Assignment 5: VBA Programming

Solution

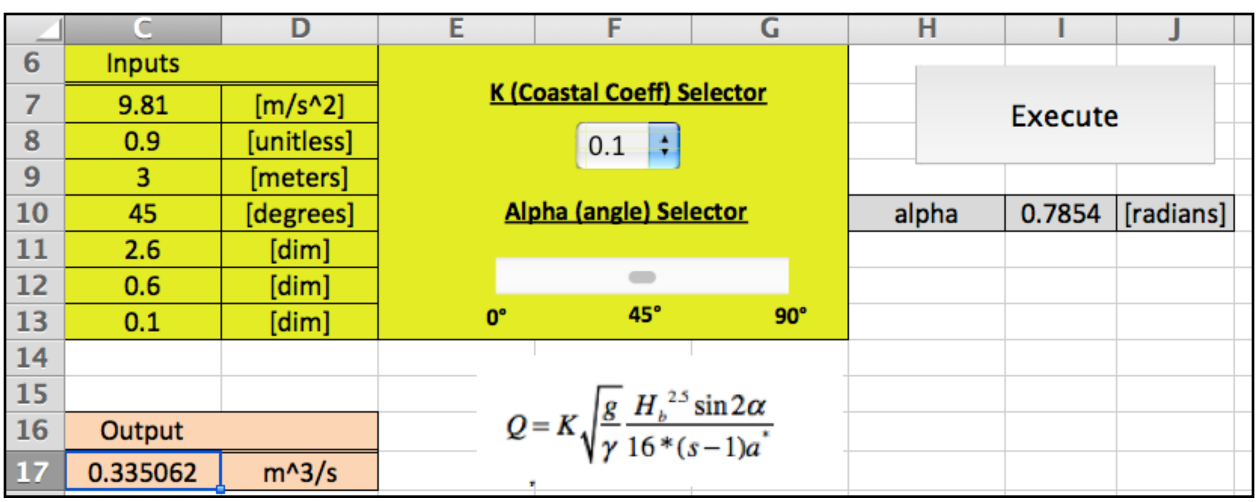
Date Due: March 5, 2015 Instructor: Trani

Problem 1

a) VBA Program & Excel interface

```
Sub TransportRate()
'This subrutine estimates the transport rate of sediment for beaches exposed
'to waves.
'
' Programmer: Moises Bobadilla
' Date: March/03/2015
'
'Inputs:
'K = coastal coefficient [dim]
'gamma = wave height to water depth at breaking ratio [dim]
'g = gravity constant [m/s^2]
'Hb = significant wave height [m]
'alpha = angle between waves and beach [degrees]
'ap = ratio of solid to total vol. of sediment [dim]
'
'Output:
'Q = longshore transport rate [m^3/s]

Sheets("Problem 1").Select


'------------Variable Assignment------------
Range("C7").Select
g = ActiveCell.Value

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

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

Range("I10").Select
alpha = ActiveCell.Value

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

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

Range("C12").Select
ap = ActiveCell.Value

Range("C13").Select
K = ActiveCell.Value
```

