

CEE 3804 Final Exam (Spring 2022)

Computer Applications in Civil Engineering

Open Book and Notes

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 or 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 font size 14 is acceptable. If you cannot read the screen captures easily, I will not be able to read it either.**

Problem 1 (25 points)

An engineer in your company provides the following Matlab code to calculate the horizontal (H) and vertical reaction forces (VR) acting on a suspension bridge. The script also contains an equation to estimate the cable tension (TR) at the support point (N)

```
% Inputs:
% l = bridge length (m)
% wo = load per unit length (N/m)
% f = cable sag distance (m)

% Outputs:
% H = horizontal force at cable support point (N)
% VR = vertical reaction force at cable support point (N)
% TR = cable tension force at support point (N)

l = 300;      % meters
wo = 1e5;    % N/m
f = 20;      % meters

% Formulas

H = wo * l.^2 ./ (8*f);
VR = wo .* l / 2;
TR = VR * sqrt(1 + l.^2 ./ (16 * f.^2)); % tension in cable

L = 1/2 * sqrt(1 + (wo .* l / (2*H)).^2) + H/wo * sinh(wo * l / (2*H));
```

a) Create a Matlab function to estimate the reaction forces (H and VR) and the tension (TR). The function takes three parameters l - bridge length, wo- load per unit length, and f - cable sag distance and produces three outputs: H, VR and TR.

b) Test the function created using the following values of l, wo and f.

```
l = 400 meters
wo = 1.5e5 N/m
f = 26 meters
```

c) Test the function with the original values provided by your colleague in the original script.

Show all your work and answers.

Problem 2 (25 points)

Data from thunderstorm events has been collected over time. Table 1 shows the runoff (i.e., amount of water generated by a large parking lot at a stadium) during a severe thunderstorm event.

- a) Create a Matlab script to read the data in separate column vectors.
- b) Add to the script to plot the runoff as a function of time (in seconds)
- c) Add to the script to estimate the total water accumulated during the severe thunderstorm event.

Table 1. Runoff data.

Time (hrs)	Time (seconds)	Runoff (cubic meters/second)
0.000	0	0.00
0.025	90	0.45
0.050	180	0.90
0.075	270	1.40
0.100	360	1.78
0.125	450	1.90
0.150	540	2.30
0.175	630	2.60
0.200	720	2.80
0.225	810	3.10
0.250	900	3.50
0.275	990	4.00
0.300	1080	3.50
0.325	1170	3.10
0.350	1260	3.15

Problem 3 (25 points)

You are a civil/environmental engineer working for the Oregon Department of Transportation. Your task is to estimate the fuel and emissions produced by vehicles driving around Portland. The file “fuelEmissionsData.m” contains the fuel consumption (l/s) and emission rates (Hydrocarbons, CO, and NOx) produced by a small car driving under normal speed conditions. The file has the following information.

```
% Fuel and emissions data for a small car

% Column 1 = speed in km/hr
% Column 2 = fuel consumption (l/s)
% Column 3 = HC emissions in (mg/s)
% Column 4 = CO emissions in (mg/s)
% Column 5 = NOx emissions in mg/s

0    0.000210000000000000    0.1850000000000000    1.6750000000000000    0.1750000000000000
10   0.000280000000000000    0.2480000000000000    1.9480000000000000    0.2240000000000000
15   0.000320000000000000    0.2800000000000000    2.4300000000000000    0.2760000000000000
20   0.000360000000000000    0.3080000000000000    3.3200000000000000    0.3520000000000000
30   0.000440000000000000    0.3760000000000000    5.0600000000000000    0.5360000000000000
40   0.000520000000000000    0.4600000000000000    7.1240000000000000    0.7920000000000000
50   0.000600000000000000    0.5640000000000000    9.6080000000000000    1.1440000000000000
60   0.000680000000000000    0.7160000000000000    12.8760000000000000    1.6240000000000000
70   0.000800000000000000    0.9480000000000000    17.7920000000000000    2.2680000000000000
80   0.000960000000000000    1.3280000000000000    26.2760000000000000    3.1360000000000000
90   0.001120000000000000    2.0080000000000000    43.0440000000000000    4.3120000000000000
100  0.001440000000000000    3.3200000000000000    81.1120000000000000    5.9200000000000000
```

- Create a Matlab script to read the fuel and emissions rate data provided in the text file provided.
- Add to the script in part (a) to plot the fuel consumption (l/s) vs. speed (km/hr) and to estimate the value of fuel consumption as a function of V using a third order polynomial as shown below. For this part is OK to estimate the coefficients of the polynomial in code or using the Matlab Basic Fitting function.

$$fc = AV^3 + BV^2 + CV + D$$

where:

fc = fuel consumption (l/s)

A, B, C, D are regression coefficients of the polynomial

Save the coefficients of the polynomial for later use.

- Repeat the process of part (b) to estimate the HC (Hydrocarbon emissions) as a function of V using another 3rd order polynomial.

d) Using the two polynomial equations found, create a **Matlab function** to estimate the fuel consumption and HC emissions as a function of V . Your Matlab function should have two outputs: 1) fuel consumption (l/s) and 2) HC emissions (mg/s). The Matlab function has one input variable (speed in km/hr).

e) Add code to the script created in part (a) to test your function for a vector of speeds ranging from 0 to 85 km/hr at steps of 1 km/hr.

Problem 4 (25 points)

Use the same data employed in Problem 3 to do the tasks below.

a) **Create a VBA function (not a Subroutine)** that estimates the fuel consumption (f_c) of the car as a function of V (speed). Use the same polynomial equation found in part (b) of the previous problem. The function takes a value of V (speed) supplied via the function argument and produces a single value for fuel consumption.

b) In the Excel file used to do part (a), create a vector of speeds ranging from 0 to 85 km/hr at steps of 1 in column A. Calculate the fuel consumption using the function created in part (a) and show the results in column B. Label the headers appropriately.

Include screen captures of VBA function code and also a screen capture of the table with solutions obtained for f_c . Show me a screen capture on how do you invoke the function created.