Assignment 4

Congratulations on your recent appointment as a Trainee Reservoir Engineer! The Senior Reservoir Advisor has an assignment for you: to upgrade an existing 2-D undersaturated oil reservoir material balance simulator to 3-D. The 2-D simulator is currently scripted in a Python file: *mat_bal.py*.
Below is the algorithm that underlies the 2-D simulator.

Cumulative oil produced from a block, in a discretized model, is computed thus:

$$N_p = \frac{NB_{oi}c_e(P_i - P_{now})}{B_o} - - - - - - - - P5$$

- N_p is the cumulative oil produced from a given block.
- N is the initial oil in-place (STOIIP) for each block (assumed constant for all blocks)
- B_{oi} is the initial oil formation volume factor (assumed constant for all blocks)
- c_e is the effective compressibility (assumed constant for all blocks)
- P_i is the initial reservoir pressure (assumed constant for all blocks)
- P_{now} is the current reservoir pressure (varies across blocks depending on proximity to producer well)
- B_o is the current value of the oil formation volume factor (depends on current pressure in a block)

Below is the expression to calculate the B_o value corresponding to a given current pressure:

$$B_o = B_{ob}[1 - c_o(P_{now} - P_b)] - - - - - - - - - - - P6$$

Given a set of parameter (N_p, B_{oi}, B_{ob}, c_e, c_o and P_i) values and a grid of current pressure values, script *mat_bal.py* implements Equations P5 and P6 for each block. Also include statements to sum up and present the total cumulative oil produced from the entire reservoir.

Specifically, the upgrades required of you in this assignment are thus:

- Make provision for discretization along z-axis; i.e. create variable nz.
- In addition to the existing rows and columns '*for*' loops, incorporate a layer '*for*' loop into the script to handle the extra dimension.
- Make provision for varying initial pressure Pi across layers of the reservoir; i.e. Pi is only assumed constant for all blocks in a given layer.
- Make provision for varying initial oil formation volume factor, Boi across layers of the reservoir; i.e. Boi is only assumed constant for all blocks in a given layer.
- Fetch and edit the *mat_bal.py* script (hosted on *TTOWG/ PET328_Class_2022* GitHub repository) to perform these upgrades.
- Save the upgraded script (with same name), commit and push it to your GitHub repository. Submit the URL to your copy of the repository.

You may test your script with the following data:

Parameters

$n_x = 4$
$n_y = 3$
$n_z = 2$
$N = 200{,}779.157$ STB
$P_b = 3330$ psi
$B_{oi} = 1.2417$ RB/STB
$B_{ob} = 1.2511$RB/STB
$c_e = co = 0.0000113\ psi^{-1}$
Layer 1:
$P_i = 4025$ psi; Bo = 1.2410
Layer 2:
$P_i = 4000$ psi; Bo = 1.2417

Current pressure values in grid:

Layer 1

4018.913	4018.875	4018.802	4018.699
4018.905	4018.866	4018.79	4018.682
4018.89	4018.848	4018.765	4018.648

Layer 2

4016.380	4016.343	4016.270	4016.167
4016.373	4016.334	4016.258	4016.150
4016.448	4016.316	4016.233	4016.116