CEE 3804: Computer Applications in Civil Engineering Spring 2012

Final Exam (2 Hours)

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Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

____ (your signature)

Write your solutions in a single MSWord file. **Create a PDF file**. Cut and Paste all your answers using screen captures. Show all your work. Label your file with your last name and CEE3804. Email your solutions to vuela@vt.edu and tao81@vt.edu. In the email header use the words CEE 3804 Quiz.

Problem 1 (25 points)

A construction company has determined the hourly truck driver staffing demands for a paving project. The company wants to complete the project soon but at the same time with minimum staffing cost. Table 1 illustrates the staffing needs estimated by the company .

Table 1. Estimated Truck Driver Staffing Needs for a Project.

Hours	Truck Drivers Needed in the Period
12 AM to 6:00 AM	20
6:00 AM to 11:00 AM	12
11:00 AM to 3:00 PM	16
3:00 PM to 9:00 PM	18
9:00 to 12:00 AM	20

Assume that drivers work eight-hour shifts per day. Drivers can start at any hour of the day and they will be paid $300 per day. The objective of creating a linear programming problem is to minimize the number of drivers employed by the company to complete the job and thus minimize the total cost.

Let x_i be the set of decision variables define the optimization problem. In particular,

x_1 be the number of drivers that start work at 12:00 AM (midnight)

x_2 be the number of drivers that start work at 1:00 AM

...

x_{24} be the number of drivers that start work at 11:00 PM

Our objective function is to minimize the cost of the operation so that the product of the cost per driver and the number of drivers is a minimum. Let C be the cost per day per driver.

a) Formulate the objective function (Z) of the linear programming problem to minimize the total cost of the drivers per day.

b) Formulate the **Linear Programming problem constraints** so that for every hour of the day (24 hours), the number of drivers available satisfies the truck driver needs stated in Table 1. For example, for hour 12:00 AM to 1:00 AM the sum of the drivers working (i.e., decision variables x_i) should be equal or greater than 8 (see Table 1). Repeat other constraints for each hour of the day.

c) Solve the problem using Excel Solver. Find the minimum number of drivers needed. Specify the hours when the drivers are expected to report for work and state the number of drivers in starting in the *ith* hour. Calculate the minimum cost per day. Comment on the results obtained.

Problem 2 (25 points)

Array x contains five columns and **an unknown number of records**. The array contains information about each site as shown below. The file is a tab-separated text file between the columns. The following data is provided below.

Column 1 : Excavation site

Column 2 : Elevation (meters)

Column 3 : Average temperature of hottest month (deg.) at the excavation site

Column 4 : Latitude (deg.)

Column 5 : Longitude (deg.)

Table 2. Sample Excavation Site Records.

Lynchburg	1238	27.5	38.34	-87.35
Roanoke	1235	18.6	38.67	-87.50
...	...	...	...	...
Bedford	1356	30.5	39.56	-88.30

a) Create a basic Matlab script to read this file. If you want to test your program you can always use the three records in Table 2.

b) Determine the size of the array using known Matlab commands and calculate the average temperature of the hottest month considering all data points.

c) Write a simple Matlab code to determine the number and names of the sites whose average temperature exceed 20 deg. C.

Problem 3 (25 points)

An engineer wants to know the maximum deflection of a beam subjected to a single load. The equations for the beam deflection are given below as a function of several beam parameters.

```
% Beam parameters:

% W = 4000 lb (applied load) in pounds
% a = 150 in (distance to applied load) in inches
% b = 100 in (distance from applied load to beam end) in inches
% L = a + b (length of beam) in inches
% I = 120 in-in-in-in (Beam moment of inertia) in in-in-in-in
% E = 29e6 lbf/in-in (Modulus of Elasticity)
% x = station distance form beam support (inches)

% Calculation of the Reaction forces

R = W * (3*b^2*L-b^3) / (2*L^3);     % reaction at support
R1 = W * (3*a*L^2-a^3) / (2*L^3);    % reaction at wall


if x < a
    Deflection = 1/ (6*E*I) *(3*R *L^2 * x - R * x^3 - 3 *W *(L-a)^2 * x);
else
    Deflection = 1/ (6*E*I) *(R1 *(2*L^3 -3*L^2*x + x^3) - 3*W*a*(L-x)^2);
end
```

a) Can we use Excel Solver to find the maximum deflection of the beam? Explain how to do it but do not solve using Solver.

b) Develop a simple Matlab function to find the deflection of the beam for a given value of x and values of the remaining beam parameters.

c) Use the function developed in Part (b) to find the station with maximum deflection.

Problem 4 (25 points)

An engineer needs to calculate the area under the curve made by the two vectors shown below:

```
station=[0 10 20 30 40 50 60];    % meters
elevation = [0 12 27 34 29 13 0];% meters
```

a) Plot the station vs elevation data provided
b) Create a Matlab script or function (your choice) to calculate the area under the elevation-station curve. Your script (or function) should display the result in the command window of the total area under the curve. Display the units of the area under the curve as well. In solving this problem you are allowed to use either Newton-Cotes or Trapezoidal rule methods.