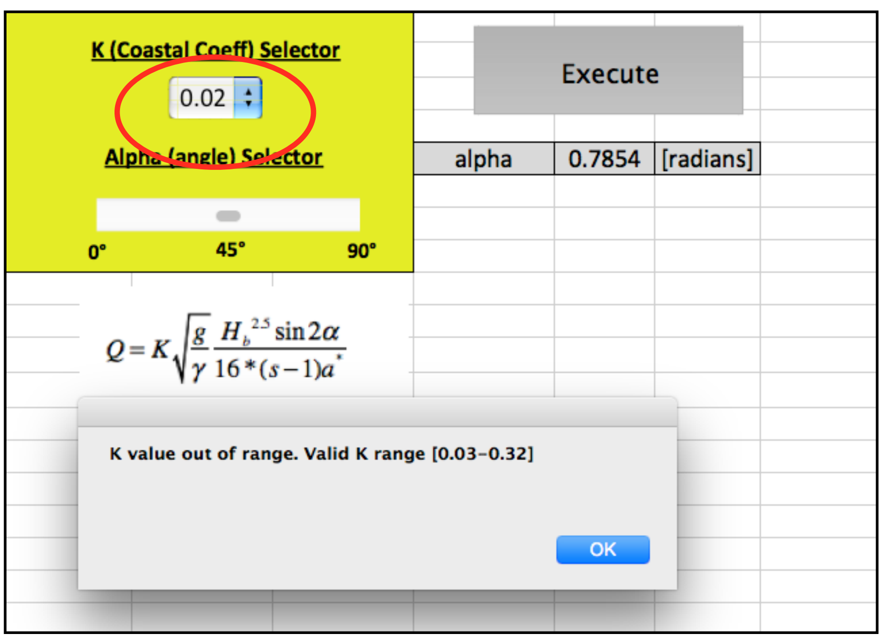
```
'-------------Data validation---------------
' A message box is output if the K value the user inputs is either below
'0.03 or greater than 0.32. Also, another if-statements check wheter the
'variable alpha is out of range (0 - 90 degrees).
If (K < 0.03) Then
    MsgBox ("K value out of range. Valid K range [0.03-0.32]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (K > 0.32) Then
    MsgBox ("K value out of range. Valid K range [0.03-0.32]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (alphaDeg < 0) Then
    MsgBox ("Alpha value out of range. Valid alpha range [0-90 degrees]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (alphaDeg > 90) Then
    MsgBox ("Alpha value out of range. Valid alpha range [0-90 degrees]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

'If none of the data ranges were violated, then the following calculation is made
' and the output is shown in the selected cell.
Else
    Q = K * (g / gamma) ^ 0.5 * (((Hb) ^ 2.5) * (Sin(2 * alpha))) / (16 * (s - 1) * ap)
    Range("C17").Select
    ActiveCell.Value = Q
End If


End Sub
```



b) Data Validation

```
'-------------Data validation--------------
' A message box is output if the K value the user inputs is either below
'0.03 or greater than 0.32. Also, another if-statements check wheter the
'variable alpha is out of range (0 - 90 degrees).
If (K < 0.03) Then
    MsgBox ("K value out of range. Valid K range [0.03-0.32]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (K > 0.32) Then
    MsgBox ("K value out of range. Valid K range [0.03-0.32]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (alphaDeg < 0) Then
    MsgBox ("Alpha value out of range. Valid alpha range [0-90 degrees]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

ElseIf (alphaDeg > 90) Then
    MsgBox ("Alpha value out of range. Valid alpha range [0-90 degrees]")
    Q = "Out of Range"
    Range("C17").Select
    ActiveCell.Value = Q

'If none of the data ranges were violated, then the following calculation is made
' and the output is shown in the selected cell.
Else
    Q = K * (g / gamma) ^ 0.5 * (((Hb) ^ 2.5) * (Sin(2 * alpha))) / (16 * (s - 1) * ap)
    Range("C17").Select
    ActiveCell.Value = Q
End If
```

This part of the code checks for both alpha and K, and warns the user in case the established valid range of values is violated.
Note: Can also use the Data Validation built in in Excel



Problem 2

a) VBA Code & Interface

```vba
'---------Program Variable Declaration ------------
Option Explicit
Dim A As Single
Dim B As Single
Dim D As Single
Dim R As Single
Dim velocity As Single
Dim i As Single
Dim CellNumber As String
Sub RailResistance()
'This program estimates the basic resistance for the high-speed train for a
'range of velocities in which the train operates
'
' Programmer: Moises Bobadilla
' Date: March/03/2015
'
'Inputs:
'
'A = 8.20200 [kN]
'B = 0.10656 [kN s/m]
'C = 0.01193 [kN s-s/m-m]
'v = velocity [m/s]
'
'Output:
'Rbasic = Train resistance [kN]


Sheets("Problem 2").Select 'Opens spreadsheet to read/write

'-------------Variable assignment-------------
Range("C2").Select
A = ActiveCell.Value

Range("C3").Select
B = ActiveCell.Value

Range("C4").Select
D = ActiveCell.Value
```

```vba
'---------------Table Headers-----------------
Range("B10").Select
ActiveCell.Value = "Velocity (m/s)"
Range("B10").Font.Bold = True

Range("C10").Select
ActiveCell.Value = "Range (kN)"
Range("C10").Font.Bold = True



'----Loop to estimate resistance at different speeds----
velocity = 0
For i = 0 To 85
    CellNumber = "B" & (i + 11)
    Range(CellNumber).Select
    ActiveCell.Value = i

    R = A + (B * velocity) + (D * (velocity) ^ 2)
    velocity = velocity + 1
    CellNumber = "C" & (i + 11)
    Range(CellNumber).Select
    ActiveCell.Value = R

Next


End Sub
```

