HOMEWORK – 3

DECISIONS AND LOOPS

1. Given the range of a real value \( x \) from 0 to 100 as: 0, 0.5, 1.0, 1.5, 2… 100, compute the value of \( y \) for the following equations using FOR loops. Note, you should use loop index (i,j,k etc..) as an integer; this also implies you cannot use “step 0.5” to solve this problem. In general, it is mandatory in this course to use only integer as loop indices.
   
   a. \( 2y = 7x - 4 \)
   
   b. \( 5y = 3x^2 - 2x - 1 \)
   
   c. \( y = \frac{x^3}{6} + \frac{2x^2}{9} - \frac{x}{3} - 1 \)

   You code should output both \( x \) and \( y \) values. Plot \( Y \) vs \( X \) and label appropriately.

   Submit only the plots (no data, please) and source code with your homework.

2. Develop a VB code that reads two arbitrary integer numbers as inputs and let the user know whether the number is a negative number, positive number, or a zero.

3. A company classifies its new recruits into the following 4 categories: Entry level, Mid level, Senior level and Expert level. They assign them relevant positions based on these categories. The criteria for each category is as follows:

<table>
<thead>
<tr>
<th>Entry Level</th>
<th>Experience: 0 - 1 years (i.e., ( \leq 1 \text{ yr.} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Education: Bachelor’s or Masters</td>
</tr>
<tr>
<td>Mid Level</td>
<td>Experience: 1-7 years (i.e., ( 1 &lt; x \leq 7 \text{ yrs} ))</td>
</tr>
<tr>
<td></td>
<td>Education: Bachelor’s or Masters</td>
</tr>
<tr>
<td>Senior Level</td>
<td>Experience: 7-12 years</td>
</tr>
<tr>
<td></td>
<td>Education: Masters</td>
</tr>
<tr>
<td>Expert Level</td>
<td>Experience: &gt; 12 years</td>
</tr>
<tr>
<td></td>
<td>Education: Masters</td>
</tr>
</tbody>
</table>

   Set up your spreadsheet to input two parameters: Experience and Education. The input for experience is a real number and the input for Education can only be one of the two letters B (Bachelor’s) or M (Masters). Write a visual basic program to classify the user into one of the above 4 categories based on the above criteria.

4. Develop a VB code that calculates the sum, average and standard deviation of the following ten numbers: 2, 3, 3.5, 6, 7, 8.1, 5, 9, 2.5, 1.5 Note: the formula for standard deviation is:

   \[
   SD = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})^2}
   \]

   Your program must use loops.

5. The following stress-strain data was collected from an experiment in the lab:

<table>
<thead>
<tr>
<th>Strain (m/m)</th>
<th>Observed Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.001</td>
<td>26.0</td>
</tr>
<tr>
<td>0.002</td>
<td>53.0</td>
</tr>
</tbody>
</table>
The Young’s modulus for the material is 26500 MPa. The stress for any material can be calculated if the Young’s modulus and the strain are given. Write a VB program to calculate the corresponding stress for the given strain using the formula: Stress = Strain * (Young’s Modulus). The program should also calculate the Error (e), which is the difference between the experimental value (i.e., the observed value) and the predicted (i.e., the calculated) value. Finally, compute the sum of the square of the errors which is: \[ S_e = \sum_{i=1}^{n} e^2 \]

6. Go to help within the Visual Basic environment and find out what the internal function “Mod” can do. Write a brief summary of this function and tell us what it can do. Also, explain clearly what would happen if the variables are real numbers and not integers.

7. Given an integer, determine if the integer is a prime number. A prime number is a number which has exactly two distinct natural numbers divisors: 1 and itself. Use the following pseudo code.

*Pseudo code:*

a) Read the integer, n
b) Check if the number is an even number (divisible by 2).
c) If the number is even and ≠ 2, then conclude it is not a prime number.
d) If the number is not even, continue.
e) Start a “for” loop from 3 to n.
f) Verify if the number is divisible by each number between 3 and n (use Mod function).
g) factors = factors + 1, if it is divisible.
h) If factors = 0, then it is a prime number.

8. Modify the above code so it checks if the integer is divisible only by every odd number (instead of every number) between 3 and n.

9. Text Problem 4.2

Federal income tax marginal rates on taxable income for single individuals in the United States are:

<table>
<thead>
<tr>
<th>Taxable income</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1 to $7000</td>
<td>10%</td>
</tr>
<tr>
<td>$7001 to $28,400</td>
<td>15%</td>
</tr>
<tr>
<td>$28,401 to $68,000</td>
<td>25%</td>
</tr>
<tr>
<td>$68,001 to $143,300</td>
<td>28%</td>
</tr>
<tr>
<td>$143,301 to $311,950</td>
<td>33%</td>
</tr>
<tr>
<td>Above $311,950</td>
<td>35%</td>
</tr>
</tbody>
</table>

*Marginal* means the rate applies to the increment in the given range. Thus, for $10,000, the first $7000 would be taxed at 10%, and the remaining $3000 (equal to 10,000 minus 7000) would be taxed at 15%. Thus, the tax on $10,000 would be

\[ 0.1 * 7000 + .15 * (10000-7000) = 700 + 450 = 1150. \]

Write a program to input taxable income and compute the tax owed. Apply your program to $25,000; $50,000; $75,000; and $175,000.
10. Do 4.5 from the text book. Use For loops (Instead of WHILE loop) and limit to 30 terms. The general Maclaurin cosine series is

\[
\cos(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots
\]

Evaluate the Maclaurin cosine series using For loops and limit to 30 terms. Use a tolerance of 0.5e^{-6} and \( x = 28^\circ \).

11. Bessel functions can be generated from the following series. Use this series to compute (hand calculate) the value of \( J_2(1.6) \):

\[
J_n(x) = \sum_{k=0}^{3} \frac{(-1)^k}{2^{n+2k}} \frac{x^{n+2k}}{k! \Gamma(n + k + 1)}
\]

Where \( \Gamma \) is the gamma function and \( \Gamma(m) = (m-1)! \) if \( m \) is an integer, \( \Gamma(1) = 1 \), and \( \Gamma(2) = (2-1)! \), and \( \Gamma(3) = 2! \), and so on. Also \( 0! = 1 \).

12. Using the above equation, write a VBA program that takes as input the values of \( x \) and \( n \) (the maximum number of terms in the summation sign). Run the code for \( n = 2 \) and \( x = 1.6 \) and verify your hand calculated answer. Also, run the code for \( n = 10 \), \( x = 1.8 \), and \( k \) varying from 0 to 15, and report the final output.

13. Give the output of this code? Show hand calculation

```vba
Dim i As Integer, k As Integer, sum As Single, a As Single
a = 2.25
sum = 9#
For i = 1 To 3
    For k = 1 To 2
        sum = sum + a * i * k
    Next k
Next i
Cells(1, 1) = sum
End Sub
```

Note, # is same as ".0"; If you type a real number 5.0 then Visual Basic will display it as 5#.

14. Find the error related to the following code segments. Do not use the Excel debugger.

a) **assume all variables are declared**

\[
x=5
y=\log\left(\frac{(x^2)-32}{(x-1)}\right)
\]

b) **assume all variables are declared**

\[
x=1
y=\log\left(\frac{(x^2)+32}{(x-1)}\right)
\]

15. Hand solve the bubble sort problem for 9, 11, 21, 3, 15