

Making Choices


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Mechanical Engineering 209
**Computer Programming for
Mechanical Engineers**

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Outline


- Review last class
 - Transferring information in functions and subs
- Using the \ and MOD operators
- String variables and constants
- Relational operators
- Logical operators
- Overall operator precedence
- If statements



Review Integer Operations

- Use the \ operator to get integer division with truncation (decimal part eliminated)
 - In VBA an operation like 1/3 gives .333333
 - In VBA 1\3 gives zero
- The MOD operator gives the remainder
 - N1 MOD N2 gives the remainder when N1 is divided by N2 (N1 and N2 integers)
 - Examples: 25 / 4 25 \ 4 25 MOD 4
 - 4 / 25 4 \ 25 4 MOD 25

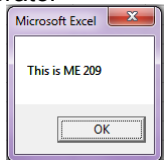

– Results: 6.25 6 1
 0.16 0 4



Review String Variables


- Declare string variables hold text information using Dim <variable> As String
- String constants: any text bordered with quotation marks e.g.: "ME 209"
- Concatenate (join) two strings with the concatenation (&) operator

```
Dim s As String
s = "ME 209"
MsgBox "This " & s
```


Review Relational/Logical Operator

- Relational operators compare other variables and have true or false results
- VBA operators are <, <=, =, >, >=, <>
 - Usual definitions with <> as not equal
- Logical operators {Not And Or} combine logical results
 - **X And Y** is true if both **X** and **Y** are true
 - **X Or Y** is true if either **X** or **Y** are true
 - **Not X** is true(false) if **X** is false(true)



Review All Operator Precedence

Parentheses (Evaluate me first)
 Exponentiation ^
 Unary minus - (E.g. -x)
 Multiply/Divide * /
 Integer Division \
 Remainder Mod (E.g. 7 Mod 4 = 3)
 Addition/Subtraction + -
 String concatenation &
 Relational < <= = >= > <>
 Logical in following order: Not And Or



When is a year is a leap year?

- Years that are evenly divisible by 4
- Except years evenly divisible by 100 and not leap years – unless the year is evenly divisible by 400
- If year is an integer program variable, how would you write a general condition that is true for any leap year and false if a year is not a leap year?
- HINT: Start with year MOD 4 = 0

Choice Statements

- The If statement <condition> must have a Boolean value of true or false
 If <condition> Then
 <statements to be executed if the condition is true>
 End If
 <Transfer control to first statement after the End If if <condition> is false>
- Alternative version for one statement in If
 If <condition> Then <statement1>

Overtime Example

```

' Compute base pay for all hours
pay = hours * rate
If hours > 40 Then
' Add overtime pay
    pay = pay + 0.5 * rate _
        * (hours - 40)
End If
MsgBox "Pay = " & pay
    
```

If - Else Statements

- The If-Else statement <condition> must have a Boolean value of true or false
 If <condition> Then
 <statements to be executed if the condition is true>
 Else
 <statements to be executed if the condition is false>
 End If
 <Transfer control here after execution>

If-Else Example

- Test for complex roots in solution of quadratic equation, $ax^2 + bx + c = 0$
 – Complex if $b^2 - 4 * a * c < 0$, real otherwise
- ```

If b^2 - 4 * a * c < 0 Then
 MsgBox "Complex Roots"
Else
 MsgBox "Real Roots"
End If

```

### Equality Comparisons

- Real data types (single and double) may have slight errors due to round-off after calculations
  - If  $x = 1.000000000000$  and  $y = 1.000000000001$  the two are practically equal, but  $x = y$  is false
  - Test  $abs(x - y) <= eps * (abs(x) + abs(y))$  where  $eps$  is a small number ( $\approx 1e-14$  for type Double)
    - Consider  $x = y$  if  $expression$  is true

### If – Else If

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```

If <condition1> Then
 <Statements done if condition1 is true>
ElseIf <condition2> Then
 <Statements done if condition2 is true>
ElseIf <condition3> Then
 <Statements done if condition3 is true>
<May be other conditions>
Else
 <Statements done if all conditions false>
End If
<Execute here after any statements done>

```

May have zero or many ElseIf's; Else is optional

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### If – Else If Explained

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- For the first true condition, statements following the If or Else If are executed
- Once any statements are executed, transfer to the first statement after the End If
- Statements for only the first true condition are executed
- The Else block is optional
  - If no conditions are true those statements are executed

```

If <condition1> Then
 <Statements done if condition1 is true>
ElseIf <condition2> Then
 <Statements done if condition2 is true>
ElseIf <condition3> Then
 <Statements done if condition3 is true>
<May be other conditions>
Else
 <Statements done if all conditions false>
End If
<Execute here after any statements done>

```

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### Use of If Statements

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- Consider the following function y(x)
  - y = 0 for x < 0
  - y = x for 0 ≤ x < 1
  - y = x<sup>2</sup> for 1 ≤ x ≤ 10
  - y = 100 for x > 10
- What is the code to compute y for any x?