	B	C	D	E	F
1		Inputs			
2	A	8.20200	[kN]		
3	B	0.10656	[kN s/m]		
4	C	0.01193	[kN s-s/m-m]		
5					
6		Train Resistance program			
7		Programmer: Moises Bobadilla			
8		Date: March/03/2015			
9					
10	**Velocity (m/s)**	**Range (kN)**			
11	0	8.20199966			
12	1	8.32048988		Run	
13	2	8.46284008			
14	3	8.6290493			
15	4	8.81911945			
16	5	9.03304958			
17	6	9.27083969			
18	7	9.53248978			
19	8	9.81799984			
20	9	10.1273699			

b) Improved program with sliders, user-defined lower and upper bound for velocity and speed step size selector

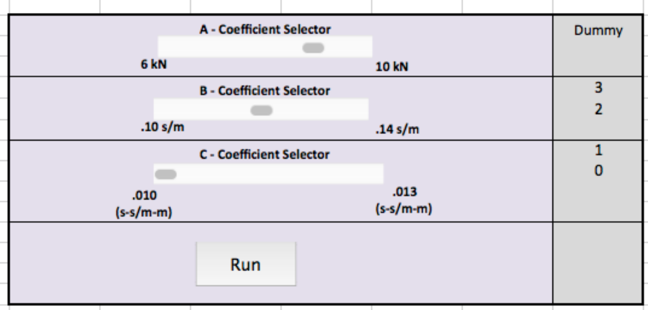
1. VBA Code

```
Dim velocity As Single
Dim i As Single
Dim MinRange As Single
Dim MaxRange As Single
Dim x As Single
Dim StepSize As Single
Dim NumberRows As Double
Dim CellNumber As String
Sub RailResistanceTask2()
'This program estimates the basic resistance for the high-speed train for a
'range of velocities in which the train operates at a user-defined step size
'
' Programmer: Moises Bobadilla
' Date: March/03/2015
'
'Inputs:
'
'A = 8.20200 [kN]
'B = 0.10656 [kN s/m]
'C = 0.01193 [kN s-s/m-m]
'v = velocity [m/s]
'
'Output:
'Rbasic = Train resistance [kN]


Sheets("Problem 2 -Task 2").Select

'-------------Variable assignment-------------
Range("C2").Select
A = ActiveCell.Value

Range("C3").Select
B = ActiveCell.Value

Range("C4").Select
D = ActiveCell.Value

'User-defined lower velocity bound
Range("C7").Select
MinRange = ActiveCell.Value

'User-defined upper velocity bound
Range("C8").Select
MaxRange = ActiveCell.Value

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

```
'---------------Table Headers-----------------
Range("B10").Select
ActiveCell.Value = "Velocity (m/s)"
Range("B10").Font.Bold = True

Range("C10").Select
ActiveCell.Value = "Resistance (kN)"
Range("C10").Font.Bold = True

Range("A11:D300").Clear

x = 0
velocity = MinRange 'Initial velocity defined as the Minimum velocity as
                    'defined by the user


 '----Loop to estimate resistance at different speeds----
NumberRows = ((MaxRange - MinRange) / StepSize) + MinRange
For i = MinRange To NumberRows
   CellNumber = "B" & (x + 11)
   Range(CellNumber).Select
   ActiveCell.Value = velocity

   R = A + (B * velocity) + (D * (velocity) ^ 2)
   CellNumber = "C" & (x + 11)
   Range(CellNumber).Select
   ActiveCell.Value = R

   velocity = velocity + StepSize 'increases velocity by the user-defined step size
   x = x + 1
Next


