CBE 263 Practice Exam

Material since Exam 1 | Python, problem solving, and computational tools

Instructions. Show your work. For code questions, write valid Python where requested and briefly explain what it does. Assume NumPy, SciPy, and Pint are available when needed. This practice exam has 16 questions across the eight requested topic areas.

Based on the posted CBE 263 lecture notes and homework, including Homework 8.

Name: _____ **Date:** _____

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1. Terminal

1.1 You are in a directory containing `hw09.ipynb` and a folder named `data`. Write terminal commands to:
a. Print the current working directory.
b. List the files, including hidden files.
c. Change into `data`.
d. Return to the parent directory.

1.2 You ran a Python script from the wrong directory and got a “file not found” error for `measurements.csv`. Describe two commands you could use to check where you are and whether the file is in that directory. Then give one command to run `analysis.py` using Python.

2. Vim

2.1 In Vim, you are in normal mode. Give the keystrokes to:
a. Enter insert mode before the cursor.
b. Save the file and continue editing.
c. Delete the current line.
d. Search forward for the word `temperature`.
e. Quit without saving.

2.2 You opened a file in Vim and accidentally typed several characters into it. Explain how to return to normal mode, undo the last change, and save the file. Why does pressing `i` have a different effect in normal mode than in insert mode?

3. Python Functions

3.1 Write a function named `pressure_drop` that accepts `flow_rate` and `resistance`, calculates their product, and returns the result. Then call it with `flow_rate = 2.5` and `resistance = 8`.

3.2 Consider this code:

```
def adjust(value, factor=2):
    result = value * factor

x = adjust(5)
print(x)
```

What does the code print? Modify the function so that it returns the calculated result, then add a call that uses a factor of 3.

4. Conditionals

4.1 Write an `if`/`elif`/`else` block that assigns a label based on `temperature`: `"cold"` if it is below 273 K; `"moderate"` if it is from 273 K up to, but not including, 373 K; and `"hot"` if it is 373 K or higher.

4.2 What does this code print for `x = 4`? Explain why. Then change the code so that it prints `"medium"` only when 2 < x <= 5.

```
if x > 5:
    print("large")
elif x > 2:
    print("medium")
else:
    print("small")
```

5. Solving Linear Equations

5.1 Write the linear system 3x + 2y = 12 and x - y = 1 in matrix form A x = b. Then write NumPy code using `np.linalg.solve` to calculate x.

5.2 A classmate writes:

```
x = np.linalg.solve(b, A)
```

Identify the error and correct the line. What dimensions must A and b have for a system of n equations in n unknowns?

6. Solving Nonlinear Equations

6.1 Rewrite the equation x^2 - 5x + 4 = 0 as a Python function f(x) whose root solves the equation. Identify both roots by inspection. Why might a numerical solver need an initial guess to find one of them?

6.2 You want to find a root of f(x) = x^3 - x - 1 between 1 and 2.
a. Show that the interval brackets a root by evaluating the signs of f(1) and f(2).
b. Describe one step of the bisection method.
c. In a numerical solver, what is the difference between an error tolerance on the root estimate and a tolerance on the function value f(x)?

7. Markdown and LaTeX

7.1 Write Markdown source that produces a level-two heading titled “Results”, a bulleted list containing “Pressure”, “Temperature”, and “Flow rate”, and the inline equation PV = nRT.

7.2 Write LaTeX for the displayed equation dC/dt = -kC. Then write LaTeX for the piecewise function f(x) = x^2 when x < 0, and f(x) = 2x + 1 when x >= 0.

8. Units with Pint

8.1 Write Python code that creates a Pint `UnitRegistry`, defines a length of 3 feet and a time of 2 seconds, and calculates the speed in meters per second. Include the conversion step.

8.2 A calculation attempts to add 3 meters to 4 seconds. What happens, and why? Write one valid Pint expression that calculates the total distance traveled at 12 meters/second for 5 seconds, and state the result with units.