CEE 3804: Computer Applications for CEE | Spring 2012

Quiz 2

Date: March 29, 2012 | Instructor: Trani

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 Name ______Solution Key

Your Signature ____

Write your solutions in a single Word file and **then 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 PDF file with solutions to vuela@vt.edu and tao81@vt.edu. In the email header use the words **CEE 3804 Quiz**.

Problem 1 (40 Points)

A Geotechnical engineer gives you a file with comma-delimited data on soil samples collected at three counties in Virginia. The data contains the following fields:

Column 1 = Soil sample (a sequence of letters and numbers)

Column 2 = County where sample was collected (the name of county is a string)

Column 3 = Soil sample California Bearing Ratio - CBR (dimensionless value between 0-100) - compares the stiffness of the soil compared to crushed stone which has a CBR value of 100.

A sample of the file is shown below.

Montgomery267334,Montgomery,13.91927865

Roanoke474683,Roanoke,16.47805669

Radford721316,Radford,17.2867411

Radford674358,Radford,12.61586975

Montgomery694735,Montgomery,16.88321812

Roanoke82912,Roanoke,14.46352245

Montgomery629851,Montgomery,18.71900252

a) Create a script in Matlab to read the data using the t**extscan** command.

```
% Script to study soil samples from a comma delimited data file
% Toni Trani
% March 29, 2012

clear; clc

% Read the data. The format of the data read is three columns seperated by commas as follows:

% Montgomery267334,Montgomery,13.91927865
% Roanoke474683,Roanoke,16.47805669
% Radford721316,Radford,17.2867411
% Radford674358,Radford,12.61586975
% Montgomery694735,Montgomery,16.88321812
% Roanoke82912,Roanoke,14.46352245
% Montgomery629851,Montgomery,18.71900252

% Column 1 = Soil sample (a sequence of letters and numbers)
% Column 2 = County where sample was collected (the name of county is a string)
% Column 3 = Soil sample California Bearing Ratio - CBR (dimensionless value between 0-100) -
%            compares the stiffness of the soil compared to crushed stone which has a CBR value of 100.

% Task (a) - Create a script in Matlab to read the data using the textscan command.

fid = fopen('geotechData_noheaders.csv');                    % open the file (Matlab assigns a file ID)
readData = textscan(fid, '%s %s %f', 'delimiter', ',');      % read six columns with two strings and a floating point
fclose(fid)                                                  % closes the file that we opened in the previous line

% Define new variables before doing the analysis

soilSample = readData{1};
countyOfSample = readData{2};
cbrValue = readData{3};
```

b) Improve the script created in (a) to find the number of samples collected at each one of three counties: Montgomery, Radford and Roanoke.

```
% Task (b) - Improve the script created in (a) to find the number of samples collected at each one of three
% counties:  Montgomery, Radford and Roanoke.

% Two approaches are possible:

% a) if all distinct counties are known you can create an array with counties and then compare each record
% to the list of counties.

% b) You can let Matlab identify the unique names of counties in the data.
% This requires a command called "unique"

counties ={'Roanoke' ; 'Montgomery'; 'Radford'};       % creates an array of three counties sampled

uniqueCounties = unique(countyOfSample);            % alternative method to get "unique" counties

% Compare the string variable "counties" with the variable
% "countyOfSample".
% I use the strcmp command to compare the string variables
% The resulting "pointer variables" contain the indices of zeros/ones  to indicate if the sample comes
% from the county in question (a one). If not a zero is assigned.

indicesOfSoilSamples_fromRoanoke = strcmp(counties(1),countyOfSample);
indicesOfSoilSamples_fromMontgomery = strcmp(counties(2),countyOfSample);
indicesOfSoilSamples_fromRadford = strcmp(counties(3),countyOfSample);

noSamplesFromRoanoke = sum(indicesOfSoilSamples_fromRoanoke);
noSamplesFromMontgomery = sum(indicesOfSoilSamples_fromMontgomery);
noSamplesFromRadford = sum(indicesOfSoilSamples_fromRadford);

% Display the results

disp(['No. of samples from Roanoke County = ', num2str(noSamplesFromRoanoke)])
disp(['No. of samples from Montgomery County = ', num2str(noSamplesFromMontgomery)])
disp(['No. of samples from Radford County = ', num2str(noSamplesFromRadford)])
```

```
No. of samples from Roanoke County = 403
No. of samples from Montgomery County = 277
No. of samples from Radford County = 320
```