End Sub
```

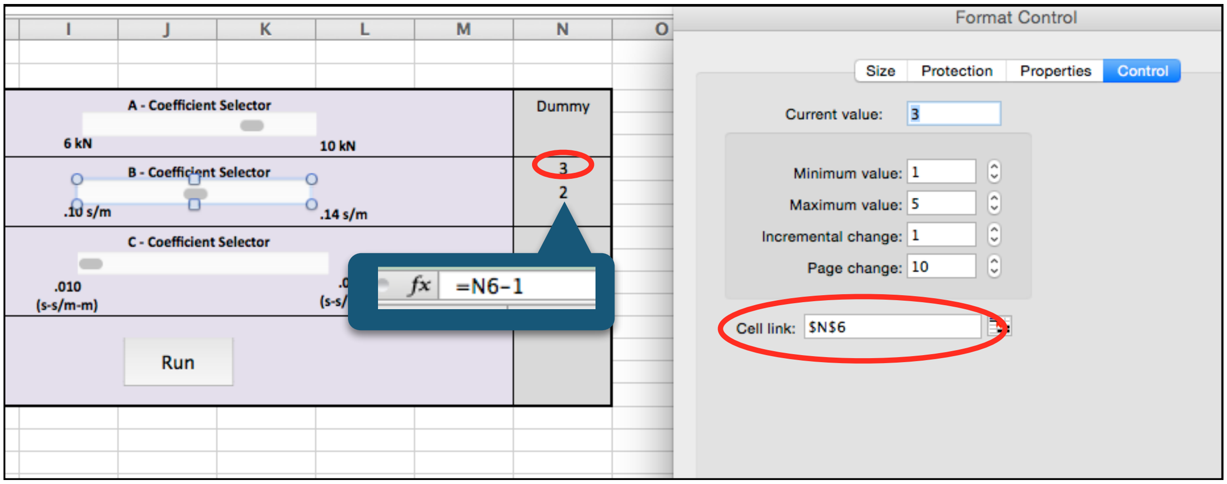
2. Interface

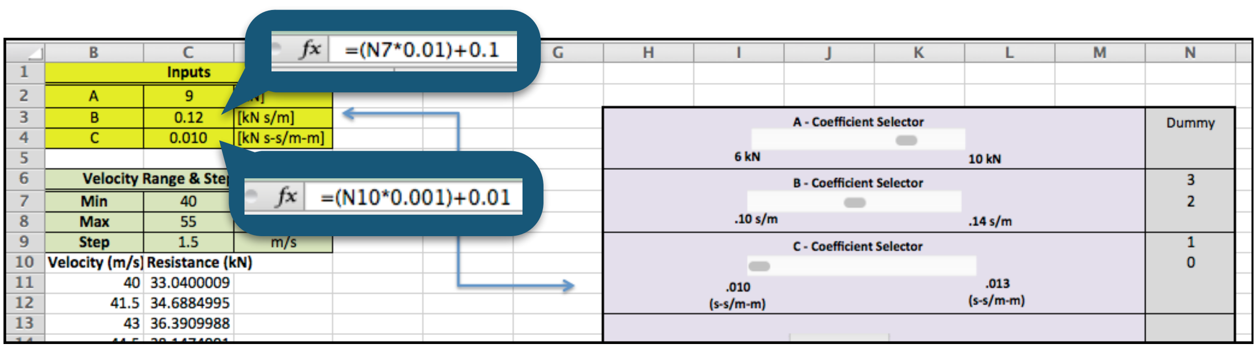
	B	C	D
1		Inputs	
2	A	9	[kN]
3	B	0.12	[kN s/m]
4	C	0.010	[kN s-s/m-m]
5			
6	Velocity Range & Step Selector		
7	Min	40	m/s
8	Max	55	m/s
9	Step	1.5	m/s
10	Velocity (m/s)	Resistance (kN)	
11	40	33.0400009	
12	41.5	34.6884995	
13	43	36.3909988	
14	44.5	38.1474991	
15	46	39.9580002	
16	47.5	41.8224983	
17	49	43.7410011	
18	50.5	45.713501	
19	52	47.7400017	
20	53.5	49.8204994	
21	55	51.9550018	
22			



a.3. Sliders

There are many ways to do this. Because sliders only take integers, I linked the slider to a "Dummy" number and then used a formula to link this number to the the input area where it would use the correct value. Shown below:





c) Test for various Shinkansen train sets

a. Shinkasen 200

Inputs		
A	9.21	[kN]
B	0.12	[kN s/m]
C	0.012	[kN s-s/m-m]
Velocity Range & Step Selector		
Min	20	m/s
Max	21	m/s
Step	1	m/s
Velocity (m/s)	Resistance (kN)	
20	16.4300003	

b. Shinkasen 300

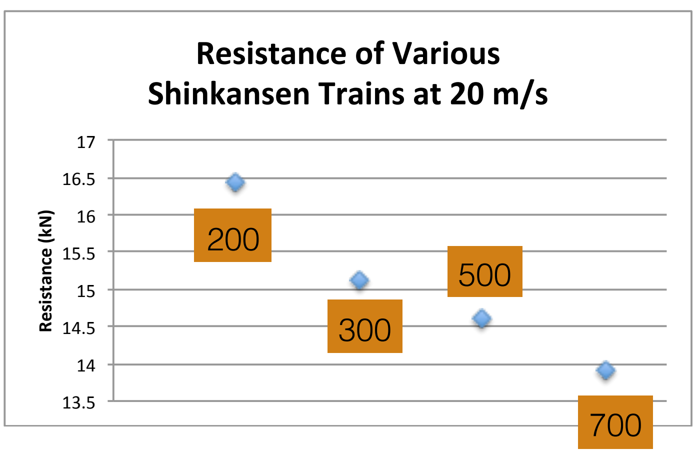
Inputs		
A	8.20	[kN]
B	0.11	[kN s/m]
C	0.012	[kN s-s/m-m]
Velocity Range & Step Selector		
Min	20	m/s
Max	21	m/s
Step	1	m/s
Velocity (m/s)	Resistance (kN)	
20	15.1199999	

c. Shinkasen 500

Inputs		
A	8.10	[kN]
B	0.11	[kN s/m]
C	0.011	[kN s-s/m-m]
Velocity Range & Step Selector		
Min	20	m/s
Max	21	m/s
Step	1	m/s
Velocity (m/s)	Resistance (kN)	
20	14.6000004	

c. Shinkasen 700

Inputs		
A	7.92	[kN]
B	0.10	[kN s/m]
C	0.010	[kN s-s/m-m]
Velocity Range & Step Selector		
Min	20	m/s
Max	21	m/s
Step	1	m/s
Velocity (m/s)	Resistance (kN)	
20	13.9200001	



As it can be seen above, the train which shows the least resistance at a speed of 20 m/s is **Shinkansen 700**. From this information, it can be inferred that this train is also the fastest from the four in question. This information is confirmed in the Wikipedia article (Under 'Speed Records').

Problem 3

a) **(Tasks 1 & 2)** VBA Code & Interface

