CEE 3804 Exam1 (Spring 2023)

Computer Applications in Civil Engineering

Take Home Exam: 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 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 (40 points)

A common problem in Civil Engineering is to estimate the head loss inside a pipe due to friction using the Darcy-Weisbach equation.

$$h_{friction} = f_{coeff} LV^2/(2gD)$$

Where:

$h_{friction}$ is the head loss due to friction inside the pipe (in meters)

f_{coeff} is the coefficient of friction inside the pipe (dimensionless)

L is the length of the pipe in meters

V is the speed of the fluid inside the pipe (in m/s)

g is the gravity constant (9.81 m/s^2)

D is the diameter of the pipe in meters

For turbulent flow, the coefficient of friction is estimated using the following equation:

$$f_{coeff} = \frac{0.079}{R_e^{0.25}}$$

Where:

R_e is the Reynold's number (dim)

The Reynold's number is defined by:

$$R_e = \frac{VD}{\nu}$$

Where:

R_e is the Reynold's number (dim)

V is the speed of the fluid inside the pipe (in m/s)

D is the diameter of the pipe in meters

ν is the kinematic viscosity of the fluid (m^2/s)

The units in this model are all consistent.

Table 1. Numerical Constants for Problem 1

Parameter	Value	Units
V	3.0	m/s
D	0.35	m
L	125	M
ν	1.04E-06	m^2/s (water)

a) **Create a VBA function (not a Subroutine)** to estimates the value of head loss in the pipe ($h_{friction}$) given the parameters in Table 1. The parameters in Table 1 are arguments of the function. The function produces the value of $h_{friction}$. The values of the parameters in Table 1 are read from the spreadsheet. Please include a brief explanation in the spreadsheet of the problem, your name, and the parameters used (including units).

Figure 1. Head Loss due to Friction VBA Function.

```
Public Function hfriction(L, V, D, viscosity)

' Function to estimate the head loss due to friction
' inside a water pipe
'
' Inputs:
' L - pipe length (m)
' V - fluid speed (m/s)
' g - constant
' D -pipe diameter (m)
' nu - kinematic viscosity (m^2/s)

' Define gravity constant (g) in m/s-s
g = 9.81

' Calculate the Reynolds Number (R) given speed and pipe length

R = (V * D) / viscosity
```

```
' Calculate the frcition coefficient inside the pipe wall

fcoeff = 0.079 / (R ^ 0.25)

' Calculate the head loss

hfriction = (fcoeff * L * V * V) / (2 * g * D)

End Function
```

b) Test the function created in part (a) with the values in Table 1.

Figure 2. Excel Use of the Head Loss Function.

Program estimates the head loss in a pipe using the Darcy equation			
Programmer	Trani		
Date	3/19/23 21:40		
Formulas	h=f*L*V^2/(2*g*D)	Head Loss	
	f = 0.079/Re^0.25	Friction coefficient	
	Re=V * D / nu	Reynolds Number	
Inputs to problem			
Variable	Quantity	Units	Variable Name
L	125	meters	Length of pipe
V	3	meters/second	Speed of fluid inside pipe
D	0.35	meters	Diameter of pipe
nu	1.04E-06	m-m/s	viscocity
Head Loss	0.40829	meters	

c) Create a table with values of $h_{friction}$ for water flows ranging from 1.0 to 3.5 meters per second at steps 0.125 m/s. Write code to generate the table in VBA automatically.

Figure 3. Subroutine to Estimate the Head Loss due to Friction.

