ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

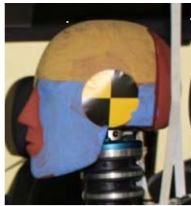ME 123   Computer Programming

EXAM 1 – COMPUTER PORTION

Put all of your code in one script and name it lastname_firstname.m (all lower case). Include your name, section number, and CM number in the header section of your code. **There should be no output other than what is requested**.

Problem (48 pts)

For this exam problem, we will work with the two Excel files `ford_f_150_data` and `virtual_head_displacement` posted on the course **Moodle** page. These files contain data associated with the motion of the driver dummy's head in a car crash dummy test. (See dummy photo at left.) In the steps below, you will compare the head displacement from a motion capture with the displacement found by integrating the acceleration twice. If all goes well they should be very similar.

a) (22 points) The file `ford_f_150_data` contains two columns. The first column is time in seconds. Note that the time actually starts with a negative value because the data logging began before the impact. The second column contains the acceleration data (from the dummy head accelerometer), in g's. Extract the data from the file, multiply the accelerations by 9.81 to convert them to m/s^2, and plot the acceleration as a function of time. **Do not** hard code the dimensions of the loaded array. Add good axis labels and a title.

b) (10 points) The file `virtual_head_displacement` contains the virtual head displacement results from the motion capture system. There are two columns—the first is the time in seconds and the second column is the displacement in meters. Extract the data from the file and, on a new figure, plot the displacement as a function of time using black circle markers. **Do not** hard code the dimensions of the loaded array. Add good axis labels and a title.

c) (16 points) Add code to your script to perform numerical integration on the acceleration to get a vector of velocities. Then perform numerical integration on the velocities to get a vector of displacements. (See notes below on this process.) Create a new figure, and plot these displacements as a function of time as well as the virtual displacements from part (b). Use a solid black line for the integrated displacements and black circle markers for the virtual displacements. **Do not** hard code the dimensions of the array. Add a legend, good axis labels, and a title.

Notes: For the numerical integration, you may assume that the initial velocity and displacement are zero. Also, use a (left-sided) rectangle rule, so that you will have

$$t_{i+1} = t_i + \Delta t$$
$$v_{i+1} = v_i + \Delta t * a_i$$
$$x_{i+1} = x_i + \Delta t * v_i$$

Where Δt = 0.0001 seconds for this data.

When you are finished, put your script (lastname_firstname.m) in the Moodle assignment dropbox.

NOTE: All programming must stop 5 minutes before the end of the period. You will have 5 minutes after that to post your file to Moodle if you need that time.