```
Sub WaterTank()
'This subrutine estimates the reaction force generated by a leaking tank
'
' Programmer: Moises Bobadilla
' Date: March/03/2015
'
'Inputs:
'h1 = water depth to the leaking point [meters]
'h2 = distance from the bottom of the tank to the leaking point [meters]
'A = Area of leaking orifice [m^2]
'phi = equivalent friction paramter [dim]
'gamma = Specific Weight of water, (1000 kg/m^3) [kg/m^3]
' mu = contraction coefficient [dim]
'
'Outputs:
'v = velocity of leaking water flow [m/s]
'd = horizontal distance traveled by the leaking water [meters]
'Q = volumetric flow rate [m^3/s]
'F = friction force acting on tank [N]


Sheets("Problem 3").Select

'-------------Variable assignment-------------
g = 9.81

Range("C7").Select
h1 = ActiveCell.Value

Range("C8").Select
h2 = ActiveCell.Value

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

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

Range("C11").Select
gamma = ActiveCell.Value
```

```
'ComboBox linked to I8. IF thank is thin, this cell gets a value
'of 1, if thick it gets a value of 2. Later used in if-statement.
Range("I8").Select
ThinThick = ActiveCell.Value

'------------Assignment of mu value--------------
If ThinThick = 1 Then
    mu = 0.62

    Range("C12").Select
    ActiveCell.Value = mu

ElseIf ThinThick = 2 Then
    mu = 0.97
    Range("C12").Select
    ActiveCell.Value = mu

