Computer Tools

- **In today's technology world, every engineering and computer science discipline uses computers:**
  - **For computer scientists, as an aid in writing programs.**
  - **For engineers, as a tool to help in the design process, and also to help in solving complex equations.**
- **In most scientific and engineering disciplines, the most useful mathematical equations normally do not have closed solutions.**
  - **Often, useful equations are non-linear, perhaps involving second-order differential equations, for which there is no general solution.**

Tools (2)

- **This means that many equations are solved using a numerical approach (a fancy way of saying that answers are tried until one works!).**
- **For modern technologists, there are many useful computer tools, normally programs that aid in solving complex equations.**

Tools (3)

- **In a course such as ECS 1200, we simply do not have the time to examine many of the available tools.**
- **However, there are two tools, both readily available, that are useful to undergraduates in ECS that we can survey briefly.**
- **These tools are:**
  - **Excel – An application in the Microsoft Office™ suite of programs, that is quite use for mathematical analysis and charting of simpler mathematical relationships.**
  - **MatLab – A more advanced tool that can frequently help in problem solving, circuit simulation, and graphical analysis.**

Tool Availability

- **Microsoft Excel™ is available in the Microsoft Office™ package.**
  - **Generally not available stand-alone but only as a part of the Office suite of programs.**
  - **Very reasonably priced (the Office package is available at the UTD Technology Store [in the same building and adjacent to the UTD Bookstore]for $33.00).**
- **MatLab™ is available to the student at UTD at a large discount, similar to the Office suite of software.**
  - **At the UTD Tech. Store, cost is $98.99 (normally ~$500).**
  - **Although you may not use MatLab a great deal for a year or two, it will be a very useful tool your junior and senior years.**

Using Excel

- **Excel is a chart development language, designed to organize large arrays of data and perform calculations on this data as required.**
- **In addition, Excel has the ability to convert chart material into graphs, making it easier to understand specific datasets.**
- **Besides addition, subtraction, multiplication, and division, Excel does many other calculations, including counting functions, trigonometry functions, compound interest, and statistical functions such as average, median, and standard deviation.**

Some Excel Examples

- **Following are some examples of Excel functionality. You can use these for reference when doing the homework assignment on mathematical tools.**
  - **Counts values within certain ranges; also averages values in a partially-filled chart. Excel can use the countif function to easily calculate averages of various parts of a dataset.**
  - **Calculates trigonometric functions of a string of values and easily converts the answers into a graph.**
  - **Calculate many useful financial functions, such as future value of a savings plan, net present value of an investment, etc.**
- **Note that for what started out as essentially a financial and numerical charting tool, Excel has grown up!**

General Comments on Excel

- **Excel is a chart-building application that facilitates the collection and arrangement of data, and also allows processing of that data in many useful ways.**
- **One of the features of Excel is the ability to quickly format a chart to do many kinds of calculations.**
  - **Further, if calculations need to be made multiple times, Excel makes use of a "Copy" function to allow a formula to be used in many cells, with only a single entry of the formula.**
  - **Due to the ability of the user to replicate functionality and even rows or columns of data, complex datasets with even more complex calculations can be set up very quickly.**

Comments (2)

- **Because Excel is very flexible in its ability to arrange data and quickly include computational directions, Excel is a favorite in business and academia for a variety of applications:**
  - **Class grades (!)**
  - **Accounting and bookkeeping**
  - **Scientific areas where data is often arranged in chart format and calculations are primarily algebraic or trigonometric.**
  - **Business requirements for statistical or financial calculations.**
  - **Record keeping, where the ability to quickly make copies of information and disseminate it is valuable.**

Chart Set-Up

- **Set-up may be accomplished very quickly in Excel, due to its ability to replicate information and formulae.**
- **The following example shows how rapidly a chart may be set up to provide useful information.**

Excel Chart #1→→→→ →→→→

Basic Math and Some Useful Functions

- **Many charts are put together simply to summarize certain values (expenditures, receipts, salaries, expenses, etc.)**
- **While adding columns of figures is straightforward, sometimes special data requirements will mandate the use of more sophisticated Excel functionality.**

Excel Chart #2→→ →→ →→ →→

Trigonometric Calculations

- **Excel can perform many straightforward mathematical calculations, include both regular and hyperbolic trig functions, powers, logarithms (natural and base 10), array calculations, etc.**
- **Once a chart has been created and calculations completed, it is easy to convert sets of data into graphs. Excel allows many types of graphs. If you need a special type, you may need to experiment a bit to find the right graphical representation.**

Excel Chart #3→→ →→ →→ →→

Financial Calculations

- **Excel is quite good at many sorts of financial calculations (accounting and bookkeeping), and is even useful for personal finances.**
- **For example, what if you want to start a savings account by putting $50 in an account each month. Interest rates are not very high right now, but could go higher soon. How would your savings accumulate at various interest rates?**

