MATH.2360 Engineering Differential Equations
The Runge-Kutta Method for Systems of First-Order DE's

1. You will need Professor White's MATLAB script rk4.m. To download this file, go to our course web page. Click on the *Class handouts etc.* link under the **Course Materials** heading, then scroll down to *MATLAB Handouts* and look for the entry on Numerical Methods for Systems. Right-click "rk4.m," click on "Save Link As" (or "Save Target As") and save the file.

2. Start MATLAB and change to the directory where you stored rk4.m

3. (**Homework Problem for Section 4.3**) Before using rk4, create a file defining the system you want to solve. Click on *New Script*. An Editor/Debugger box will open on the screen. For the homework problem from section 4.3, type in the following five lines (including the last line with the word end):

```
function w = f(t, z)
x = z(1);
y = z(2);
w = [-t.*x+y; x+sin(t)];     % Note the ; between the 2 components of w. The first
% component of w is what x' equals, and the second component of w is what y' equals.
end
```

   (Don't forget the semicolon at the end of the second, third, and fourth lines.) Save the file and return to the MATLAB command window.

   To use the Runge-Kutta Method on the problem
   $x' = -tx + y,\ y' = x + \sin(t),\ x(0) = 1,\ y(0) = -2$ for $0 \le t \le 1$ with $n = 2$ subintervals, type the commands

```
a = 0;
b = 1;
xi = 1;
yi = -2;
n = 2;
[t, z] = rk4('f', a, b, [xi ; yi], n);     %Note the ; between xi and yi
```

   You should see three columns of numbers. The leftmost column contains the t values at which the solution was calculated. The middle column contains the calculated x values, and the rightmost column contains the calculated y values.

   The matrix z contains the computed x and y values. The x values are in the first column of z, and the y values are in the second column of z.

   Repeat the last 2 commands with $n = 10$.

OVER

4. (This part is for future use. You do not have to turn this in.) To use *ode45* to solve the $x' = -tx + y,\ y' = x + \sin(t),\ x(0) = 1,\ y(0) = -2$ for $0 \leq t \leq 1$, type the following commands in the MATLAB command window. (Note that you have already created the file f.m defining this system.)

```
a = 0;
b = 1;
xi = 1;
yi = -2;
[t, z] = ode45('f', [a, b], [xi ; yi])
```

You could also use the single command

```
[t, z] = ode45('f', [0, 1], [1 ; -2])
```

If you wanted to graph x vs. t, you would use the command `plot(t, z(:,1))`. To plot y vs. t, use the command `plot(t, z(:,2))`