Assignment 4: VBA Programming

Date Due: February 23, 2022

Instructor: Trani

Problem 1

A simple formula used in storm water runoff calculations is presented in the equation below.

$$Q = C_f CIA$$

where:

Q = peak storm water runoff rate (ft^3/s)

C_f = runoff coefficient adjustment factor (dim)

C = runoff coefficient (dim)

I = rainfall rate (in/hr)

A = discharge area (acres)

The runoff coefficient adjustment factors are 1.0 for storm return periods 1-10, 1.1 for 25, 1.2 for 50, and 1.25 for 100. The return period is the probability that a storm will occur in a period of time (i.e., return period).

Table 1. Typical Values of Runoff Coefficients.

Surface	Runoff Coefficient (dim)
Forest	0.12
Asphalt	0.85
Brick	0.80
Concrete	0.86
Shingle Roof	0.88
Farmland	0.22
Pasture	0.21

a) Create a VBA Sub Procedure to estimate the runoff produced (Q) as a function of parameters C, C_f, I, and A.

All four parameters will be entered by the user in the worksheet. I suggest column A defines the parameter names, column B defines their numerical values and column C defines the units of each parameter. The output of the VBA Sub is the value of (Q).

The result is sent back to the worksheet and written in column format below the range of cells used to define the input parameters.

```
'Worksheet'
Sheets("Sheet1").Select

' Parameters'
Range("B2").Select
C = ActiveCell.Value

Range("B3").Select
Cf = ActiveCell.Value

Range("B4").Select
I = ActiveCell.Value

Range("B5").Select
A = ActiveCell.Value

q = C * Cf * I * A
Cells(6, 2).Value = q

Range("B8").Select
x = ActiveCell.Value
```

b) Test the VBA code created in (a) using the following parameters:

Area = 15 acres
Surface = Asphalt
Storm return period = 50 years Rainfall
intensity = 10 inches/hr

Parameters	Values	Units
C	15	dim
Cf	1.2	dim
I	10	in/hr
A	15	acres
Q	153	ft^3/s

c) Improve the VBA code created in part (a) allowing the user to select the **surface** used in the runoff calculation. Create a separate table in the spreadsheet with “surfaces” and values of runoff coefficient (C). Replace the Excel cell location of runoff coefficient with a list of materials. Refer to the pavement thickness class example.

```
' Parameters'
Range("B2").Select
Surface = ActiveCell.Value

If Surface = "Forest" Then
C = 0.12
ElseIf Surface = "Asphalt" Then
C = 0.85
ElseIf Surface = "Brick" Then
C = 0.8
ElseIf Surface = "Concrete" Then
C = 0.86
ElseIf Surface = "Shingle Roof" Then
C = 0.88
ElseIf Surface = "Farmland" Then
C = 0.22
ElseIf Surface = "Pasture" Then
C = 0.21
End If

Range("B3").Select
Cf = ActiveCell.Value

Range("B4").Select
I = ActiveCell.Value

Range("B5").Select
A = ActiveCell.Value

q = C * Cf * I * A
Cells(6, 2).Value = q

Range("B8").Select
x = ActiveCell.Value
```

Parameters	Values	Units
Surface	Asphalt	dim
Cf	1.2	dim
I	10	in/hr
A	15	acres
Q	153	ft^3/s

Surface	Runoff Coefficient
Forest	0.12
Asphalt	0.85
Brick	0.8
Concrete	0.86
Shingle Roof	0.88
Farmland	0.22
Pasture	0.21

d) Run the improved code created in part (c) and create a table (see example below) in the spreadsheet with solutions for runoff for various rainfall rate intensities ranging from 0.25 to 10 inches per hour at steps 0.25 inches/hr.

