Quiz 2

Write your solutions in a single Word document and convert to 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 the solution to <u>vuela@vt.edu</u> and to Carol Liang (<u>yqliang@vt.edu)</u>.

Problem 1 (40 Points) - Show all your code

You are given the task to calculate the volume of earth material to be removed from a hill during the construction of a new road project. Figure 1 shows surveyed elevation points (red dots) on the hill contour where the cut is to be made. The elevations and stations of the surveyed points are shown below.

station = [0 10 20 30 40 50 60 70 80 90 100];   % in meters

elevation = [0 14 21 25 26 25 22 18 13 8 0]; % in meters

a) Create a Matlab script to approximate the hill contour shown in Figure 1 using a 4th order polynomial. Write down the coefficients of the polynomial.

elevation = A (station)^4 + B (station)^3 + C (station)^2 + D (station) + E

b) Add to the script created in part (a) the necessary Matlab code to estimate the area of the cut to be made. Use the numerical integration method that employs the Newton-Cotes method in Matlab.

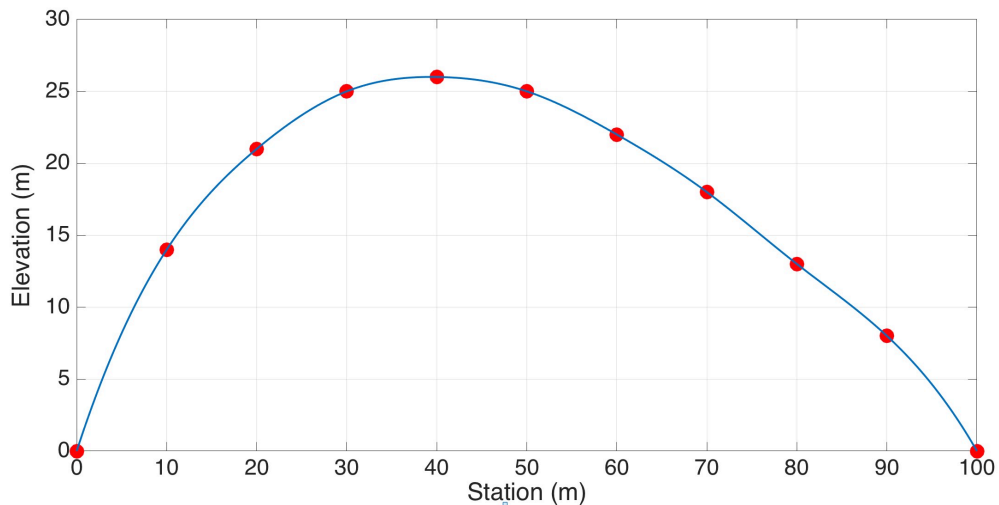c) Verify the answer obtained in part (b) using the trapezoidal rule method.

Figure 1. Elevation Profile of a Hill to be Removed in the Construction of a Road Project.

```matlab
% Script to estimate the area under a hill contour
clear
clc
% Function calls: elevationCalculation

station = [0  10 20 30 40 50 60 70 80 90 100];    % in meters
elevation = [0  14  21  25  26  25  22  18  13  8  0];  % in meters


% Make a plot

plot(station,elevation,'or','markersize',10)
xlabel('Station (m)')
ylabel('Elevation (m)')
grid

coeff= polyfit(station,elevation,4);

% Task (b) - Calculate the volume of material to be removed

% Evaluate the polynomial obtained using QUAD (Newton-Cotes method)

areaOfCut = quad('elevationCalculator',0,100);     % call quadrature formula

disp(['The volume of the cut is (square meters)  ', num2str(areaOfCut)])


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% Function to be integrated in Problem 1 in Quiz 2

function [elevation] = elevationCalculator(x)

% Define polynomial representing terrain and obtained from curve fit

coefficients = [-1.07808857808857e-06,0.000298951048951047,...
   -0.0357896270396269,1.66754079254079,0.139860139860197];

% Define formula to claculate elevations
```

```
elevation = coefficients(1) * x.^4 + coefficients(2) * x.^3 + coefficients(3) * x .^2 + ...
   coefficients(4) * x + coefficients(5);


end
```

The area of the cut using the Newton-Cotes method is 1739.4134 square meters.

