CE 640 / OC 512 Matlab
Homework 7 – Differential Equations

1. The equations of motion for a projectile subject to air resistance are:

$$\frac{du}{dt} = -\gamma\left|\vec{V}\right|u$$
$$\frac{dv}{dt} = -\gamma\left|\vec{V}\right|v - g$$

In these equations, u and v are the velocity components, $\vec{V}$ is the velocity vector whose magnitude is the speed $\left|\vec{V}\right| = \sqrt{u^2 + v^2}$, g is gravity, and γ is a drag coefficient. If you define four variables, say y1 → y4, as the horizontal position (x), vertical position (y), horizontal velocity $\left(u = \frac{dx}{dt}\right)$, and vertical velocity $\left(v = \frac{dy}{dt}\right)$, you can restate the problem as a set of four first order ODEs.

Use the initial conditions

$$x(0) = 0$$
$$y(0) = 0$$
$$u(0) = \left|\vec{V}\right|\cos(\theta)$$
$$v(0) = \left|\vec{V}\right|\sin(\theta)$$

with a launch angle of 40 degrees and a launch speed of 180 m / s. Compute and plot the trajectory for friction coefficients of 0, 0.05, 0.1, and 0.2. Either superimpose all four plots, or, if the axis limits for the 4 cases are very different, you may find it more pleasing to make a 2x2 subplot. As usual, label axis with names and units, and use legends as necessary.