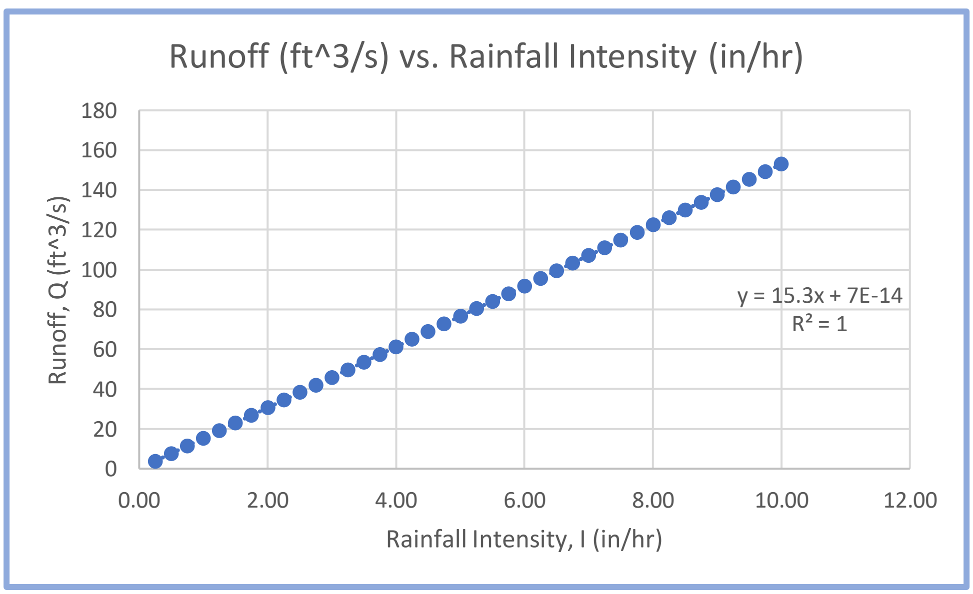
Rainfall Intensity (in/hr)	Runoff (ft^3/s)
0.25	Your solution
0.50	…
…	….
10.0	….

Table 2. Format of your solution.

```
'Calculate number of Interations
CellNumber = "B" & (9)
Range(CellNumber).Select
Iterations = 10 / x
ActiveCell.Value = Iterations


For y = 1 To Iterations

CellNumber = "E" & (y + 1)
Range(CellNumber).Select
R_I = x * y
ActiveCell.Value = R_I


CellNumber = "F" & (y + 1)
Range(CellNumber).Select
Run_off = C * Cf * R_I * A
ActiveCell.Value = Run_off

Next y


End Sub
```

Rainfall Intensity, I (in/hr)	Runoff, Q (ft^3/s)
0.25	3.825
0.50	7.65
0.75	11.475
1.00	15.3
1.25	19.125
1.50	22.95
1.75	26.775
2.00	30.6
2.25	34.425
2.50	38.25
2.75	42.075
3.00	45.9
3.25	49.725
3.50	53.55
3.75	57.375
4.00	61.2
4.25	65.025
4.50	68.85
4.75	72.675
5.00	76.5
5.25	80.325
5.50	84.15
5.75	87.975
6.00	91.8

e) Plot the solutions of runoff (Q) versus rainfall intensity (I) obtained in part (d). Label the axes appropriately. Show sample screen captures of the spreadsheet output and the VBA code.



```
Public Sub RO()

'Worksheet'
Sheets("Sheet1").Select

' Parameters'
Range("B2").Select
Surface = ActiveCell.Value

If Surface = "Forest" Then
C = 0.12
ElseIf Surface = "Asphalt" Then
C = 0.85
ElseIf Surface = "Brick" Then
C = 0.8
ElseIf Surface = "Concrete" Then
C = 0.86
ElseIf Surface = "Shingle Roof" Then
C = 0.88
ElseIf Surface = "Farmland" Then
C = 0.22
ElseIf Surface = "Pasture" Then
C = 0.21
End If

Range("B3").Select
Cf = ActiveCell.Value

Range("B4").Select
I = ActiveCell.Value

Range("B5").Select
A = ActiveCell.Value
```

```
Range("B5").Select
A = ActiveCell.Value

q = C * Cf * I * A
Cells(6, 2).Value = q

Range("B8").Select
x = ActiveCell.Value

'Calculate number of Interations
CellNumber = "B" & (9)
Range(CellNumber).Select
Iterations = 10 / x
ActiveCell.Value = Iterations


For y = 1 To Iterations

CellNumber = "E" & (y + 1)
Range(CellNumber).Select
R_I = x * y
ActiveCell.Value = R_I


CellNumber = "F" & (y + 1)
Range(CellNumber).Select
Run_off = C * Cf * R_I * A
ActiveCell.Value = Run_off

Next y


End Sub
```

Problem 2

This problem deals with deflection calculations for a cantilever beam (i.e., a beam supported at one end to a wall) with a total load *W* distributed along the beam (see Figure 1). More information about the equations of the beam can be found at: http:// www.engineersedge.com/beam_bending/beam_bending8.htm.

