P2110A: MATLAB Tutorial 3 activity

October 2, 2018

For today's task, we will be using ode45, a MATLAB function for solving ordinary differential equations via the Runge-Kutta method. The structure for implementing it is: `[t,y] = ode45(odefun,tspan,y0)` where t and y are the dependent and independent variables, $tspan$ is the range for t, and $y0$ is the initial y. $odefun$ is the equation, which ideally should be given as a function. Since Runge-Kutta works for equations of the form $\frac{dy}{dt} = f(t,y)$, we will need to rewrite second order equations as first order equations.

1. Look at `pendulumDE`. This is the system of coupled first-order ODEs for a pendulum. To solve for it's motion, in a time range from 0-25 seconds, and initial conditions of θ_0=1.0, and $\frac{\theta}{dt}_0$=1.0, you would type in `[t,y] = ode45(@pendulum,[0 25],[1.0 1.0])`. The output y has 2 columns- the first is y and the second is the derivative of y. Plot y vs. t. Change the initial conditions and time range, and see how the plot changes.

2. Now solve the ODE for a harmonic oscillator ($\frac{d^2x}{dt^2} = -kx$ instead of $\frac{d^2\theta}{d\theta^2} = -\omega^2 x$) over the same time range, with the same initial conditions, and a spring constant of k=1. (It would be best to make a new function in the form of `pendulumDE`, but call it `springDE`. After solving via ode45, plot x vs. t.

3. Repeat part 2, but now for a damped harmonic oscillator with a damping constant b=0.2.