CEE 3804 Exam1 (Spring 2024)

Computer Applications in Civil Engineering

Solution Key

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 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 12 is acceptable.

Problem 1 (30 points)

Figure 1 shows a file containing marine dock facilities in the United States and US Territories. The file is provided in the assignments website.

Name	Facility	State	Waterway Name
TOBINS HBR	Dock	MI	Lake Superior
NATIONAL PARK SER NPS MAHONE BAY	Dock	MI	Lake Superior
GRAND MARAIS PUBLIC DOCK	Dock	MN	Lake Superior
PIER 40	Dock	GU	APRA HARBOR, GUAM ISLAND, GU
APRA HARBOR-OPEN WATER	Open Water	GU	APRA HARBOR, GUAM ISLAND, GU
COMMERICAL PIER	Dock	GU	APRA HARBOR, GUAM ISLAND, GU
PORT APRA F-4, F-3	Dock	GU	APRA HARBOR, GUAM ISLAND, GU
NAVAL BASE GUAM, VICTOR WHARF	Dock	GU	APRA HARBOR, GUAM ISLAND, GU
SAIPAN	Dock	AK	NORTHERN MARIANA ISLANDS

Figure 1. Docks in the United States and US Territories.

The fields in the file are explained below.

Name - name of the facility

Facility - type of facility (docks, anchorages, junctions, etc.)

State - the State or US territory

Waterway name - name of the waterway where the facility is located

Port name - name of the port where the facility is located

a) Create a Pivot Table (a matrix) to **count the number of facilities** (in columns) for each state (in rows).

Count of Name	Facility							
State	Anchorage	Bridge	Dock	Fleeting Area	Junction	Lock and/or Dam	Lock Chamber	Marina
AK	80		768					
AL		14	414		11	14	18	1
AR		2	125		15	15	15	
AS			1					
CA	26	10	725	2	2	1	1	10
CT	12	5	225					61
DC			34					5
DE	10	2	65					3
FL	6	34	695	1	80	10	10	31
GA	1	10	187		1	3	3	8
GU			4					
HI	3		165					
IA		8	110			5	6	
ID			27		1			
IL	1	11	541	19	3	21	22	
IN		1	177	1	1	3	4	
KS			7					
KY		6	423	14	16	23	34	4
LA	14	14	1950	25	73	27	27	2
MA	31	6	486					112

Figure 1a. Summary Pivot Table.

b) Tell me the **number of docks** in the state of Florida (FL) and in Guam (GU).

695 docks in Florida. Four docks in Guam.

c) Create a **Pivot Chart to count the number each type of facility**. Make sure the Pivot Chart has labels.

	A	B
1	Count of Name	
2	Facility	Total
3	Anchorage	389
4	Bridge	266
5	Dock	15239
6	Fleeting Area	143
7	Junction	397
8	Lock and/or Dam	239
9	Lock Chamber	281
10	Marina	397
11	Open Water	780
12	Tie Off	14
13	Virtual Marina	6
14	Grand Total	18151

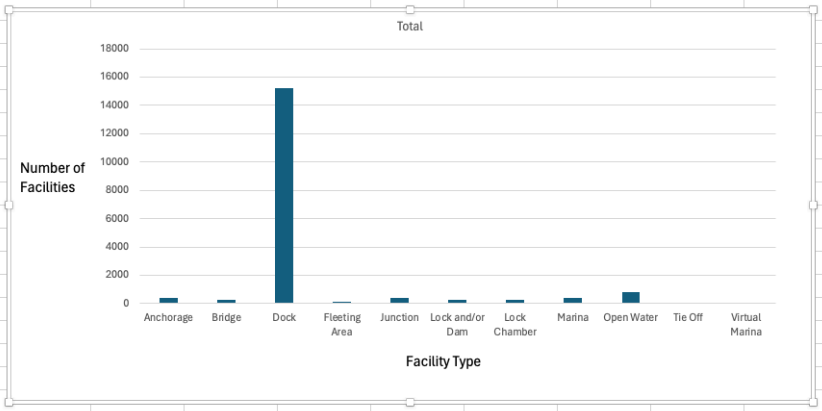


Figure 1b. Pivot Chart with Count of Facilities.

