CEE 3804 Exam2 (Spring 2026)

Computer Applications in Civil Engineering

Open Book and Notes (Take Home - Due April 27, 2026)

Your Name _____

Your Signature * _____

* The answers in this exam are the product of my own work. I certify that I have not received nor I have provided help to others while taking this examination.

Directions:

Solve the problems. Copy and paste the VBA/MATLAB code and solutions such as graphs in a Word Document and convert to a single PDF file. **Make sure your code is not too small for me to be able to read it.** Minimum acceptable font size 10.

Problem 1 (30 points)

Civil engineering undergraduate students collected airport noise data in the summer of 2015 as part of a study abroad program (see Figure 1). Airport noise is important to mitigate environmental impacts around airports.

Figure 1. Virginia Tech students collecting airport noise data at the Punta Cana International Airport. A second group of students collected noise levels at the airport ramp. That data is provided to you.

The noise level data collected was recorded as a function of time (see Figure below). A data file with the data collected is provided. The information in the file includes the time of day of the recording (in decimal hours) and the A-weighted equivalent continuous sound level (Called Noise level) in decibels - a measure of the noise produced by the aircraft. A screen capture of the data provided is shown below.

	A	B	C
1	Day	Time of Day (hrs)	Noise Level (dBA)
2	1	5.5067	48.1
3	1	5.5069	51.01
4	1	5.5072	52.43
5	1	5.5075	51.54
6	1	5.5078	51.01

Figure 2. Noise Data Collected at the Ramp at Punta Cana Airport by Virginia Tech Students.

a) Create a Matlab script to read the data. Label the variables appropriately and include their units as part of the variable name.

b) Add code to the Matlab script created in part (a) to plot the noise levels (as a function of time) recorded by the students. Use the subplot command to partition the figure into two plots. One for Day 1 and one for Day 2. Comment on the observed patterns. The time is in the x-axis. Noise level is on the y-axis.

c) Calculate the mean and the standard deviation of the Noise Level values recorded by the instrument on **Day 1**.

d) Create a histogram of the Noise Levels recorded on Day 1. What kind of distribution do you see at the airport ramp noise levels?

e) Find the number of times (in Day 1) when the noise level exceeds 65 dBA. Estimate the total time people working at the ramp may be exposed to 65 dBA or higher.

Problem 2 (35 points)

The ACME company makes a $1050 profit on every metric ton of high-strength concrete mix produced and delivered. The company makes $980 on every metric ton of standard-strength concrete mix produced and delivered. After formulating the problem as an optimization problem to maximize the revenue for the ACME company, the engineers produce the following **constraint equations** that account for production and delivery constraints.

$x_1 + x_2 <= 545$

$x_1 + 1.6x_2 <= 800$

$1.4x_1 + x_2 <= 705$

$x_1, x_2 >= 0$

Where:

x_1 is the amount of high-strength concrete produced and delivered

x_2 is the amount of standard-strength concrete produced and delivered

a) Convert the problem into the **standard (canonical) form** to be solved by hand using the Simplex Method. Write down the transformed equations and add variables as needed.

b) Plot the constraint equations using Matlab. Show me you Matlab code and the plot. Label the three constraint equations and label using the legend in the plot.

c) Find the optimal solution to the problem by hand using the Simplex Method (tables and row operations) explained in class. Indicate the numerical values of all decision variables in every table. Indicate the value of the objective function Z in every table. This task requires calculations and row operations and you need to show me your row operations clearly.

d) Solve the problem using Excel Solver. Verify the solution obtained in part (c).

Problem 3 (35 points)

A civil engineering company performs an experiment to predict the productivity of a new 0.75 cubic meter bucket capacity excavator. Figure 2 shows measured cycle times for the excavator. The excavator cycle time includes four phases: digging, swinging (loaded), dumping, and swinging (unloaded) back to digging position.

Measurement	Cycle Time (seconds)
1	30.4
2	30.9
3	28.7
4	28.3
5	32.8
6	33.9
7	30
8	34.2

Figure 2. Sample Excavator Cycle Times Measured at a Construction Site.

The basic equation to estimate the productivity (called production rate - P_R) of the excavator is:

$$P_R = \frac{3600 * C_B * E_f}{T_{cycle}}$$

Where:

P_R is the production rate of the excavator (cubic meters/hr)

C_B is the bucket capacity of the excavator (cubic meters)

E_f is the efficiency factor of the excavation process (dimensionless)

T_{cycle} is the excavator cycle (in seconds)

The formula to estimate the cost of the excavator is:

$$C_{vol} = \frac{P_R}{C_{hr}}$$

P_R is the production rate of the excavator (cubic meters/hr)

C_{vol} is the unit cost of moving material with the excavator ($/cu. Meter)

C_{hr} is the cost per hour to use the excavator ($/hr)

a) Create a **function in Matlab** to estimate the production rate (P_R) and the unit cost of moving material (C_{vol}) with the excavator as a function of parameters C_B, E_f, T_{cycle}, and C_{hr}. Your function produces two outputs and accepts four inputs.

b) Create a **separate Matlab script** to read the field data containing values of T_{cycle} provided in the Excel file. The Matlab script calls the function created in part (a) to estimate the production rate (P_R) associated with every measured cycle time T_{cycle} in the Excel file provided. The function also return the unit cost of moving material with the excavator. Ran the script that calls the function assuming an efficiency factor (E_f) of 0.86 and the excavator cost is $150/hour.

c) Add code to the Matlab script created in (b) to plot the excavator cycle (x-axis) versus production rate (y-axis). Use Marker Size 10 and blue circular markers in the plot.

d) Add more code to the Matlab script and perform a polynomial fit of the data (as plotted in part c) using a second order polynomial in Matlab. Display the polynomial coefficients in the Command Wind.