepest well is converted to a constant rate water injector
   d. Additional wells are converted to constant rate water injectors if they reach 95% water cut
   e. A constant rate injector well is converted to a constant BHP injector is reached
   f. The simulation ends when the last producer reaches 95% water cut or 20 years, which ever comes first.