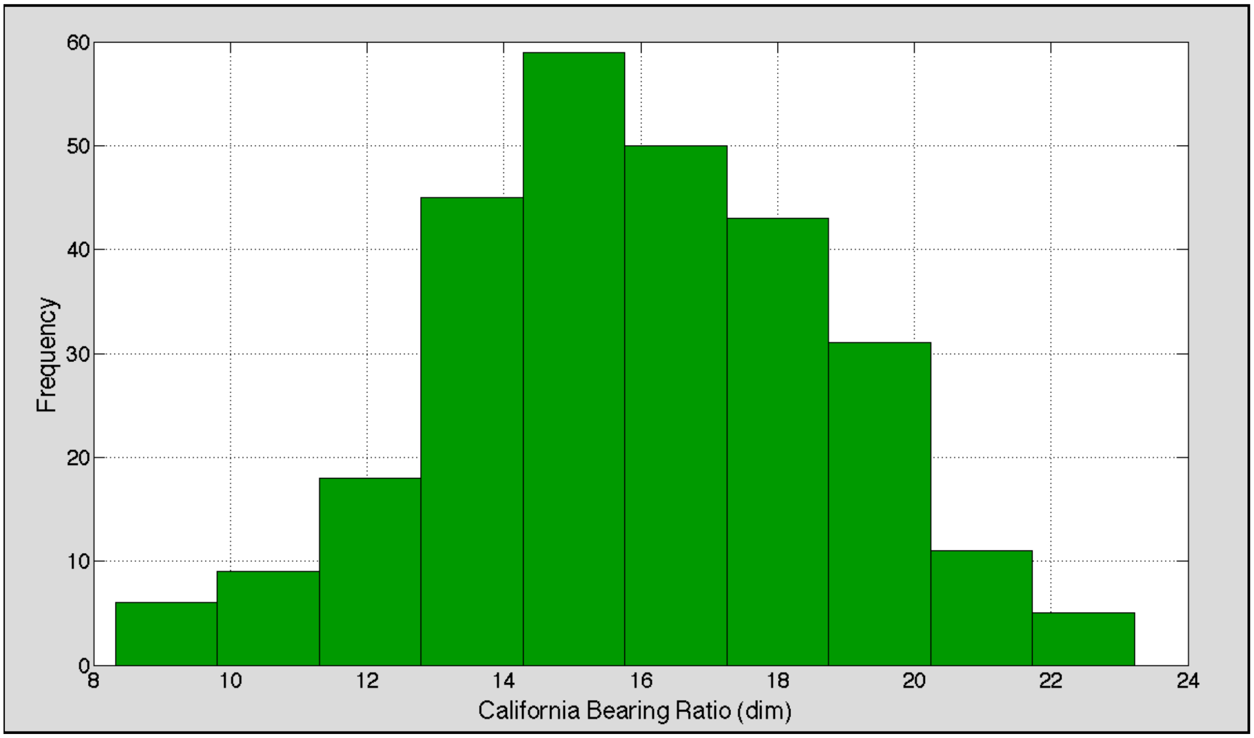
c) Write code to save the numeric values of CBR for the samples collected at Montgomery County in a separate variable called CBR_Montgomery_County.

```
% Task (c) - Write code to save the numeric values of CBR for the samples collected at Montgomery
% County in a separate variable called CBR_Montgomery_County.

CBR_Montgomery_County = cbrValue(indicesOfSoilSamples_fromMontgomery);
```

d) Plot a histogram of all the values of CBR for samples collected at Montgomery County. Label the histogram appropriately.

```
% Task (d) - Plot a histogram of all the values of CBR for samples collected at Montgomery County.
% Label the histogram appropriately.

hist(CBR_Montgomery_County)
xlabel('California Bearing Ratio (dim)')
ylabel('Frequency')
grid
```

The plot produced is shown below.



