**MEMORANDUM** 22 Feb 2011

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To: Prof. G. E. Piper

Subj: Lab Report

Encl: (1) Simulink Models and Matlab Graphs. This enclosure contains all graphs and Simulink models from this lab. The one exception is that the exact Simulink model from step #1 was not included because the only difference between it and the one from step #2 was the gain was “2” in step #1 and “6” in step #2 as shown.

**1. OBJECTIVES:**

1. To become familiar with Simulink.
2. To use Simulink to model solutions to Differential Equations.
3. To understand how to export Simulink data to MATLAB.
4. To use Simulink and MATLAB to model real-world situations and investigate the effects of using simplifying assumptions.

**2. NARRATIVE AND OBSERVATIONS/RESULTS**:

In steps one and two, we used Simulink to model simple, 1st order differential equations with 0 initial conditions. We used the “scope” function in Simulink to get a view of the solution graph, exported the data to MATLAB in array format, and graphed the solution in MATLAB.

Question 1: Yes the results match the Introduction to SIMULINK course notes.

Question 2: The graphs were similar, but the second graph had a change in amplitude from (2/3) to 2.

In step three, we adjusted the model from step two to include an initial condition of y(0)=-2. We checked the solution using the “scope” in Simulink, and then we exported the data to MATLAB and graphed it there.

Question 3: Here there was a change in initial condition. This caused the starting value to be -2 instead of 0, causing the graph to take more time before settling out at the same final value of 2.

In part 3.3, we used Simulink to construct a linear approximation of pendulum motion based on input parameters. To set these input parameters, we used MATLAB to define the values of the input variables L, g, and θ0, keeping in mind that we wanted the output graph to be displayed in degrees while the input for computation in Simulink must be in radians. We then exported the values from Simulink to MATLAB and graphed the results for a length of 0.5m and 1.0m with initial offset of 10 degrees.

Question 4: Adjusting the length from 0.5 meters to 1.0 meters caused an increase in period.

In part 3.3, we used a nonlinear model to simulate pendulum motion. We ran this more accurate, nonlinear model for initial angles of both 10 and 45 degrees against the linear model at the same angles.

Question 5: As the values of theta grow so does the discrepancy in the graphs. This error is caused by the estimation of sin(θ). With very small numbers, sin(θ) is very close to θ itself. As the initial value of θ grows, so does the error in the linear model.

3. **CONCLUSIONS:** Simulink is a very helpful tool to display and solve differential equations. In this program the results varied as expected with the accuracy of the equation used. It is also a valuable tool to show how small differences in equations affect the output of the function. We used it today to determine that increasing the length of a pendulum causes an increase in period, as well as that the linear approximation model for a swinging pendulum is only valid for small initial values of θ.

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