Show me the upper left portion of the Pivot Table and the full Pivot Chart. Highlight the numbers with your answers.

Problem 2 (30 points)

Engineers test a new commuter train and measure the noise level generated at different speeds. One of the civil engineers in the team, proposes a quadratic regression equation to approximate the noise level produced as a function of speed.

$$L_{eq} = A + BV + CV^2$$

where:

L_{eq} is the equivalent noise level produced by the train (in decibels - dBA)

V is the train speed (in miles per hour)

A, B, C are the regression constants of the model

After numerous tests, the numerical values of the constants A, B, C are:

A = 40.486, B = 1.2984, C = -0.0086

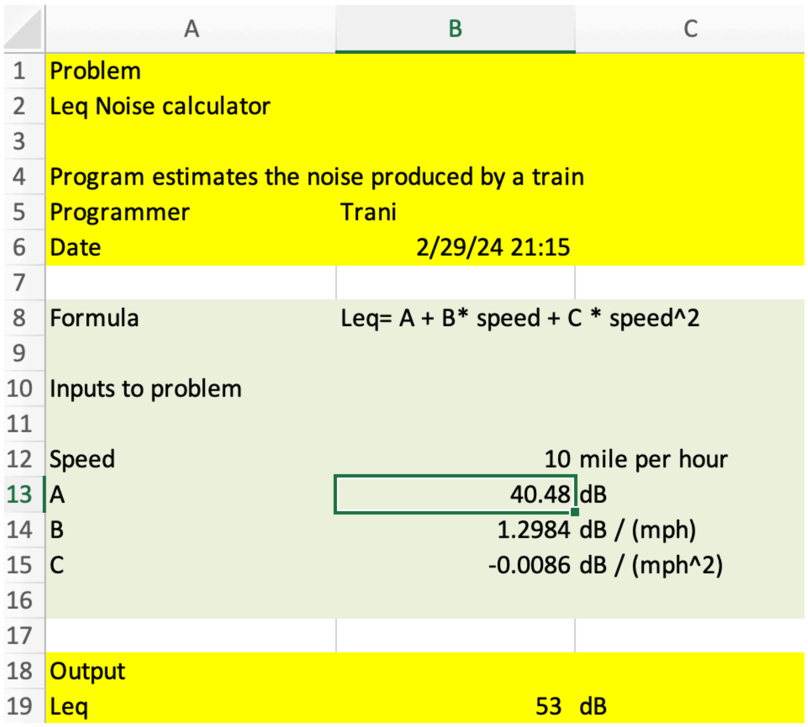
All constants are dimensionally correct to produce a value of L_{eq} in decibels (a unit of noise level).

a) Write a **Public Function in VBA** to estimate the equivalent noise level (L_{eq}) as a function of train speed (V). Use the equation provided in your function. Use **Option Explicit in your code.**

```
Option Explicit

Dim speed As Single
Dim A As Single
Dim B As Single
Dim C As Single


Public Function noiseLevel(speed, A, B, C) As Single
' Function to calculate Leq values given:
'
'   Inputs: speed, A, B, and C
'   Output: Leq

    noiseLevel = A + B * speed + C * speed ^ 2

End Function
```