End If

'------------------Calculations------------------

v = phi * ((2 * g * h1) ^ 0.5)
Range("C16").Select
ActiveCell.Value = v

D = 2 * ((h1 * h2) ^ 0.5)
Range("C17").Select
ActiveCell.Value = D

Q = phi * (mu * A * (2 * g * h1) ^ 0.5)
Range("C18").Select
ActiveCell.Value = Q

F = 2 * gamma * g * A * h1
Range("C19").Select
ActiveCell.Value = F


End Sub
```

Type of tank
Thin

Inputs		
h1	18	[meters]
h2	1	[meters]
A	0.1	[m^2]
phi (Φ)	0.97	[dim]
gamma (γ)	1000	[kg/m^3]
mu (μ)	0.62	[dim]

Outputs		
v	18.2287752	[m/s]
d	8.48528137	[meters]
Q	1.13018406	m^3/s
F	35316	[N]

Run

b) (Task 3) Test program with following input: h1 = 18, h2 = 1.0, A=0.10, phi=0.97, gamma = 1000

Type of tank		
Thin		

Inputs		
h1	18	[meters]
h2	1	[meters]
A	0.1	[m^2]
phi (Φ)	0.97	[dim]
gamma (γ)	1000	[kg/m^3]
mu (μ)	0.62	[dim]

Run

Outputs		
v	18.2287752	[m/s]
d	8.48528137	[meters]
Q	1.13018406	m^3/s
F	35316	[N]

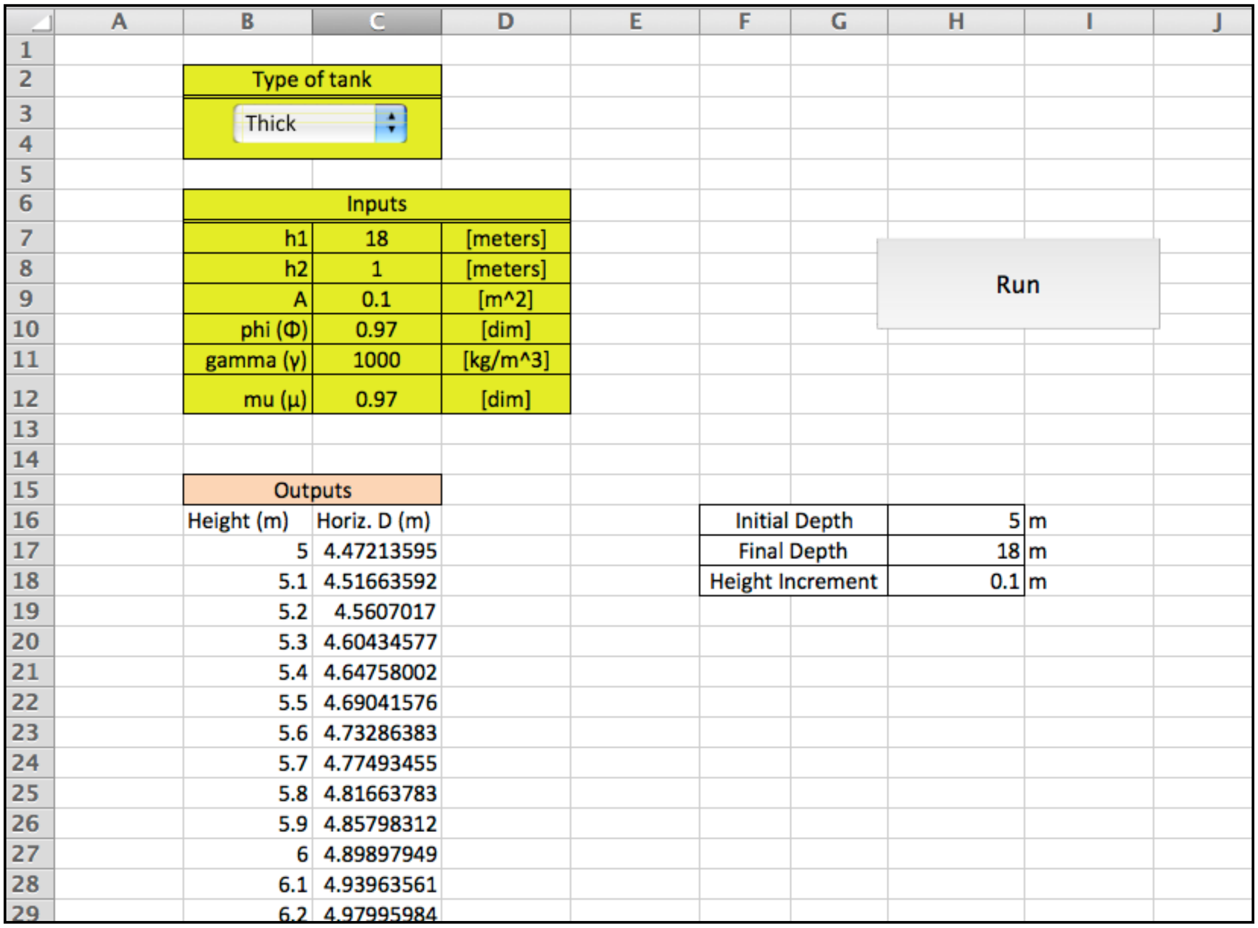
c) (Task 4) Examine sensitivity of d with water tank depth

a. VBA Code

