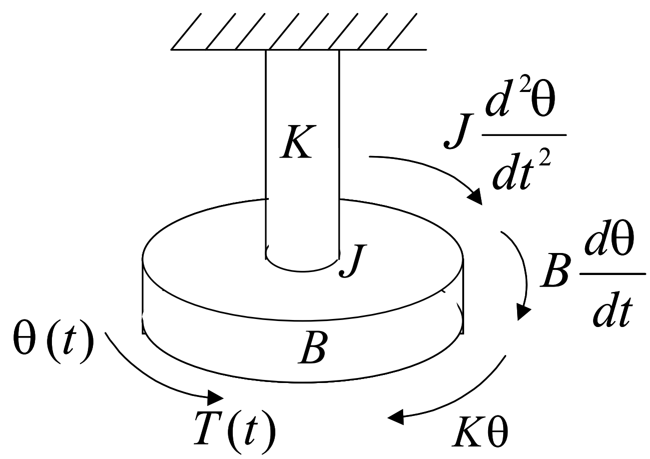
ECEN 3723 Systems I
Spring 2002

Computer Project

This project accounts for 10% of your final grade. The purpose of the project is to help you familiarize with computer aided system analysis using MATLAB®. Include every step to show your work.

Consider a motor rotational system shown in the following figure, consists of a disk mounted on a shaft that is fixed at one end. The moment of inertia of the disk about the axis of rotation is *J*, The edge of the disk is riding on the surface, and the viscous friction coefficient between the two surfaces is *B*. The inertia of the shaft is negligible, but the torsional spring constant is *K*.

From the figure, a motor is coupled to an inertial load through a shaft with a spring constant *K*. A nonrigid coupling between two mechanical components in a control system often causes torsional resonance that can be transmitted to all parts of the system. The system variables and parameters are defined as follows:



$T_m(t)$ = motor torque; J_m = motor inertia; B_m = motor viscous friction coefficient; J_L = load inertia, K = spring constant of the shaft; $\theta_m(t)$ = load displacement;

The torque equations of the system are:

$$\frac{d^2\theta_m(t)}{dt^2} = -\frac{B_m}{J_m}\frac{d\theta_m(t)}{dt} - \frac{K}{J_m}[7\theta_m(t) + \theta_L(t)] + \frac{1}{J_m}T_m(t)$$

$$-K[\theta_m(t) + \theta_L(t)] = J_L\frac{d^2\theta_L(t)}{dt^2}$$

1) Assume initial values for all the variables are all zeros, get the Get the transfer function between $\theta_m(s)$ and $T_m(s)$-- ($G(s) = \theta_m(s) / T_m(s)$.

2) Using the transfer function from (1), create a transfer function object and find the poles for the both of the transfer functions of the system by using the following parameters and using *roots* command in MATLAB:

$J_m = 0.11$, $J_L = 0.09$, $B_m = 2$, $K = 3$

3) Based on the poles, guess the impulse response of the system. Explain the reason of your guess. (Do not use MATLAB for this problem).

4) Draw all the zeros and poles by using *pzmap* command in MATLAB.

5) Get the impulse, step and sinusoid responses for the system.

6) Get the response of the system with the following input:

$$x(t) = \begin{matrix} 0 & 0 \le 0 < 2 \\ 0.05 \times (t-2)^2 & 2 \le t < 3 \\ 0.1 & 3 \le t < 10 \\ 0 & 10 \le t \end{matrix}$$

7) Get discrete transfer function with sampling period (T=0.01, 0.1 and 1).

8) Plot the poles and zeros of discrete transfer functions from step 7.

9) Get impulse responses of the discrete transfer functions resulted from step 7. Plot them. Compare the impulse responses resulted from continuous transfer function and discrete transfer functions.

10) Assume spring constant shaft are $K = 3$, $K = 0.3$ and $K = 0.0003$, the other parameters are maintained same with those in 2), compare the impulse responses resulted from these three K values and draw conclusion on the stability characteristics of the systems resulted from three settings.