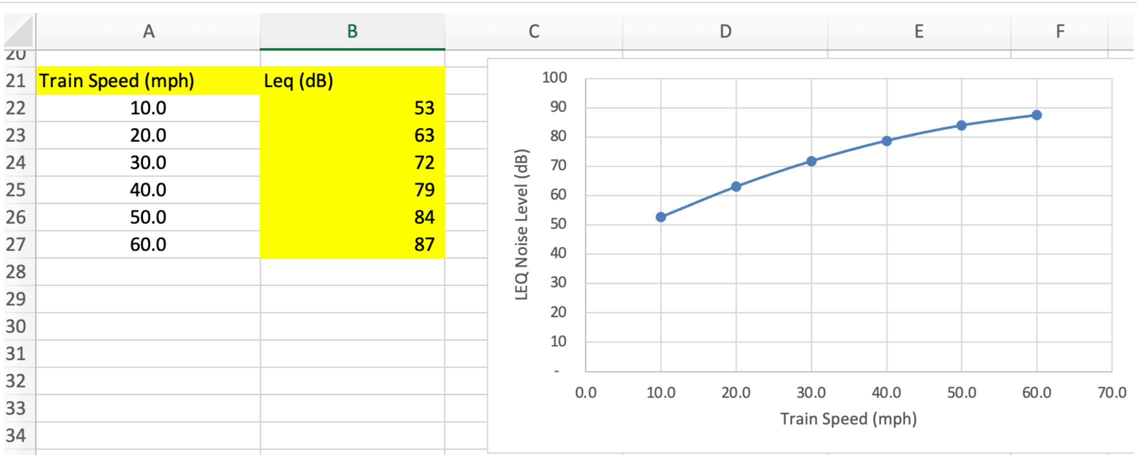
Figure 2. Public Function to Estimate Leq Noise Level.

b) Test the function created in part (a) to estimate the value of L_{eq} for speed values ranging from 10 to 60 miles per hour at intervals of 10 mph. Show the value of L_{eq} for each speed tested. To test the function, use Excel and create a two column table with values of speed (in column A) and L_{eq} in column B.



	A	B	C
1	Problem		
2	Leq Noise calculator		
3			
4	Program estimates the noise produced by a train		
5	Programmer	Trani	
6	Date	2/29/24 21:15	
7			
8	Formula	Leq= A + B* speed + C * speed^2	
9			
10	Inputs to problem		
11			
12	Speed	10	mile per hour
13	A	40.48	dB
14	B	1.2984	dB / (mph)
15	C	-0.0086	dB / (mph^2)
16			
17			
18	Output		
19	Leq	53	dB

Figure 2a. Excel Interface to Test the Function to Estimate Leq Noise Level.



	A	B
21	Train Speed (mph)	Leq (dB)
22	10.0	53
23	20.0	63
24	30.0	72
25	40.0	79
26	50.0	84
27	60.0	87

Figure 2b. Excel Table to Estimate Values of Leq Noise Level for Various Speeds.

Problem 3 (40 points)

A common problem in Civil Engineering is to estimate the deflection of a cantilever beam at different stations (see Figure 3).

$$y = \frac{Px^2}{6EI}(3l - x) \qquad \textbf{(Equation 1)}$$

Where:

y is the deflection at any point in the beam (inches)

x is the distance from the wall to any point on the beam (inches)

P is the load applied (lbs.)

l is the length of the beam (inches)

E is the modulus of elasticity (lb/in^2)

I is the moment of inertia (in^4)

The units in this model are all consistent.