```

If x < 0 Then
 y = 0
ElseIf x >= 10 Then
 y = 100
Else
 y = x
End If

```

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### Use of If Statements

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```

If x < 0 Then
 y = 0
ElseIf x < 1 Then
 y = x
ElseIf x <= 10 Then
 y = x^2
ElseIf x > 10 Then
 y = 100
End If

```

Do not put a space between the else and the if of ElseIf

Can type in lower or upper case – VBE will rewrite in its preferred case

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### Exercise

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- Write a function that accepts a type double variable x and uses an if-elseif structure to return a string value of “Positive”, “Negative” or “Zero” depending on the value of x
- Test your function with positive, negative and zero values from the worksheet
- Hint: What is your function header?

```

Function <name>(x As Double) As String

```

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### Next Programming Assignment

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- Apply if-else if structure to solution of quadratic equation: ax<sup>2</sup> + bx + c = 0
- Consider cases of improper specification (e.g.: a = 0)
- Regular results include  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ 
  - Two distinct real roots
  - Duplicate real root when b<sup>2</sup> = 4ac
  - Complex roots when b<sup>2</sup> < 4ac

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### Input-Output Example

| Solution of Quadratic Equation |          |    |  |  |
|--------------------------------|----------|----|--|--|
| Input Data                     |          |    |  |  |
| a                              | b        | c  |  |  |
| 1                              | 4        | 1  |  |  |
| Output Results                 |          |    |  |  |
| Two real roots                 |          |    |  |  |
| X1                             |          | X2 |  |  |
| -0.26795                       | -3.73205 |    |  |  |

Description of Output Situation → (points to 'Two real roots')  
 Description of Individual Output Items → (points to 'X1')  
 Numerical Results → (points to '-0.26795')

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### Another Input-Output Example

| Solution of Quadratic Equation |   |                |  |  |
|--------------------------------|---|----------------|--|--|
| Input Data                     |   |                |  |  |
| a                              | b | c              |  |  |
| 1                              | 2 | 5              |  |  |
| Output Results                 |   |                |  |  |
| Complex Roots                  |   |                |  |  |
| Real Part                      |   | Imaginary Part |  |  |
| -1                             | 2 |                |  |  |

Description of Output Situation → (points to 'Complex Roots')  
 Description of Individual Output Items → (points to 'Real Part')  
 Numerical Results → (points to '-1')

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### Example of Output For Input Error

| Solution of Quadratic Equation |   |   |  |  |
|--------------------------------|---|---|--|--|
| Input Data                     |   |   |  |  |
| a                              | b | c |  |  |
| 0                              | 0 | 0 |  |  |
| Input Error a=b=c=0            |   |   |  |  |
| Infinite Roots                 |   |   |  |  |

Description of Input Error → (points to 'Input Error a=b=c=0')  
 Description of Result Implied by Bad Input → (points to 'Infinite Roots')  
 No Numerical Results → (points to 'Infinite Roots')

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- ### What Is Required
- Write a macro that gets data from the worksheet using statements like a = Range("A1").Value
  - Returns labels and results to worksheet using statements like Range("G4").Value = "Two Real Roots"
  - Table on next page, copied from assignment, shows required output for all possible cases
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| Output Requirements Table                 |                                           |                                    |                     |                                    |
|-------------------------------------------|-------------------------------------------|------------------------------------|---------------------|------------------------------------|
| Situation                                 | Output 1 descriptor                       | Output 1 Equation                  | Output 2 descriptor | Output 2 Equation                  |
| Non-numeric data in a, b, or c            | Use MsgBox function to give error message |                                    |                     |                                    |
| a=b=c=0, infinite solutions               |                                           |                                    |                     |                                    |
| a=b=0, c->0, no solution                  |                                           |                                    |                     |                                    |
| Linear equation (a=0), only one solution  | x                                         | -c/b                               |                     |                                    |
| Duplicate real root                       | x1 = x2                                   | -b/(2a)                            |                     |                                    |
| Two real roots                            | x1                                        | $\frac{-b + \sqrt{b^2 - 4ac}}{2a}$ | x2                  | $\frac{-b - \sqrt{b^2 - 4ac}}{2a}$ |
| Complex Root, real part ± i(complex part) | Real part                                 | $\frac{-b}{2a}$                    | Complex part        | $\frac{\sqrt{4ac - b^2}}{2a}$      |

Macro will always use same input and output cells. Copy input and results from each case given on assignment to separate area on worksheet before running another case.