Problem 2 (30 Points)

A formula to estimate the noise generated by a subway is,

$$L_{eq} = K_{ref} + 10\log(N_{cars}) + 22\log\left[\frac{v}{32}\right] + 13\log(q)$$

where:

log is the base (10) logarithm which in Matlab is **log10**.

L_{eq} = equivalent noise level (decibels in scale A - dBA)

K_{ref} = reference sound exposure level (decibels - dBA)

N_{cars} = number of cars in the train

v = train speed (mph)

q = hourly average train volume (trains per hour)

a) Write a **Matlab script** to calculate the value of L_{eq} given values of v (speed), K_{ref} (sound exposure level), N_{cars} (train cars), and hourly train volume (q). The values of the four input variables are to be entered in the Matlab script as inputs.

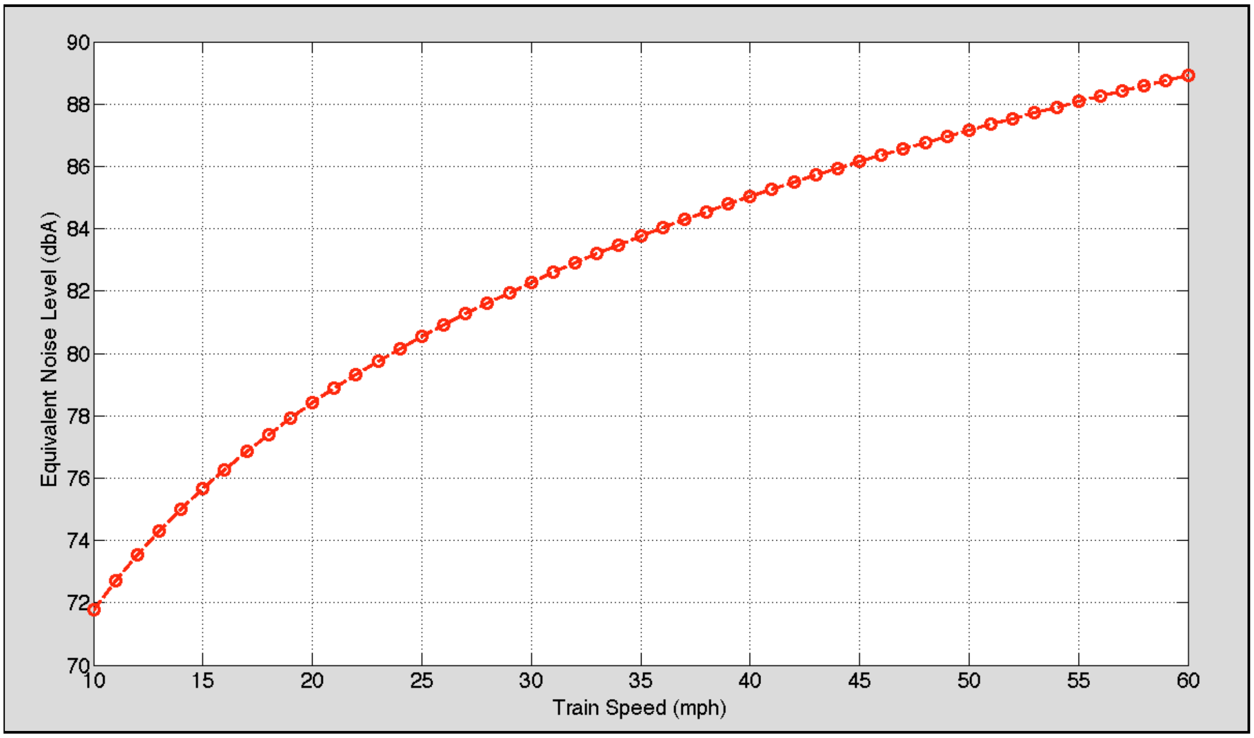
```
% Script to predict the noise generated by a mass transit system
% T. Trani
% March 29, 2012

clear
clc

% Equation to use is:
% Leq = Kref + 10* log10(Ncars) + 22 * log10 (trainSpeed/32) + 13 * log10(trainVolume)

% Write the inputs to the program:

Kref = 58;              % reference sound exposure level (dbA)
Ncars = 10;             % number of cars
trainVolume = 14;       % hourly train volume
trainSpeed = 10:1:60;   % train speed (mph)

% Calculate the equivalent noise level (decibels)

Leq = Kref + 10* log10(Ncars) + 22 * log10 (trainSpeed/32) + 13 * log10(trainVolume);
```

