

Assignment 4: VBA Programming

Date Due: February 21, 2012

Instructor: Trani

Problem 1

The distance between two points on the surface of the Earth can be calculated using the following equation derived from spherical coordinates.

$$d_{earth} = R_E \cos^{-1}(\cos(\theta_1)\cos(\theta_2)\cos(\gamma_1 - \gamma_2) + \sin(\theta_1)\sin(\theta_2))$$

where: R_E is the Earth's radius in kilometers, θ_1 and θ_2 are the latitudes of two points on the surface of the Earth and γ_1 and γ_2 are the longitudes of the same two points in question.

The latitudes and longitudes of some cities in the U.S are shown in Table 1. You are allowed to convert the latitude and longitude coordinates into decimal format into your program before doing computations.

Table 1. Latitude and Longitudes of Various Airports.

City	Latitude (deg)	Longitude (deg)
Blacksburg	37-12-27.5000N	080-24-28.2000W
San Francisco, CA	37-37-08.3000N	122-22-29.6000W
New York, La Guardia	40-46-38.1000N	073-52-21.4000W
Seattle, WA	47-26-59.6000N	122-18-42.4000W

Task 1:

Create a GUI and the corresponding VBA code to estimate the distance between any two points. The program should read two sets of latitude and longitude points (i.e., two cities), calculate the distance between Blacksburg and the other 3 cities. Do the calculations in both kilometers and statute miles. Display the results (both km and miles) in the same interface and label accordingly. As usual, declare all variables in your code.

NOTE: to estimate the inverse cosine of an angle use the statement (in the VBA program)

application.acos(*angle*)

where ***angle*** is the angle (in radians) to be calculated. This statement invokes the acos function in the Excel application.

Task 2:

Test the program created by estimating the distance between Blacksburg and your home city.

Problem 2

This problem deals with a beam supported at both ends and with a uniformly distributed load W . More information about the equations of the beam can be found at: http://www.engineersedge.com/beam_bending/beam_bending1.htm.

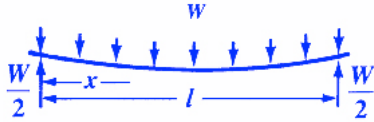


Figure 1. A simple beam supported at both ends. Source: http://www.engineersedge.com/beam_bending/beam_bending1.htm.

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)

dN = 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 / dN

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

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

The deflection of the beam (y) (in inches) is given by:

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

Task 1:

Create a VBA Sub Procedure to estimate the stress (s) at stations along a beam and the deflection of the beam (y) as a function of known quantities W , E , I , dN and x . Your subroutine should take as inputs the following values: W , E , I , dN and l . These values will be entered by the user in the worksheet as shown in Figure 2. The output of the VBA Sub Procedure consist of values of stress (s) and displacement (y). These values should be passed back to the worksheet and written as a function of the beam station length x (see Figure below). 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.

Task 2:

Test your VBA Sub procedure using the following values for the beam model parameters. Assume a beam is 400 inches in length and that we need to calculate the stress and deflection of the beam at various stations (say every 5 inches).

W = 2500 lb
 E = 30e6 psi
 I = 258 in⁴
 l = 300 inches
 distNeutralAxis = 12 inches

Task 3:

Try the analysis for a 400 inch beam made of titanium with a value of E = 25e6.

Show all your screen captures of the output and the VBA code.

Problem 3

An infrastructure engineer studies the cooling properties of a newly developed geosynthetic material to be used in pavement design applications. The geosynthetic material specimens are heated to approximately 200 degrees Celsius and then let alone to cool down naturally at ambient temperature. The engineer assumes the temperature can be explained with the following model:

$$T_t = T_a + (T_0 - T_a)e^{-ht}$$

where:

T_t = is the temperature of the material as a function of time (t)

T_a = ambient temperature (degrees Celsius)

T_0 = is the initial temperature of the geosynthetic material (deg. Celsius)

h = is a cooling constant of the material (1/minute)

t = is the time at which the temperature of the material is recorded (minutes)

Task 1:

Create a VBA subroutine to estimate the temperature of the geosynthetic material (T_t) for any temperature (t) given the following parameters:

T_a = 30 degrees Celsius

T_0 = 200 deg. Celsius

h = 0.01 (1/minute)

t = 20 (minutes)

Task 2:

Create a simple interface using Excel Form controls for this program to select the input parameters and in the same interface display all output parameters. The following ranges of the parameters are suggested:

T_0 = 100-250 deg. Celsius

T_a = -10 to 40 degrees Celsius

h = 0.01 to 0.1 (1/minute)

Task 3:

Use the computer program created in Task 3 to examine the sensitivity of T_t with time (t). Create a table in Excel for values of (t) starting at 1 minute and ending at 200 minutes (steps of 5 minutes). As usual, create the headers for the table in VBA code in the same VBA subroutine. Pass the output results to the spreadsheet and create a plot outside VBA showing the variation of T_t with time (t). Find the temperature of the geosynthetic material after 150 minutes.

Problem 4

Figure 3 illustrates the basic forces acting on a suspension bridge. The weight per unit length (w) is 125 kN/meter for the bridge in question. Formulas to calculate the horizontal (H) and vertical (V) forces acting on the bridge tower are:

$$V = \frac{1}{2} wS$$

$$H = \frac{wS^2}{8d}$$

$$T = \sqrt{H^2 + V^2}$$

where: w is the load applied on the suspension cable per unit length (kN/m), S is the span of the suspension bridge (meters), d is the maximum dip (meters) of the cable (see Figure 2) and T is the suspension cable tension (N).

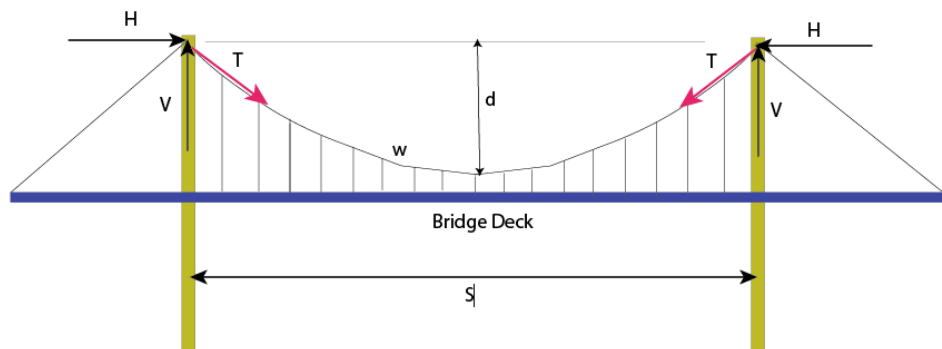


Figure 3. Suspension Bridge.

Task 1:

Create a simple VBA program to calculate the values of V , H and T . Produce three outputs in your subroutine and bring them back to a separate worksheet that acts as user interface. In your program declare all variables explicitly (use the Option Explicit command).

Test your program with the following values: $w = 150$ kN/meter, $S = 250$ meters, $d = 23$ meters

Task 2:

Create a user interface with three slider controls (in a separate sheet) and link them to the three input parameters w , S , and d . Test your interface and predict the tension in the bridge cable if w is 120 kN/m.