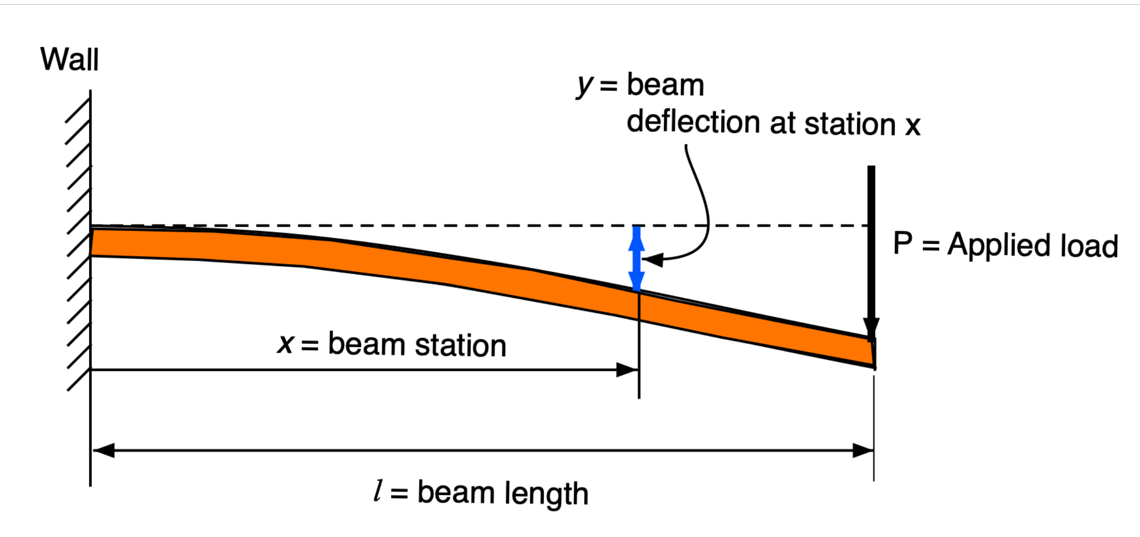


Figure 3. Cantilever Beam Subject to a Single Load (P).

Table 1 shows the values of E (Modulus of Elasticity) for three materials.

Table 1. Values of Modulus of Elasticity for Two Materials.

Material	E (lb/in^2)
Steel	2.9E+07
Titanium	1.65E+07

a) **Create a Visual Basic Subroutine** to estimate the beam deflection (y) given the parameters on the right hand side of Equation 1. The values of x, P, l, and I are defined in the Excel spreadsheet and then read by the VBA code. The VBA code reads the beam **material property as a list with the names** of the two materials in Table 1. The value of E (modulus of elasticity) is assigned in the VBA code once the beam material has been selected from the spreadsheet. The value of deflection (y) is shown in the spreadsheet. Use **Option Explicit in your code.**

```
(General)
Option Explicit

Dim x As Single
Dim EModulus As Single
Dim material As String
Dim MInertia As Single
Dim Blen As Single
Dim y As Single
Dim P As Single

Sub beamDeflection()

Sheets("blank").Select

Range("B12").Select
P = ActiveCell.Value

Range("B13").Select
Blen = ActiveCell.Value
```

```
(General)

Range("B14").Select
x = ActiveCell.Value

Range("B15").Select
material = ActiveCell.Value

If material = "Steel" Then
    Range("E9").Select
    EModulus = ActiveCell.Value
ElseIf material = "Titanium" Then
    Range("E10").Select
    EModulus = ActiveCell.Value
End If

Range("B16").Select
MInertia = ActiveCell.Value
```

```
    y = (P * x * x) * (3 * Blen - x) / (6 * EModulus * MInertia)

' Send the results back to the spreadsheet

Range("B19").Select
ActiveCell.Value = y

Range("B20").Select
ActiveCell.Value = EModulus

Range("B21").Select
ActiveCell.Value = material

Range("B22").Select
ActiveCell.Value = MInertia
```

Figure 3a. Cantilever Beam Code.

b) Test the function created in part (a) with the following values:

x = 174 inches

P = 2000 lbs.

l =250 inches

Material = Steel

I = 200 in^4

	A	B	C	D	E
1	Problem				
2	Cantiliver Beam Problem				
3					
4	Estimate the beam deflection				
5	Programmer	Trani	Run Deflection		
6	Date	2/29/24 16:17			
7					
8	Formula	y=Px^2/(6EI)*(3l-x)		Material	E (in^2)
9				Steel	2.90E+07
10	Inputs to problem			Titanium	1.65E+07
11					
12	Load	2000	pounds		
13	Beam Length	250	inches		
14	Station	174	inches		
15	Material	Steel	in^2		
16	Moment of Inertia	200	in^4		
17					
18	Output				
19	Deflection	1.002	inches		

Estimate the beam deflection				
Programmer	Trani	Run Deflection		
Date	2/29/24 21:27			
Formula	y=Px^2/(6EI)*(3l-x)		Material	E (in^2)
			Steel	2.90E+07
Inputs to problem			Titanium	1.65E+07
Load	2000	pounds		
Beam Length	250	inches		
Station	174	inches		
Material	Titanium	in^2		
Moment of Inertia	200	in^4		
Output				
Deflection	1.762	inches		
Check E selected	16500000			
Material selected	Titanium			

Figure 3b. Cantilever Beam Excel Interface. Top Section Uses Steel. Bottom Section Uses Titanium.