```
Sub WaterTank2()
'This subrutine examines the sensitivity of d with water depth
'
' Programmer: Moises Bobadilla
' Date: March/03/2015
'
'Inputs:
'h1 = water depth to the leaking point [meters]
'h2 = distance from the bottom of the tank to the leaking point [meters]
'A = Area of leaking orifice [m^2]
'phi = equivalent friction paramter [dim]
'gamma = Specific Weight of water, (1000 kg/m^3) [kg/m^3]
' mu = contraction coefficient [dim]
'
'Outputs:
'v = velocity of leaking water flow [m/s]
'd = horizontal distance traveled by the leaking water [meters]
'Q = volumetric flow rate [m^3/s]
'F = friction force acting on tank [N]

Sheets("Problem 3 - Task 4").Select

'-------------Variable assignment-------------

'Initial water height, h1
Range("H16").Select
Yinitial = ActiveCell.Value

'Final water height, h2
Range("H17").Select
Yfinal = ActiveCell.Value

'height step
Range("H18").Select
dy = ActiveCell.Value

g = 9.81
```

```
Range("C7").Select
h1 = ActiveCell.Value

Range("C8").Select
h2 = ActiveCell.Value

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

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

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

Range("I8").Select
ThinThick = ActiveCell.Value

'------------Assignment of mu value--------------
If ThinThick = 1 Then
    mu = 0.62
    Range("C12").Select
    ActiveCell.Value = mu

ElseIf ThinThick = 2 Then
    mu = 0.97
    Range("C12").Select
    ActiveCell.Value = mu

End If

'------------Table headers--------------------
Range("B16").Select
ActiveCell.Value = "Height (m)"

Range("C16").Select
ActiveCell.Value = "Horiz. D (m)"

NumberIterations = ((Yfinal - Yinitial) / dy)
Range("B17:C100").Clear
Z = 0
For i = 0 To NumberIterations
    D = 2 * ((Yinitial * h2) ^ 0.5)

    CellNumber1 = "B" & (Z + 17)
    Range(CellNumber1).Select
    ActiveCell.Value = Yinitial
    Yinitial = Yinitial + dy

    CellNumber = "C" & (Z + 17)
    Range(CellNumber).Select
    ActiveCell.Value = D

    Z = Z + 1

Next

End Sub
```

b. Interface



Type of tank
Thick

Inputs		
h1	18	[meters]
h2	1	[meters]
A	0.1	[m^2]
phi (Φ)	0.97	[dim]
gamma (γ)	1000	[kg/m^3]
mu (μ)	0.97	[dim]

Run

Outputs	
Height (m)	Horiz. D (m)
5	4.47213595
5.1	4.51663592
5.2	4.5607017
5.3	4.60434577
5.4	4.64758002
5.5	4.69041576
5.6	4.73286383
5.7	4.77493455
5.8	4.81663783
5.9	4.85798312
6	4.89897949
6.1	4.93963561
6.2	4.97995984

Initial Depth	5	m
Final Depth	18	m
Height Increment	0.1	m

As it can be seen above, d is directly proportional to the height.