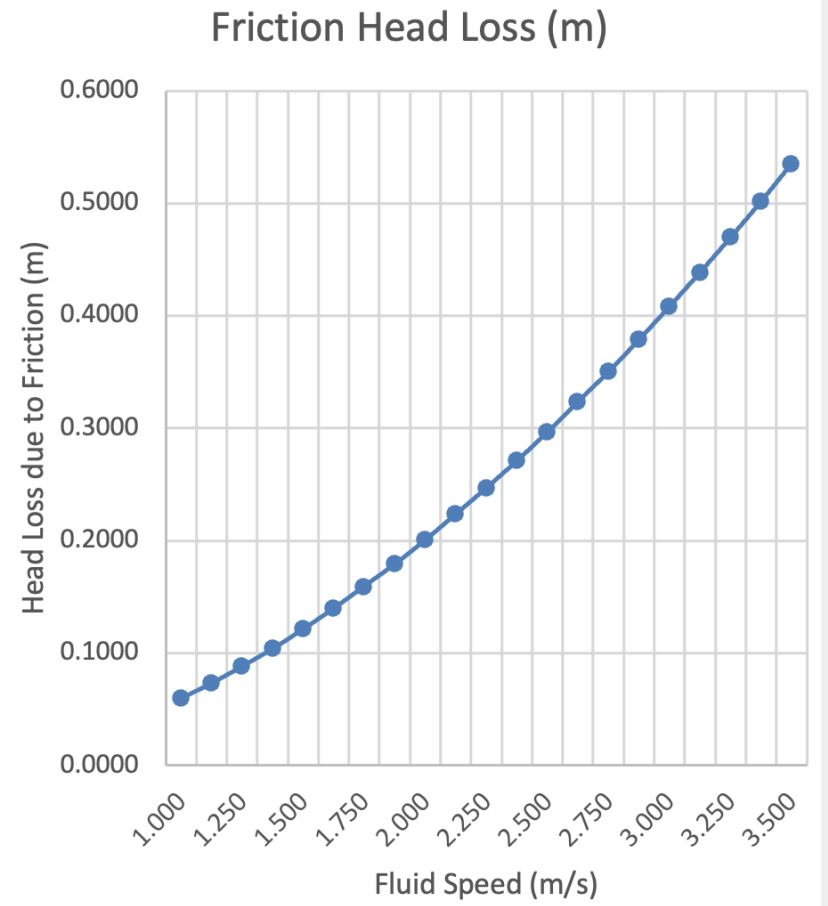
```
Sub headLossCalculator()

' Calculate head loss due to friction and
' generates a table withresults

g = 9.81   ' meters/s-s

' Read the values of L, D, and viscosity

Range("B10").Select
L = ActiveCell.Value

'Range("B11").Select
'V = ActiveCell.Value

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

Range("B13").Select
viscosity = ActiveCell.Value

' Clear contents of table

Range("D18:E1000").Clear

' Create a loop to create the table

counter = 0

For V = 1 To 3.5 Step 0.125

    ' Calculate the Reynolds Number (R) given speed
    R = (V * D) / viscosity

    ' Calculate the frcition coefficient inside the pipe
    fcoeff = 0.079 / (R ^ 0.25)

    ' Calculate the head loss

    headLoss = (fcoeff * L * V * V) / (2 * g * D)

    ' Define index i to control the position of the out

    cellNumber = "D" & (counter + 17)
    Range(cellNumber).Select
    ActiveCell.Value = V

    cellNumber = "E" & (counter + 17)
    Range(cellNumber).Select
    ActiveCell.Value = headLoss

Next V

End Sub
```

Figure 4. Table Created by the Subroutine to Estimate the Head Loss due to Friction.

Calculations with Subroutine	
Fluid Speed (m/s)	Friction Head Loss (m)
1.000	0.060
1.125	0.073
1.250	0.088
1.375	0.104
1.500	0.121
1.625	0.140
1.750	0.159
1.875	0.179
2.000	0.201
2.125	0.223
2.250	0.247
2.375	0.271
2.500	0.297
2.625	0.323
2.750	0.351
2.875	0.379
3.000	0.408
3.125	0.439

d) Use the values in the table generated in step (c) to make a plot in Excel. Label your plot accordingly. Show the calculated value of $h_{friction}$ in your spreadsheet.

Figure 5. Plot of Head Loss versus Fluid Speed.



e) Add Table 2 to your analysis allowing the user of the spreadsheet to select the value of kinematic viscosity of water at different temperatures. Modify the function to select the value of ν as a function of the temperature selected.

Table 2. Water Kinematic Viscosity at Various Temperatures.