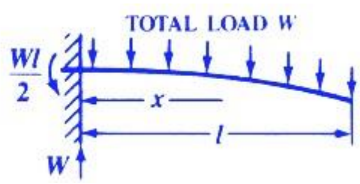


Figure 1. A simple beam supported at one end. Source: http://www.engineersedge.com/ beam_bending/beam_bending8.htm

Nomenclature for beam deflection and stress calculation equations.

W = load (lb)
E = Modulus of elasticity (lb/sq-in) I = Moment of inertia (in^4) x = distance from datum point (in) *l* = beam length (in)
d_N = distance from edge of beam to neutral axis (in)

y = deflection (in)
s = stress at the cross-section being evaluated (lb/in-in) Z = section modulus of the cross section of the beam

Z is calculated as I / d_N

The stress (in lb/sq. inch) at the cross section of the beam is calculated according to the formula:

$$s = \frac{W}{2Zl}(l-x)^2$$

The deflection of the beam (y) (in inches) at any point along the beam (x distance from datum point) is given by:

$$y = \frac{Wx^2}{24EIl}[2l^2 + (2l-x)^2]$$

a) Create a VBA Sub Procedure to estimate the stress (s) at any station along a beam and the deflection of the beam (y) as a function of known quantities W, E, I, d_N and x. Your VBA subroutine should read the input values: W, E, I, d_N and l from the spreadsheet. These values will be entered by the user in the worksheet as shown in Figure 2. The output of the VBA Sub consist of values of stress (s) and displacement (y). These values should be sent back to the worksheet and written as a function of the beam station length x (see Figure 2). Write a loop inside the Sub Procedure to write the output back to the worksheet. The values of s and y should be calculated every 5 inches along the beam.

	A	B	C	D	E
1					
2	Beam Calculations				
3	Programmer: A. Trani				
4	Date: 02/14/07				
5			Units	Calculation	
6	W	2000.00	lb		
7	E	30000000.00	psi		
8	I	240.00	in-in-in-in		
9	*l*	300.00	inches		
10	dN	12.00	in		
11	Beam Station (in)	Stress (lb/sq.in.)	Deflection (in)		
12	0.000	15000.000	0.000		
13	5.000	14504.167	0.000		
14	10.000	14016.667	-0.001		
15	15.000	13537.500	-0.002		

Figure 2. Worksheet of the Beam Calculation Problem.

```
Range("C9").Select
I = ActiveCell.Value

Range("C10").Select
l = ActiveCell.Value

Range("C11").Select
dN = ActiveCell.Value

Z = I / (dN)
Cells(2, 4).Value = Z

'Calculate number of Interations
CellNumber = "D" & (3)
Range(CellNumber).Select
Iterations = (l / 5) + 1
ActiveCell.Value = Iterations


For j = 1 To Iterations

CellNumber = "A" & (j + 13)
Range(CellNumber).Select
x = 5 * (j - 1)
ActiveCell.Value = x

CellNumber = "B" & (j + 13)
Range(CellNumber).Select
s = (W * (l - x) ^ 2) / (2 * Z * l)
ActiveCell.Value = s

CellNumber = "C" & (j + 13)
Range(CellNumber).Select
y = -((W * (x ^ 2)) / (24 * E * I * l)) * ((2 * (l ^ 2)) + (((2 * l) - x) ^ 2))
ActiveCell.Value = y

Next j


End Sub
```

Beam Calculations		Z (I/dN)	20
Programmer: Bel Caguiat		Iterations	61
Date: 2/22/2022			

Parameters		Values	Units
Load	W	2000	lb
Modulus of Elasticity	E	30000000	lbs/(in^2)
Moment of Inertia	I	240	in^4
Beam Length	*l*	300	in
Distance from Edge of Beam to Neutral Axis	dN	12	in

Beam Station (in)	Stress, s (lbs/sq.in)	Deflection, y (in)
0	15000.000	0.000
5	14504.167	-0.001
10	14016.667	-0.002
15	13537.500	-0.005
20	13066.667	-0.008
25	12604.167	-0.012
30	12150.000	-0.018
35	11704.167	-0.024
40	11266.667	-0.030
45	10837.500	-0.038
50	10416.667	-0.047
55	10004.167	-0.056
60	9600.000	-0.066

b) Test your VBA Sub procedure using the following values for the beam model parameters. Assume a beam is 250 inches in length and that we need to calculate the stress and deflection of the beam at various stations (say every five inches).

