1. (15 pts) Short Answer. Provide brief (1-3 sentence) answers to the following:

   a) What is the difference between a program that runs under a virtual machine vs. one that does not?

   b) What aspect of the .NET framework allows a programmer to easily create a program with some parts written in FORTRAN and others written in VB.NET?

   c) What happens when we compile a program?

   d) What is the difference in the binary representation between the String “5” and the number 5 represented as an Integer? (You can be general, i.e. you don’t have to specifically say exactly what bits differ)

   e) What does “Option strict on” force the programmer to do?
2. (6 pts) Arithmetic Operations

Show the output of the following code fragment:

```csharp
Console.WriteLine(CInt(5.6))
Console.WriteLine(1 + 2 * 3 + 4)
Console.WriteLine(10 Mod 3)
```

3. (9 pts) Find the Bugs

All of the following code snippets have a bug. Identify each one and fix the bug.
Assume the necessary code is in place to make a working program (e.g. the necessary
TextBoxes or ListBoxes exist, variables declared, the code is within some event, etc.).

a) The following code should print “Big” or “Bigger”

```csharp
Dim i As Integer
i = CInt(InputBox("Enter a integer."))
If (0 < i < 10) Then
    Console.WriteLine("Big")
ElseIf (10 < i) Then
    Console.WriteLine("Bigger")
End If
```

b) The following sets n to the greater of two numbers entered in textboxes:

```csharp
Dim n As Integer
If (TextBox1.Text < TextBox2.Text) Then
    n = TextBox2.Text
Else
    n = TextBox1.Text
End If
```

c) The following determines if a number n is even or odd and puts the result in a listbox:

```csharp
If ((n mod 2)=0) Then
    ListBox1.Text = n & " is even"
Else
    ListBox1.Text = n & " is odd"
End If
4. (15 pts) Working With Strings and Random Numbers

For this problem, write code that could go inside a button click event. Your program has a TextBox named **txtInput**. If the string entered in **txtInput** is less than 4 characters long, output “too short” to the Console. Otherwise, your code should select a substring at random from the entire string and output it.

For example, if the user inputs “abcd” then one of the following substrings should be printed at random: a, b, c, d, ab, abc, abcd, bc, bcd, cd.
5. (20 pts) Taxes!

In a distant land, far, far, away, the income tax rate schedule is as follows:

If $0 \leq \text{taxable income} < $6000 then
your tax is 10% of the amount over 0
If $6000 \leq \text{taxable income} < $67700 then
your tax is $600 + 15\% \text{ of the amount over 6000}
If $67700 \leq \text{taxable income}$ then
your tax is $14625 + 27\% \text{ of the amount over 67700}

Given the following form:

![Taxes! form](image)

Write code that goes into the `btnCalcTaxes_Click` event that calculates the amount of taxes based upon value entered in `txtIncome` and outputs the tax owed in the `txtTaxes` textbox.
6. (15 pts) Scoping and Parameters

Give the output of the following program when it is executed, starting in the Form_Load event. Note that some parameters are passed using ByRef and others are passed using ByVal.

```vbnet
Public Class Form1
    Inherits System.Windows.Forms.Form
    Dim s0 As String

    Private Sub Form1_Load(...) Handles MyBase.Load
        Dim s1, s2 As String
        s0 = "a cow says moo"
        s1 = "a dog says woof"
        s2 = "a dogcow says moof"
        Console.WriteLine("In Load " & s0 & ", " & s1 & ", " & s2)
        DoStuff(s1, s2)
        Console.WriteLine("In Load " & s0 & ", " & s1 & ", " & s2)
    End Sub

    Sub DoStuff(ByRef s1 As String, ByVal s2 As String)
        s1 = "a cat says meow"
        s2 = "a pig says oink"
        s0 = DoMoreStuff()
        Console.WriteLine("In DoStuff " & s1 & "," & s2)
    End Sub

    Function DoMoreStuff() As String
        Console.WriteLine("In DoMoreStuff " & s0)
        Return "a sheep says baa"
    End Function

End Class
```
7. (20 points) Yet Another Running Calculator

In this variant of the running race calculator, the inputs to the problem are:

- Distance of the race in miles
- Desired finishing time, in hours, minutes, and seconds

The output of the problem is:

- The pace you must run (expressed in minutes and seconds per mile) to finish the race in the desired time

a) Describe an algorithm that will convert the inputs into the desired output. Be specific and give the necessary equations to perform the conversion.

b) Write code that could be placed in a button click event handler to output the desired pace using a MsgBox. Use the InputBox function to read in the distance and finishing time in hours, minutes, and seconds.