Part (c) Verify with trapezoidal rule

```
% Task c Trapezoidal rule

newStation            = linspace(0,100,1000);        % create 1000 points
interpolatedElevation  = polyval(coeff,newStation);

areaUnderCut_trapz = trapz(newStation,interpolatedElevation);

disp(['The area of the cut is (square meters)  ', num2str(areaUnderCut_trapz)])
```

The area of the cut is (square meters) 1739.4113

Problem 2 (30 Points) - Show all your code

Use Matlab to solve this problem

A person wearing a parachute jumps from a hovering helicopter at 2,500 meters above ground. Neglecting the lateral speed component of the jumper, the distance traveled (d) and the vertical speed (v) as a function of time (t) according to the following equation:

    speed = v0 * exp (-cd / m * t) + g*m/cd *(1- exp (-cd /m * t));

    distance = g*t / (cd / m) - g/ (cd / m).^2 .* (1- exp (- cd / m * t)) + v0/(cd / m) .* (1- exp (- cd / m * t));

where: the parameters m, cd, m, vo and g are defined as follows:

g = 9.81; % acceleration of gravity (m/s-s)

cd = 12.5; % drag factor (kg/s)

m = 68.1; % mass of the person (kg)

v0 = 0; % initial speed (m/s)

t = time in seconds

a) Create a regular Matlab script to estimate and plot the speed and distance traveled by the jumper from the moment of the jump to a point in time 30 seconds after the jump.

b) Plot both speed and distance versus time (time in the x-axis) in the same figure. Label accordingly.

c) Find the terminal speed of the jumper.

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% Jumper problem

g = 9.81; % acceleration of gravity (m/s-s)

cd = 11; % drag factor (kg/s)

cdOpen = 110;

m = 70; % mass of the person (kg)

v0 = 0; % initial speed (m/s)

% define a vector of times

t = 0:30;

    speed = v0 * exp (-cd / m * t) + g*m/cd *(1- exp (-cd /m * t));

    distance = g*t / (cd / m) - g/ (cd / m).^2 .* (1- exp (- cd / m * t)) + v0/(cd / m) .* (1- exp (- cd / m * t));

figure

subplot(2,1,1)

plot(t,speed,'or')

xlabel('Time (s)')

ylabel('Speed (m/s)')

grid

subplot(2,1,2)

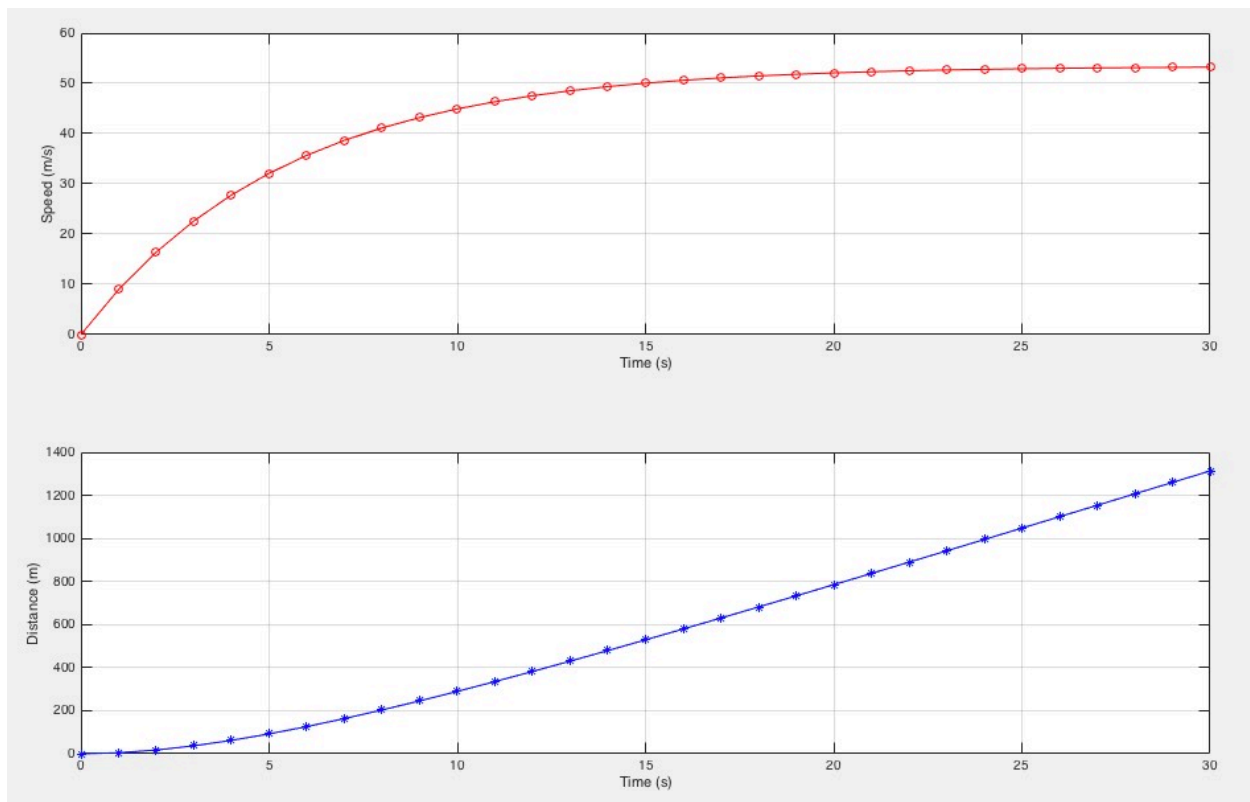plot(t,distance,'*b')