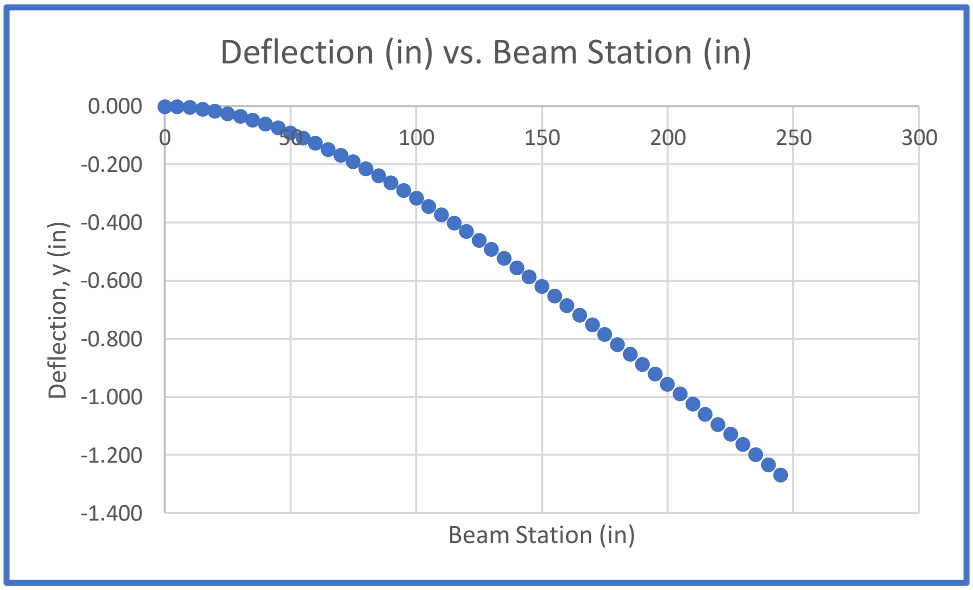
W = 1000 lb
E = 30e6 psi (steel) I =
100 in^4 l = 250 inches
distNeutralAxis = 8 inches

Beam Calculations		Z (I/dN)	12.5
Programmer: Bel Caguiat		Iterations	51
Date: 2/22/2022			

Parameters		Values	Units
Load	W	1000	lb
Modulus of Elasticity	E	30000000	lbs/(in^2)
Moment of Inertia	I	100	in^4
Beam Length	*l*	250	in
Distance from Edge of Beam to Neutral Axis	dN	8	in

Beam Station (in)	Stress, s (lbs/sq.in)	Deflection, y (in)
0	10000.000	0.000
5	9604.000	-0.001
10	9216.000	-0.002
15	8836.000	-0.005
20	8464.000	-0.008
25	8100.000	-0.012
30	7744.000	-0.017
35	7396.000	-0.023
40	7056.000	-0.030
45	6724.000	-0.037
50	6400.000	-0.045
55	6084.000	-0.054
60	5776.000	-0.064

c) Plot the solution of the steel beam deflections obtained in part (b). Label your plot accordingly.



d) Try the analysis for a 250 inch beam made of concrete with a value of E = 15e6. Show all your screen captures of your code and the output produced by the VBA code.

Parameters		Values	Units
Load	W	1000	lb
Modulus of Elasticity	E	15000000	lbs/(in^2)
Moment of Inertia	I	100	in^4
Beam Length	*l*	250	in
Distance from Edge of Beam to Neutral Axis	dN	8	in