b) Test your **Matlab script** of part (a) to estimate the values of L_{eq} using the following values: the train has 10 cars, the hourly train volume is 14 trains/hr and the reference sound exposure level value of 58 dBA. The speed of the train is a vector ranging from 10 to 60 mph.

This is shown above by defining an array of values for “trainSpeed” ranging from 10 to 60 mph.

c) Plot the speed (x-axis) vs. L_{eq} (y-axis).

```
% Plot the results obtained

figure
plot(trainSpeed,Leq,'o--')
xlabel('Train Speed (mph)','fontsize',20)
ylabel('Equivalent Noise Level (dbA)','fontsize',20)
grid
```



90
88
86
84
82
80
78
76
74
72
70
Equivalent Noise Level (dbA)
10
15
20
25
30
35
40
45
50
55
60
Train Speed (mph)

Problem 3 (30 Points)

Table 1 contains the recommended size of gutter diameters and roof drainage areas for a rainfall intensity of 100 mm/hr. These values are used in the construction of houses to avoid water accumulation on the roof.

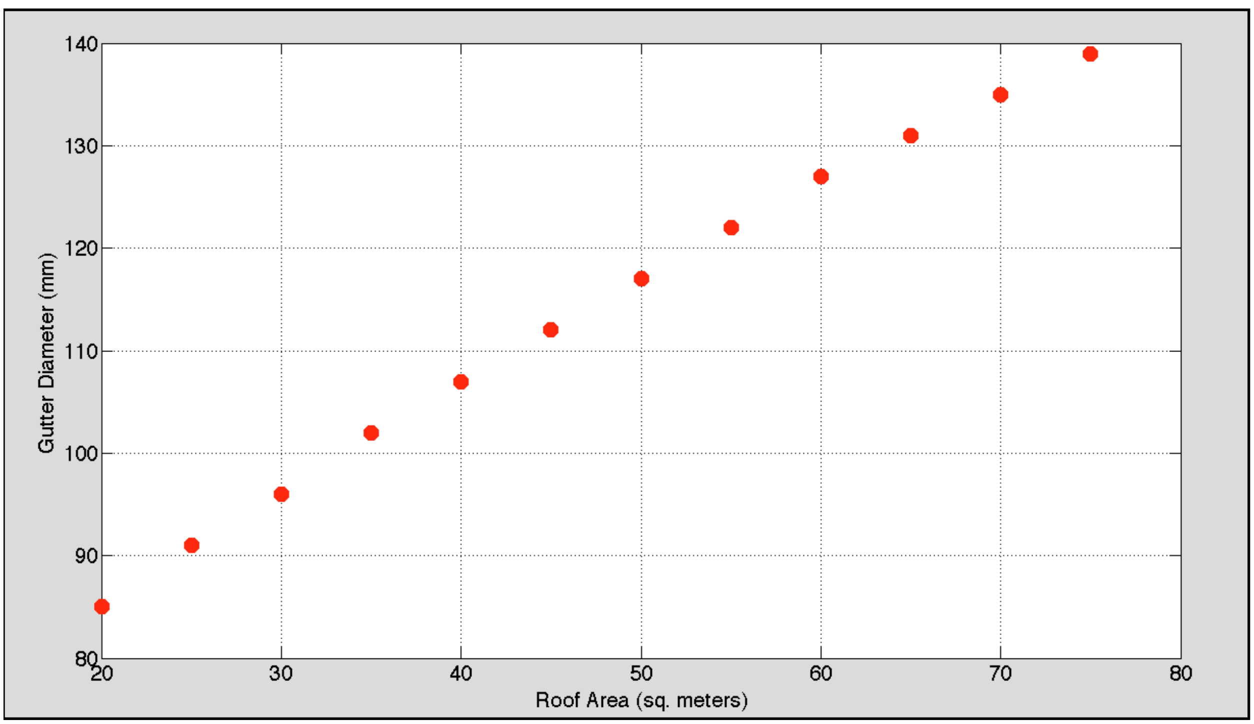
Roof Area Drained with Gutter Slopes (0.5%) (sq. meters)	Guttering Diameter (mm)
20	85
25	91
30	96
35	102
40	107
45	112
50	117
55	122
60	127
65	131
70	135
75	139