Temperature (deg. C)	ν (m²/s)
0	1.79E-06
5	1.52E-06
10	1.31E-06
20	1.04E-06

Figure 6. Code to Select the Value of Water Viscosity as a Function of Temperature.

```
' New code to select the the correct value of viscosity

    If Temperature = 0 Then
        viscosity = 1.79E-06
    ElseIf Temperature = 5 Then
        viscosity = 1.52E-06
    ElseIf Temperature = 10 Then
        viscosity = 1.31E-06
    ElseIf Temperature = 20 Then
        viscosity = 1.04E-06
    End If

    ' Write the value of viscosity to cell B13

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

Problem 2 (30 points)

A file containing aircraft assets of four airlines is provided in the assignments website.

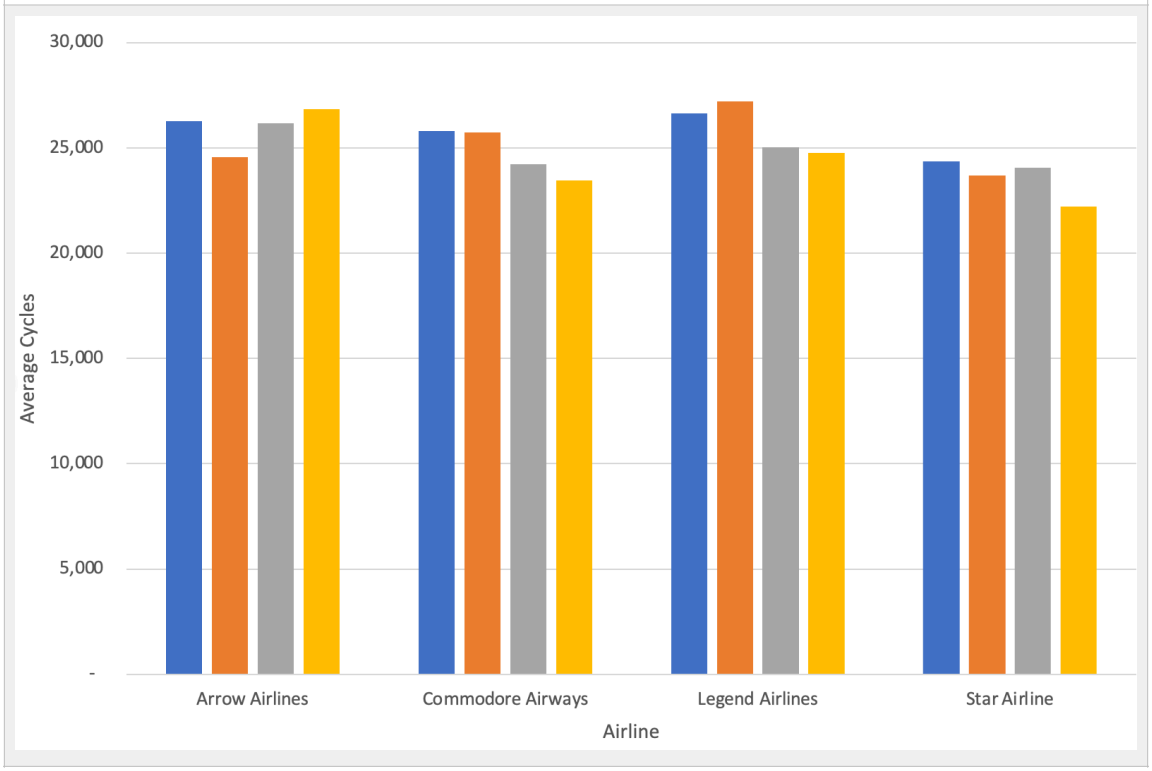
a) Create a Pivot Table to summarize the number of cycles of each aircraft by airline (matrix)

Figure 7. Pivot Table Summary of Average Number of Cycles by Airline and Aircraft.

Average of Cycles	Column Labels				
Row Labels	Airbus A320	Boeing 737-800	Bombardier CRJ-900	Embraer 175	Grand Total
Arrow Airlines	26,282	24,551	26,187	26,857	25,740
Commodore Airways	25,802	25,744	24,243	23,451	24,858
Legend Airlines	26,633	27,205	25,033	24,767	25,988
Star Airline	24,361	23,693	24,070	22,213	23,585
Grand Total	**25,744**	**25,195**	**24,860**	**24,263**	**24,980**

b) Create a Pivot Chart to summarize graphical part (a)

Figure 8. Pivot Chart Summary of Average Number of Cycles by Airline and Aircraft.



c) Find the average number of cycles for Boeing 737-800 that belong to Arrow Air

24,551 cycles

Figure 9. Pivot Table Summary of Average Number of Cycles by Airline and Aircraft.

Average of Cycles	Column Labels				
Row Labels	Airbus A320	Boeing 737-800	Bombardier CRJ-900	Embraer 175	Grand Total
Arrow Airlines	26,282	24,551	26,187	26,857	25,740
Commodore Airways	25,802	25,744	24,243	23,451	24,858
Legend Airlines	26,633	27,205	25,033	24,767	25,988
Star Airline	24,361	23,693	24,070	22,213	23,585
Grand Total	**25,744**	**25,195**	**24,860**	**24,263**	**24,980**

d) Plot the number of cycles against the number of hours. Estimate the best linear regression model to relate the two parameters.

e) Using a pivot table, find the average number of cycles for Bombardier CRJ-900 in Commodore Airways fleet.

24,243 cycles

Figure 10. Pivot Table Summary of Average Number of Cycles by Airline and Aircraft.

Average of Cycles	Column Labels				
Row Labels	Airbus A320	Boeing 737-800	Bombardier CRJ-900	Embraer 175	Grand Total
Arrow Airlines	26,282	24,551	26,187	26,857	25,740
Commodore Airways	25,802	25,744	24,243	23,451	24,858