Beam Station (in)	Stress, s (lbs/sq.in)	Deflection, y (in)
0	10000.000	0.000
5	9604.000	-0.001
10	9216.000	-0.004
15	8836.000	-0.009
20	8464.000	-0.016
25	8100.000	-0.024
30	7744.000	-0.035
35	7396.000	-0.046
40	7056.000	-0.060
45	6724.000	-0.075
50	6400.000	-0.091
55	6084.000	-0.109
60	5776.000	-0.127

```
' Parameters'
Range("C7").Select
W = ActiveCell.Value

Range("C8").Select
E = ActiveCell.Value

Range("C9").Select
I = ActiveCell.Value

Range("C10").Select
l = ActiveCell.Value

Range("C11").Select
dN = ActiveCell.Value

Z = I / (dN)
Cells(2, 4).Value = Z

'Calculate number of Interations
CellNumber = "D" & (3)
Range(CellNumber).Select
Iterations = (l / 5) + 1
ActiveCell.Value = Iterations


For j = 1 To Iterations

CellNumber = "A" & (j + 13)
Range(CellNumber).Select
x = 5 * (j - 1)
ActiveCell.Value = x

CellNumber = "B" & (j + 13)
Range(CellNumber).Select
s = (W * (l - x) ^ 2) / (2 * Z * l)
ActiveCell.Value = s

CellNumber = "C" & (j + 13)
Range(CellNumber).Select
y = -((W * (x ^ 2)) / (24 * E * I * l)) * ((2 * (l ^ 2)) + (((2 * l) - x) ^ 2))
ActiveCell.Value = y
```

e) Copy the beam deflections obtained for steel and concrete and compare the deflection profiles. Comment.

The deflection values for concrete appears to have larger negative values that deflection values for steel.

Deflection	
Steel	Concrete
0.000	0.000
-0.001	-0.001
-0.002	-0.004
-0.005	-0.009
-0.008	-0.016
-0.012	-0.024
-0.017	-0.035
-0.023	-0.046
-0.030	-0.060
-0.037	-0.075
-0.045	-0.091
-0.054	-0.109
-0.064	-0.127
-0.074	-0.148
-0.084	-0.169
-0.096	-0.191
-0.107	-0.214
-0.119	-0.239
-0.132	-0.264
-0.145	-0.290
-0.158	-0.317
-0.172	-0.344
-0.186	-0.373

Show screen captures of the output produced and the VBA code.

Problem 3

Use two construction equipment files provided in the Syllabus (weekly Planner - see Week 4) to answer the problem. Create a Macro to do the following tasks in the constructionEquiment1_blank file:

a) Change color in the header of the file to light green.

b) Format all columns (individually) using conditional formats using the color scales (green = lowest value, red - highest value).

```
Sub P3()

'a)
Range("A1:E1").Select
With Selection.Interior
.Pattern = xlSolid
.PatternColorIndex = xlAutomatic
.ThemeColor = xlThemeColorAccent6
.TintAndShade = 0
.PatternTintAndShade = 0
End With

'b)
Columns("C:C").Select
Selection.FormatConditions.AddColorScale ColorScaleType:=2
Selection.FormatConditions(Selection.FormatConditions.Count).SetFirstPriority
Selection.FormatConditions(1).ColorScaleCriteria(1).Type = _
xlConditionValueLowestValue
With Selection.FormatConditions(1).ColorScaleCriteria(1).FormatColor
.ThemeColor = xlThemeColorAccent6
.TintAndShade = 0
End With
Selection.FormatConditions(1).ColorScaleCriteria(2).Type = _
xlConditionValueHighestValue
With Selection.FormatConditions(1).ColorScaleCriteria(2).FormatColor
.Color = 255
.TintAndShade = 0
End With

Columns("D:D").Select
Selection.FormatConditions.AddColorScale ColorScaleType:=2
Selection.FormatConditions(Selection.FormatConditions.Count).SetFirstPriority
Selection.FormatConditions(1).ColorScaleCriteria(1).Type = _
xlConditionValueLowestValue
With Selection.FormatConditions(1).ColorScaleCriteria(1).FormatColor
.ThemeColor = xlThemeColorAccent6
.TintAndShade = 0
End With
Selection.FormatConditions(1).ColorScaleCriteria(2).Type = _
xlConditionValueHighestValue
With Selection.FormatConditions(1).ColorScaleCriteria(2).FormatColor
.Color = 255
.TintAndShade = 0
```

```
End With

Columns("E:E").Select
Selection.FormatConditions.AddColorScale ColorScaleType:=2
Selection.FormatConditions(Selection.FormatConditions.Count).SetFirstPriority
Selection.FormatConditions(1).ColorScaleCriteria(1).Type = _
xlConditionValueLowestValue
With Selection.FormatConditions(1).ColorScaleCriteria(1).FormatColor
.ThemeColor = xlThemeColorAccent6
.TintAndShade = 0
End With
Selection.FormatConditions(1).ColorScaleCriteria(2).Type = _
xlConditionValueHighestValue
With Selection.FormatConditions(1).ColorScaleCriteria(2).FormatColor
.Color = 255
.TintAndShade = 0
End With

End Sub
```