a) Create two vectors in Matlab that contain the data and plot. Just copy and paste the data if needed.

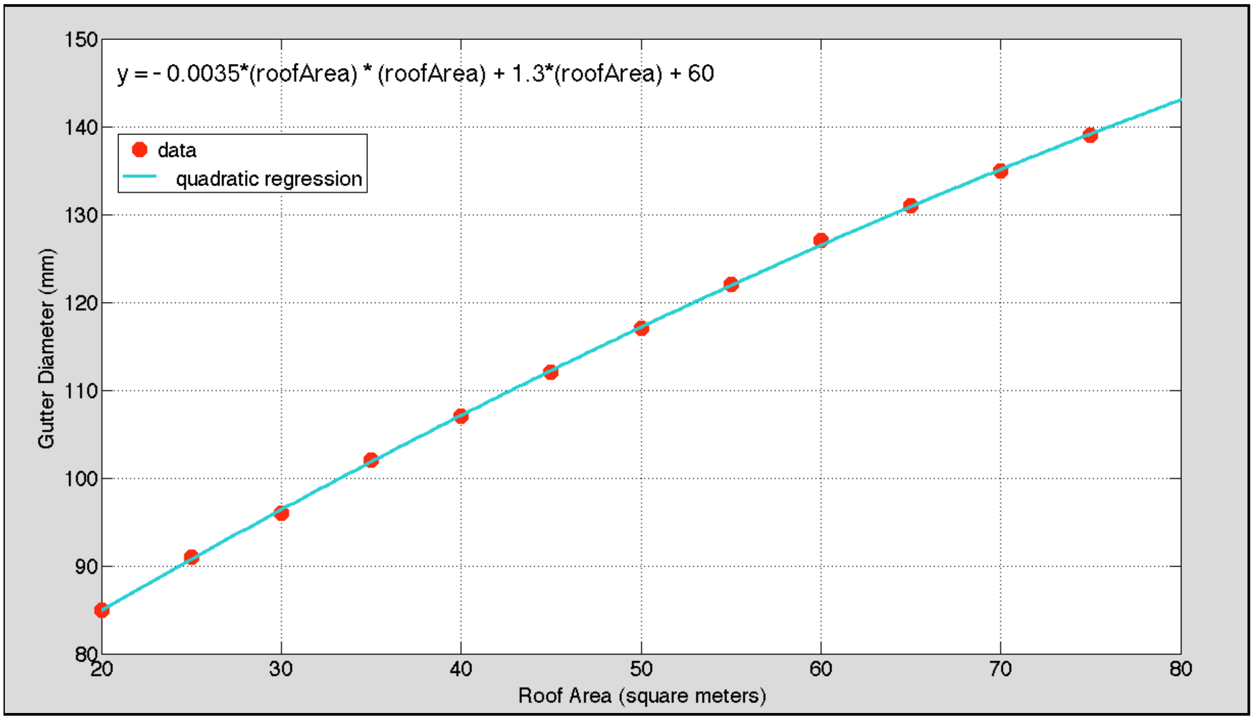
```
% Script to plot and study the relationship between roof area
% to be drained and gutter diameter.

% T. Trani
% March 29, 2012

clear
clc

% Load the data (already in numeric form)

load gutter_diameter_data.txt

% Define variables

roofArea = gutter_diameter_data(:,1);
gutterDiameter = gutter_diameter_data(:,2);

% Make a plot

figure
plot(roofArea,gutterDiameter,'o')
xlabel('Roof Area (sq. meters)','fontsize',20)
ylabel('Gutter Diameter (mm)','fontsize',20)
grid
```

b) Use the interactive features of Matlab to find if a linear of quadratic relationship fits the data. Briefly explain.