Excel Chart #4→→ →→ →→ →→

Excel Summary

- **Students can acquire Microsoft Office very reasonably at the UTD Tech. Store.**
- **Since you probably have it on your laptop (even if you have a Mac), it is well worth the time to explore its capabilities and become familiar with the mechanisms of setting up a data chart.**
- **Over the last three decades that it has been available, I have found Excel to be one of the more useful software packages that is available. Other than PowerPoint, I use it today more than any other computer tool.**

MatLab

- I have not used MatLab® a great deal (most of my experience is with MathCad, a similar tool).
- It is basically a high-performance tool for technical computing, integrating computation, visualization, and programming in such a way that problems and solutions are expressed in familiar mathematical notation.
- It is a recommended mathematical tool at UTD and, as mentioned earlier, is available at the UTD Tech. Store.
- We will watch a brief demonstration of fundamental capabilities and then go through four exercises to see a bit of MatLab capabilities. →→→→→→→→→

MatLab Example 1

- MatLab is a very powerful tool for building equations to solve complex problems, everything up to second-order differential equations that require a numerical approach.
- Clearly, in a half-lecture, we can only cover a few examples. This would be a great project for you in the summer when you have some extra time.
- MatLab itself is complex, as you would expect of a very flexible, powerful mathematical engine that can be useful in solving just about any scientific equation.

MatLab Example 1 (2)

- **MatLab can easily solve families of linear equations.**
- **For example, suppose you need to solve three linear equations for x, y, and z such that:**

  2x+3y+z=11
  x+y+z=6
  4x-3y+z=1
- **The MatLab command to solve the equations would be:**

  >> [x,y,z]=solve('2*x+3*y+z=11','x+y+z=6','4*x-3*y+z=1')
- **Note in MatLab (similar to other languages) that * = multiply, and that the equations are surrounded by apostrophes and separated by commas. →→**

MatLab Example 2

- **An even tougher set of equations – say, five linear equations, would be even easier, compared to manual solution:**

  2v+2w+2x+2y+2z=30
  2v+2w+2x+y-z=19
  4x+y-z=3
  v+w+x-y-z=5
  5v-w+2x+2y+2z=27

- **The same "solve" function is used. Equations are written as before, using "*" to denote multiplication, quotes (') to denote the range of each equation, and a comma separator. →→→→ →→→→ →→→→**

A Third MatLab Example

- **MatLab can also graph functions in two or three dimensions, and solve all sorts of trigonometric problems.**
- **Consider this simple example. We want to graph the product of two sine functions from 0 to π:**
  - **Let x be a variable ranging from 0 to 1.**
  - **y is another variable ranging from 0 to 1.**
  - **One thing that MatLab demands is that we specify the increments in which variables change over an extent.**
  - **Thus we set: x=0.01:0.01:1 and y=0.01:0.01:1 This says that x and y will vary from 0.01 to 1 in 0.01 increments.**
  - **Now, define v=sin(pi*x) and w=sin(pi*y)**

Third Example (2)

- Now say we want to multiply the two functions together.
- We set z=v'*w. Note that we have to use v' here, not v, as since v' is v transpose, and as we are multiplying two matrices together, using v' means that we get element by element multiplication.
- Now we can plot z to view the family of curves using "plot(z)", or, if we consider x and y Cartesian coordinates, we can plot the function z in three dimensions using the "surf" feature, that is, "surf (z)"
- This operation looks as follows: →→→ →→→ →→→ →→→

Final Example

- **MatLab can easily solve differential equations as well.**
- **For example, consider a 2nd order linear ordinary differential equation (ODE):**

$$\frac{d^2y}{dt^2} + \frac{dy}{dt} + y = 0, \text{ y a function of t.}$$

  - **We can set up: y = dsolve('D2y + Dy + y = 0')**
  - **We can specify initial conditions or boundary conditions along with an ODE:**
  - **y = dsolve('D2y = 2*t/Dy', 'y(0) = 0', 'Dy(0) = 1', 't')**
  - **We can also visualize the solution to your differential equation using the "ezplot" function. →→→→ →→→→ →→→→**

MatLab Summary

- **MatLab is a complex program that is an excellent mathematical tool for solving complex science and engineering problems.**
- **In general, it is so complex that it takes some "getting used to." You cannot just plunge into it today and expect to be a master in about ten minutes.**
- **However, with a little work, you can master its intricacies and become a MatLab master.**
- **Because the student price is so good, and because you will be using MatLab in some of your advanced UG courses, it would be a good idea to start learning now!**

A Comment on Math Tools

- **In general today, most mathematical problems of interest in science and engineering are not solvable by non-computer approaches.**
- **Many non-linear second-order or higher differential equations in general do not even have closed, known solutions, but must be solved (if they are solvable!) using numerical techniques.**
- **Learn and become familiar with all of these tools that you can. Somewhere down the road – perhaps as a senior, in graduate school, or in a first job – you will find one or more of them indispensible!**