c) Reduce the number of significant figures to the right of the decimal to zero for the value of the equipment, miles traveled.

```
'c)
Range("C2:D2000").Select
Selection.NumberFormat = "0.00"
Selection.NumberFormat = "0.0"
Selection.NumberFormat = "0"
```

d) Reduce the number of significant figures to one for the age of the equipment.

```
For Each cell In [D2:D2000]
cell.Value = WorksheetFunction.Round(cell.Value, 0)
Next cell
For Each cell In [E2:E2000]
cell.Value = WorksheetFunction.Round(cell.Value, 0)
Next cell
```

Spreadsheet after a), b), c), d):

Equipment	Status	Value ($)	Miles	Age
Truck	Active	197454	150618	14
Excavator	Active	310383	65988	8
Loader	Active	287546	77343	10
Paver	In Maintenar	320393	91869	8
Truck	Active	180740	111064	7
Excavator	Active	291392	75334	5
Excavator	Active	301902	68854	7
Paver	Active	319486	95500	14
Excavator	Active	306411	76521	9
Truck	Active	199173	128822	13
Loader	Active	291021	79308	11
Truck	Active	184385	128589	11
Paver	Active	311834	94638	11
Excavator	Active	289383	73224	11
Paver	Active	326122	100174	10
Loader	Active	308359	90931	9
Paver	Active	318491	97409	13
Truck	Active	184089	150569	14
Excavator	In Maintenar	295394	71365	6
Truck	Active	181240	114354	9
Excavator	Active	303473	97813	13
Excavator	Active	297659	74422	8
Paver	In Transit	325087	104968	10
Truck	Active	195994	119123	9
Loader	In Transit	292028	69319	10

e) Create a pivot table to count the equipment by type and status (two dimensions).

Count of Equipment	**Column Labels**			
Row Labels	**Active**	**In Maintenance**	**In Transit**	**Grand Total**
Excavator	577	76	75	728
Loader	336	48	43	427
Paver	251	54	28	333
Truck	419	38	54	511
Grand Total	**1583**	**216**	**200**	**1999**

f) Create a pivot chart to plot the average value of the equipment by equipment type.

Row Labels	Average of Value ($)
Excavator	298773.1013
Loader	298168.5819
Paver	322545.0122
Truck	188198.8761
Grand Total	**274338.1276**

g) Repeat the macro created to constructionEquiment2_blank

Count of Equipment	Column Labels			
Row Labels	**Active**	**In Maintenance**	**In Transit**	**Grand Total**
Excavator	578	72	66	716
Loader	357	48	36	441
Paver	269	27	44	340
Truck	390	59	53	502
Grand Total	**1594**	**206**	**199**	**1999**

Row Labels	Average of Value ($)
Excavator	270747.4135
Loader	270897.248
Paver	302484.9506
Truck	179530.2075
Grand Total	**253271.5767**

