EOSC 213 Quiz 2 *Name:*____________________ *ID:*______________

Instructions

- Read the examination before beginning.
- Answer questions on the paper, and if provided, write the final answer in the designated space at the end of the question.
- Be as precise and clear as possible – you will lose points if your answer is correct but not comprehensible.
- Point form answers are acceptable.
- If you get stuck, make an assumption, state what it is and try to carry on.
- This is a closed book examination.
- Calculators are allowed.
- You have 30 minutes for the examination. No extensions will be permitted.
- This exam consists of **2 pages**. The last page contains formulas and tables. GOOD LUCK!

15 (+2 bonus) points total.

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1) **1 point**. **True** or **False** (circle your response): *This sentence is false.*

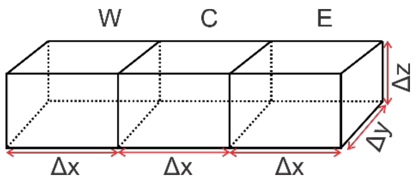
2) **1 point**. Show by analyzing the dimensions that the following expression for the area of a circle is wrong: $A = \pi d/2$ where A is area of the circle and d is the diameter of the circle.

$$A\ [L^2] = \frac{\pi[\cdot]d[L]}{2}$$

Just need to show that the dimensions of left and right side are different. No points if they don't get one of the dimensions right.

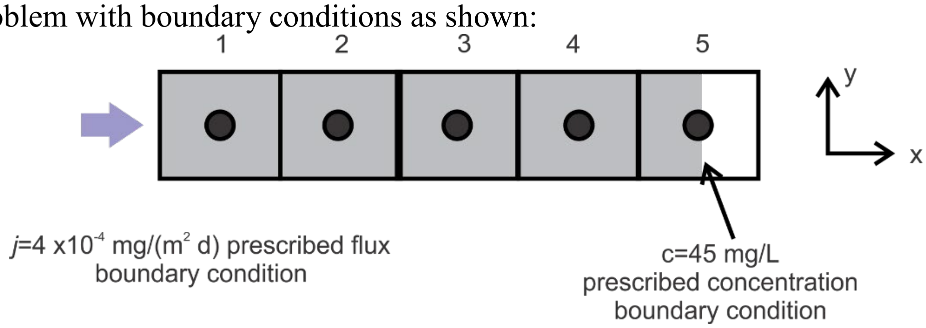
3) **6 points**. Write a python function to evaluates the function
   $f(x, y) = ax^2 + by^3 + c$
   Your function should
   a) Set default values of $a = 0,\ b = 0,\ c = 0$
   b) Require both x and y
   c) Work for x and y as scalars, python lists, or numpy arrays

4) **4 points**. Write the general finite-volume W-C-E stencil for 1-dimensional, steady-state diffusion in porous media, without sources or sinks, in terms of the concentrations c_C, c_W, c_E, the gridblock dimensions $\Delta x, \Delta y, \Delta z$, the diffusion coefficient $D\left[\frac{L^2}{T}\right]$, and porosity θ, and where Fick's law in porous media is given as $j_x = -D\theta\frac{\partial c}{\partial x}, j_y = -D\theta\frac{\partial c}{\partial y}, j_z = -D\theta\frac{\partial c}{\partial z}$.



$$\left(D\theta\frac{c_W - c_C}{\Delta x} + D\theta\frac{c_E - c_C}{\Delta x}\right)\Delta y\,\Delta z = 0$$

5) Consider the following 1-D finite-volume grid with 5 gridblocks numbered as shown for a 1-D diffusion problem with boundary conditions as shown:



a) **4 points**. What is the **net mass that enters or leaves** gridblock 3 **over a time interval** $\Delta t = 2.5\ h$, if the concentrations in gridblocks 2, 3 and 4 over that time interval are $c_2 = 63.5\ \frac{mg}{L}, c_3 = 54.8\frac{mg}{L}, c_4 = 50.1\ \frac{mg}{L}$, where $\Delta x = 2.0\ m,\ \Delta y = 1.5\ m,\ \Delta z = 1\ m$, the diffusion coefficient is $D = 7 \times 10^{-9}\ m^2/s$, the porosity is $\theta = 0.3$.

Net flux **rate** just $J_{23} + J_{43} = \left(D\theta\frac{c_W - c_C}{\Delta x} + D\theta\frac{c_E - c_C}{\Delta x}\right)\Delta y\ \Delta z$ so the net mass over Δt =2.5 hrs is $\left(D\theta\frac{c_W - c_C}{\Delta x} + D\theta\frac{c_E - c_C}{\Delta x}\right)\Delta y\ \Delta z\ \Delta t$

Mass from 2 to 3: $D\theta\frac{c_W - c_C}{\Delta x}\Delta y\ \Delta z\ \Delta t$ = 9.25e-5 mg

Mass from 4 to 3 = - 5.0e-5 mg

Net mass into 3: 4.25e –5 mg

Dth	x	y	z	j bc	Dth y z/x
2.1E-09	2	1.5	1	4.63E-09	1.575E-09

Question	j		mass		
from 2 to 3	6.8513E-09	flux 2 to 3	9.24919E-05		
from 4 to 3	-3.701E-09	flux 4 to 3	-4.99669E-05		
net	3.15E-09	- net rate flux into gridblock 3 in mg/(m^2 s)			
mass over 2.5 h	4.2525E-05	answer in (mg) over 2.5 h		4.2525E-05	

b) **2 points**. Is the system in steady state? Explain. Not at steady state because the mass in the gridblock is changing over time.