Legend Airlines	26,633	27,205	25,033	24,767	25,988
Star Airline	24,361	23,693	24,070	22,213	23,585
Grand Total	**25,744**	**25,195**	**24,860**	**24,263**	**24,980**

f) Find the minimum number of cycles for Airbus A320 aircraft fleet (i.e., any of the airlines).

1,576 for A320s of Commodore Airways.

Figure 11. Pivot Table Summary of Minimum Number of Cycles by Airline and Aircraft.

Min of Cycles	Column Labels				
Row Labels	Airbus A320	Boeing 737-800	Bombardier CRJ-900	Embraer 175	Grand Total
Arrow Airlines	1,619	1,707	2,195	3,057	1,619
Commodore Airways	1,576	1,778	2,598	1,725	1,576
Legend Airlines	2,543	1,817	1,848	2,510	1,817
Star Airline	1,740	2,429	1,760	1,645	1,645
Grand Total	**1,576**	**1,707**	**1,760**	**1,645**	**1,576**

Problem 3 (30 points)

Provide quick answers.

Question	Answer
What is the purpose of “Option Explicit” in VBA?	To define the variable types in the program. Programs runs faster since VBA does not guess the data type for each variable.
The first computer by Apple that introduced a graphic user interface. The computer was a commercial failure.	Lisa
According to Moore’s Law we double the number of transistors in a microchip every two years. Starting with the Intel 4004 chip, find the year when we could reach 10 billion transistors in a single chip.	Between 2015 and 2016
IBM launched the IBM System/360 Model 65 mainframe computer in 1964. Name two innovations of the system.	Integrated circuits Solid logic technology Business and scientific use APL Language
An engineer calculates 10 million deflections of a bridge structure in a computer program. Each calculation involves three numbers: 1) the bridge element number (single precision), 2) the deflection at each bridge element (double precision), and 3) the stress value at each bridge element (double precision). Estimate the number of bytes of computer memory required to hold all the calculations.	**200e6 bytes needed** 40e6 bytes for the bridge element number (4 bytes each cell) 160e6 bytes for the deflections and stresses (8 bytes each cell)
Magnetic tapes started a new trend in computers to save data. Name the company that introduced tape drives in computers in 1951.	Univac
State one fundamental difference between a function and a subroutine in VBA.	Functions produce one output Subroutines can produce multiple outputs Subroutines are more flexible
Write the version of Simulink installed in your computer. Show a screen capture.	MATLAB Version: 9.13.0.2080170 (R2022b) Update 1
Why do most computers use base 2 to store numbers?	Because transistors have two natural states (1 or 0)