xlabel('Time (s)')

ylabel('Distance (m)')

grid

Jumper speed and distance trailed profiles.

The jumper reaches 53.22 m/s after 30 seconds (terminal speed)

Problem 3 (30 Points) - Show all your code

The Excel file provided contains wind speed data for Chicago O'Hare International airport. A sample screen capture is shown below.

	A	B	C	D
	Date	Time_HrMin	Wind_Direction_deg	Speed_meters_second
	20130101	0	330	3.1
	20130101	51	340	4.6
	20130101	105	330	4.6
	20130101	151	360	4.6
	20130101	251	350	5.1
	20130101	258	350	5.1
	20130101	325	360	4.6
	20130101	341	340	5.7

a) Create a Matlab script to read the data provided in the Excel file.

b) Add Matlab code to find the percent (%) of time the wind speeds exceed 10 m/s. Display the result in the command window.

c) Estimate the number of observations when the wind direction is 50 degrees and the wind speed greater than 5 m/s.

_____ Automatic Script _____

```
%% Import data from spreadsheet
% Script for importing data from the following spreadsheet:
%
%    Workbook: /Users/atrani/University work/courses/cee3804/Assignments 2017/
ORD_wind_2013_2014_excel.xlsx
%    Worksheet: ORD_wind_2010_2014.txt
%
% To extend the code for use with different selected data or a different
% spreadsheet, generate a function instead of a script.

% Auto-generated by MATLAB on 2017/04/19 03:57:08

%% Import the data
[~, ~, raw] = xlsread('/Users/atrani/University work/courses/cee3804/Assignments 2017/
ORD_wind_2013_2014_excel.xlsx','ORD_wind_2010_2014.txt');
raw = raw(2:end,:);
raw(cellfun(@(x) ~isempty(x) && isnumeric(x) && isnan(x),raw)) = {''};

%% Replace non-numeric cells with NaN
R = cellfun(@(x) ~isnumeric(x) && ~islogical(x),raw); % Find non-numeric cells
raw(R) = {NaN}; % Replace non-numeric cells
```

```
%% Create output variable
data = reshape([raw{:}],size(raw));

%% Allocate imported array to column variable names
Date = data(:,1);
Time_HrMin = data(:,2);
Wind_Direction_deg = data(:,3);
Speed_meters_second = data(:,4);

%% Clear temporary variables
clearvars data raw R;
```

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Task b

```
numberOfRecords = length(Date);    % total records in set
```

% Task (b) Find percent of time wind speeds > 10 m/s

```
indicesSpeedsGT10              = find(Speed_meters_second>10);
noRecordsFound_speedGT10   = length(indicesSpeedsGT10);

percentRecords_GT10              = noRecordsFound_speedGT10  / numberOfRecords *
100;

disp(['Percent Records with Speeds Above 10 m/s  (%)',
num2str(percentRecords_GT10)])
```

The percent of wind speed records above 10 m/s is 2.32%

Task (c)

% task (c) Find records from 50 degrees and > 5 m/s

```
indicesGT5          = find(Speed_meters_second>5);
indicesFrom50deg  = find(Wind_Direction_deg==50);
```

% Merge the two sets

```
indicesOfBoth        = intersect(indicesGT5,indicesFrom50deg);
```

```
noRecordsFound50_GT5 = length(indicesOfBoth);
```

```
disp(['Records from 50 Degrees and Above 5 m/s ', num2str(noRecordsFound50_GT5)])
```

269 records found.