**Section 1: Quarter Car Model**

**Part a)**

See attached least squares fit MATLAB codes.

Using the least squares fit on the spring force and the damping force, the coefficient were determined to be as follows:



Figure 1. Plot of spring force data and its corresponding least squares fit



Figure 2. Plot of damping force data and its corresponding least squares fit

**Part b)**

Equations (1) and (2) get converted into the following 4-equation system of 1st order ODEs:

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Final 4-equation system of 1st order ODEs:

**Part c)**

See attached 4th order Runge-Kutta and simulation MATLAB codes.

NEED TO HAVE A SANITY CHECK IN THIS SECTION

**Section 2: Simulation**

**Part a)**

See attached 4th order Runge-Kutta and simulation MATLAB codes.

Characteristic time scale and timestep, h, used:

V = 10 km/hr: T = 1.8720 seconds and h = T/100 = 0.0187 seconds

V = 40 km/hr: T = 0.4680 seconds and h = T/50 = 0.0094 seconds

**Part b)**

The plots of displacements and velocities for the sprung and unsprung masses at velocities of 10 km/hr and 40 km/hr are shown below in Figure 3 and Figure 4, respectively. In Figure 5 and Figure 6, respectively, the displacement and velocity of the sprung mass are compared for V = 10 km/hr and V = 40 km/hr, From Figures 5 and 6, observe that for the sprung mass displacement and velocity, the amplitudes are significantly greater for V = 40 km/hr than they are for V = 10 km/hr. Additionally, the periods of oscillation is shorter for V = 40 km/hr than they are for V = 10 km/hr.



Figure 3. Plot displacements and velocities of sprung and unsprung masses versus time using 4th order Runge-Kutta for V = 10 km/hr



Figure 4. Plot displacements and velocities of sprung and unsprung masses versus time using 4th order Runge-Kutta for V = 40 km/hr



Figure 5. Comparison of 4th order Runge-Kutta displacement of sprung mass for V = 10 km/hr and V = 40 km/hr



Figure 6. Comparison of 4th order Runge-Kutta velocity of sprung mass for V = 10 km/hr and V = 40 km/hr

**Part c)**

In the forward Euler method, the following calculations are required:

See attached forward Euler and simulation MATLAB codes.



Figure 7. Plot displacements and velocities of sprung and unsprung masses versus time using forward Euler for V = 40 km/hr using a timestep, h, of T/50 = 0.0094 seconds (timestep used in Section 2, part a)



Figure 8. Comparison of displacements and velocities of sprung and unsprung masses between 4th order Runge-Kutta and forward Euler using a timestep, h, of T/50 = 0.0094 seconds (timestep used in Section 2, part a)