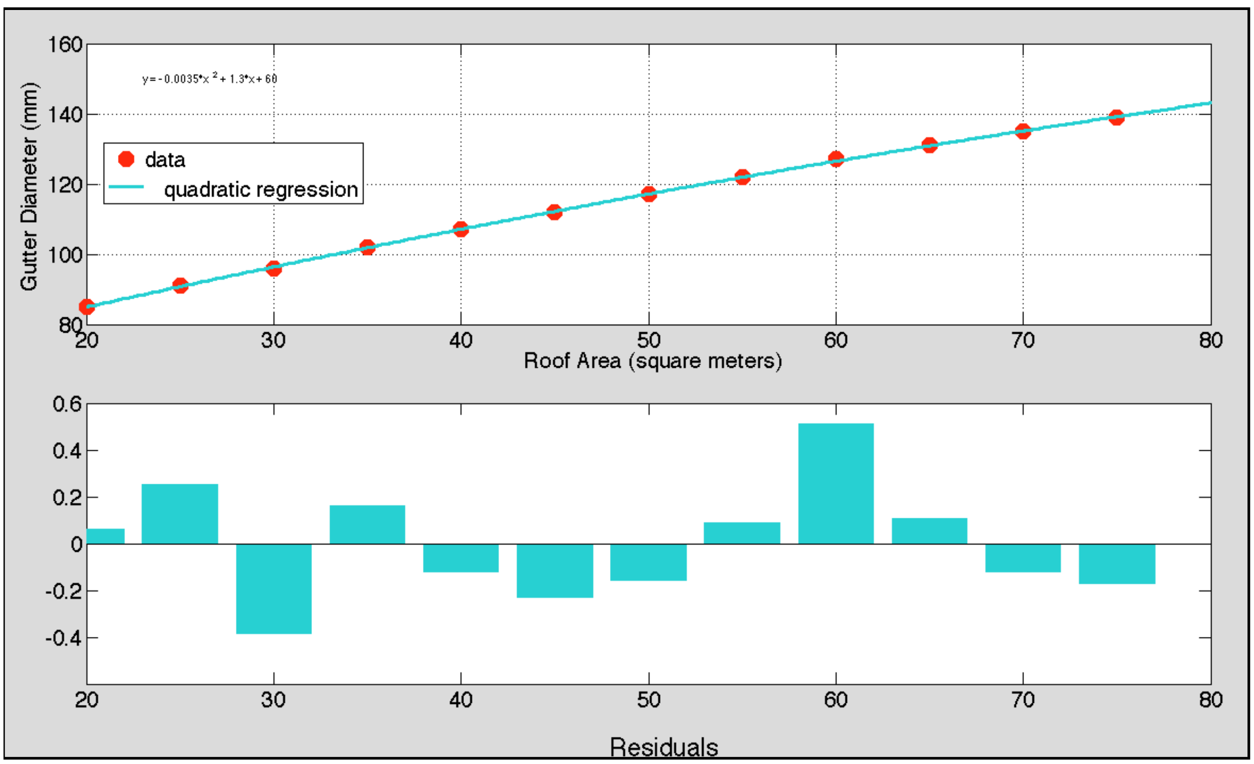
The plot generated by the script is shown below.



Using the interactive features of Matlab we approximate the relationship using a second order polynomial (quadratic).



Adding the residuals we obtain the following plot.



The residuals indicate the distance along the y-axis from the regression line to each point. For example, the plot below shows the residual for a roof area of 60 square meters. This can be verified in the plot show in the previous page.