VBA Code for e), f), g):

```
Range("A1").Select
Application.CutCopyMode = False
Sheets.Add
ActiveWorkbook.PivotCaches.Create(SourceType:=xlDatabase, SourceData:= _
"Sheet1!R1C1:R2000C5", Version:=7).CreatePivotTable TableDestination:= _
"Sheet2!R3C1", TableName:="PivotTable1", DefaultVersion:=7
Sheets("Sheet2").Select
Cells(3, 1).Select
With ActiveSheet.PivotTables("PivotTable1")
.ColumnGrand = True
.HasAutoFormat = True
.DisplayErrorString = False
.DisplayNullString = True
.EnableDrilldown = True
.ErrorString = ""
.MergeLabels = False
.NullString = ""
.PageFieldOrder = 2
.PageFieldWrapCount = 0
.PreserveFormatting = True
.RowGrand = True
.SaveData = True
.PrintTitles = False
.RepeatItemsOnEachPrintedPage = True
.TotalsAnnotation = False
.CompactRowIndent = 1
.InGridDropZones = False
.DisplayFieldCaptions = True
.DisplayMemberPropertyTooltips = False
.DisplayContextTooltips = True
.ShowDrillIndicators = True
.PrintDrillIndicators = False
.AllowMultipleFilters = False
.SortUsingCustomLists = True
.FieldListSortAscending = False
.ShowValuesRow = False
.CalculatedMembersInFilters = False
.RowAxisLayout xlCompactRow
End With
```

```
With ActiveSheet.PivotTables("PivotTable1").PivotCache
.RefreshOnFileOpen = False
.MissingItemsLimit = xlMissingItemsDefault
End With
ActiveSheet.PivotTables("PivotTable1").RepeatAllLabels xlRepeatLabels
With ActiveSheet.PivotTables("PivotTable1").PivotFields("Equipment")
.Orientation = xlRowField
.Position = 1
End With
ActiveSheet.PivotTables("PivotTable1").AddDataField ActiveSheet.PivotTables( _
"PivotTable1").PivotFields("Equipment"), "Count of Equipment", xlCount
With ActiveSheet.PivotTables("PivotTable1").PivotFields("Status")
.Orientation = xlColumnField
.Position = 1
End With
ActiveSheet.PivotTables("PivotTable1").RepeatAllLabels xlRepeatLabels
With ActiveSheet.PivotTables("PivotTable1").PivotFields("Equipment")
.Orientation = xlRowField
.Position = 1
End With
Range("D10").Select
Sheets("Sheet1").Select
Application.CutCopyMode = False
Sheets.Add
ActiveWorkbook.Worksheets("Sheet2").PivotTables("PivotTable1").PivotCache. _
CreatePivotTable TableDestination:="Sheet3!R3C1", TableName:="PivotTable2" _
, DefaultVersion:=7
Sheets("Sheet3").Select
Cells(3, 1).Select
' Creates pivot chart needed for table
With ActiveSheet.PivotTables("PivotTable2")
.ColumnGrand = True
.HasAutoFormat = True
.DisplayErrorString = False
.DisplayNullString = True
.EnableDrilldown = True
.ErrorString = ""
.MergeLabels = False
.NullString = ""
.PageFieldOrder = 2
.PageFieldWrapCount = 0
.PreserveFormatting = True
```

```
.RowGrand = True
.SaveData = True
.PrintTitles = False
.RepeatItemsOnEachPrintedPage = True
.TotalsAnnotation = False
.CompactRowIndent = 1
.InGridDropZones = False
.DisplayFieldCaptions = True
.DisplayMemberPropertyTooltips = False
.DisplayContextTooltips = True
.ShowDrillIndicators = True
.PrintDrillIndicators = False
.AllowMultipleFilters = False
.SortUsingCustomLists = True
.FieldListSortAscending = False
.ShowValuesRow = False
.CalculatedMembersInFilters = False
.RowAxisLayout xlCompactRow
End With
With ActiveSheet.PivotTables("PivotTable2").PivotCache
.RefreshOnFileOpen = False
.MissingItemsLimit = xlMissingItemsDefault
End With
ActiveSheet.PivotTables("PivotTable2").RepeatAllLabels xlRepeatLabels
With ActiveSheet.PivotTables("PivotTable2").PivotFields("Equipment")
.Orientation = xlRowField
.Position = 1
End With
ActiveSheet.PivotTables("PivotTable2").AddDataField ActiveSheet.PivotTables( _
"PivotTable2").PivotFields("Value ($)"), "Sum of Value ($)", xlSum
With ActiveSheet.PivotTables("PivotTable2").PivotFields("Sum of Value ($)")
.Caption = "Average of Value ($)"
.Function = xlAverage
End With
```

h) Find the average value of the equipment of the two files. Comment.

$$Average\ Value = \frac{274{,}338.1276 + 253{,}271.5767}{2}$$
$$\boldsymbol{Average\ Value} = \$\mathbf{263,804.8522}$$

i) Find the number of loaders active in both files. Comment.

$$Total\ \#\ of\ \ Active\ Loaders = 336 + 357$$
$$\boldsymbol{Total\ \#\ of\ \ Active\ Loaders = 693\ Loaders}$$