**MAE 511 HW Set 1**

**Due Date: Sept 5, 2018 by 3pm**

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1. Use Mathematica™ to show that Equations 3.5-1 and Equations 3.5-2 from the Thomson book are equivalent. Hint: To accomplish this, use the matrix form of these equations as found in Equations 3.5-3 and 3.5-4.

Solution Procedure:

* RHS1 is the ω matrix.
* rotmat is the rotation matrix in equation 3.5-3
* angvel is the matrix containing time derivatives of the angles as calculated from equation 3.5-3
* rotmat2 is the rotation matrix in equation 3.5-4
* angvel2 is the matrix containing time derivatives of the angles as calculated from equation 3.5-4

After defining the matrices as above, the inverse of rotmat is taken (In[55] in code). This matrix is same as rotmat2, as shown in line In[56].

Similarly, angvel and angvel2 are calculated from the equations 3.5-3 and 3.5-4 respectively and compared. These matrices are also equal as shown in line In[53].

Each step of the code is explained using comments.

2. Use matlab™ to simulate (using ode45) the equations of motion for a double pendulum found on page 78 of the Meirovitch book. Set m1 = 2 kg, m2 = 3 kg, L1 = 0.8 meters, L2 = 0.6 meters, and use initial conditions: θ1(0) = 0.2 radians, θ2(0) = 0.3 radians, dθ1/dt(0) = 0.4 radians/second, dθ2/dt(0) = 0.5 radians/second. Simulate the equations for 20 seconds and plot θ1(t) and θ2(t) versus time on separate plots.

Solution Procedure:

1. The equations are not in standard form, so the first step is to separate the expressions of Ӫ1 and Ӫ2. For this purpose, the equations from the book are written in the form.
2. The above equation is solved using the “linsolve” function of Matlab, with elements of being Ӫ1 and Ӫ2, containing their coefficients and containing the rest of the expression. The solution to this is a pair of 2nd order non-linear differential equations.
3. To convert this 2nd order differential equation into a 1st order (to use “ode45” function), state space method is used.

x1 = θ1

x2 = 1

y1 = θ2

y2 = 2

1. So, 4 equations are obtained of the following form:

T

1. A function is called that simultaneously assigns values to the (as written above) and LHS expressions that would be input into the “ode45” function.
2. The time span put in is [0 20] and the initial conditions are [0.2 0.3 0.4 0.5].

This completes all the inputs into the ode45 function and the output is at different values of t.

1. The values of θ1 and θ2 corresponds to x1 and y2 respectively, and a plot is of their values v/s time is made.