Chapter 7 HW 1 Hints and Answers

Problem 1. This should be a matter of entering matrices $\mathbf{A}, \mathbf{B}$, and sample time T to MATLAB and computing the series. The resulting $\mathbf{\Phi}$ and $\mathbf{\Gamma}$ should agree with that from MATLAB `c2d`. The series convergence might be interesting to observe...I wrote a MATLAB script file to examine convergence that I will show in class.

Problem 2. Inspection of Figure 2(c) from the Chapter 6 HW Solution indicates that the time constant (63% rise) of the motor + load inertia is about 0.01 sec. For a single real pole in the s-plane, the pole location is the negative reciprocal of the time constant; hence this time constant corresponds to a single real pole at $s \approx -100$ in the s-plane.

In the s-plane a complex pole has natural frequency ω_n equal to its magnitude (radius from the origin), so a closed-loop natural frequency around 100 rad/s (16 Hz) may be appropriate. Be sure and pick a sampling time consistent with the plant time constant and your desired natural frequencies (*e.g.* something equal to or less than 0.01 sec). *Hint:* I used $T = 0.01$.

Note that the output for this problem should be angular position of the load. Since there is as yet no reference input, you may wish to simulate the behavior of your system using the MATLAB `initial` function and some nonzero initial state $\mathbf{x}(0)$. The output should return to equilibrium (zero) with "reasonable" dynamics (corresponding to your "reasonable" desired pole locations). You may wish to examine the time history of all state variables (easily done with `initial`), as given in MATLAB "help"...

```
When invoked with left hand arguments,
       [Y,T,X] = INITIAL(SYS,X0)
returns the output response Y, the time vector T used for simulation,
and the state trajectories X.  No plot is drawn on the screen.  The
matrix Y has LENGTH(T) rows and as many columns as outputs in SYS.
Similarly, X has LENGTH(T) rows and as many columns as states.
```