Exercise 3 - TTK4130 Modeling and Simulation

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1 Problem 1

1.1 a

For spool 1:

$$\underline{\underline{\Sigma\tau = J_1\dot{\omega}_1 = F_1 r_1 - T_1 + B_1\omega_1}}$$

For spool 2:

$$\underline{\underline{\Sigma\tau = J_2\dot{\omega}_2 = -F_2 r_2 + T_2 + B_2\omega_2}}$$

1.2 c

Chose right as positive direction.

$$\begin{aligned}\Sigma F &= F_2 - F_1 \\ \dot{x} &= v_2 - v_1\end{aligned}$$

$$\underline{\underline{F_2 - F_1 = Kx^2 + B\dot{x}}}$$

1.3 d

Know that

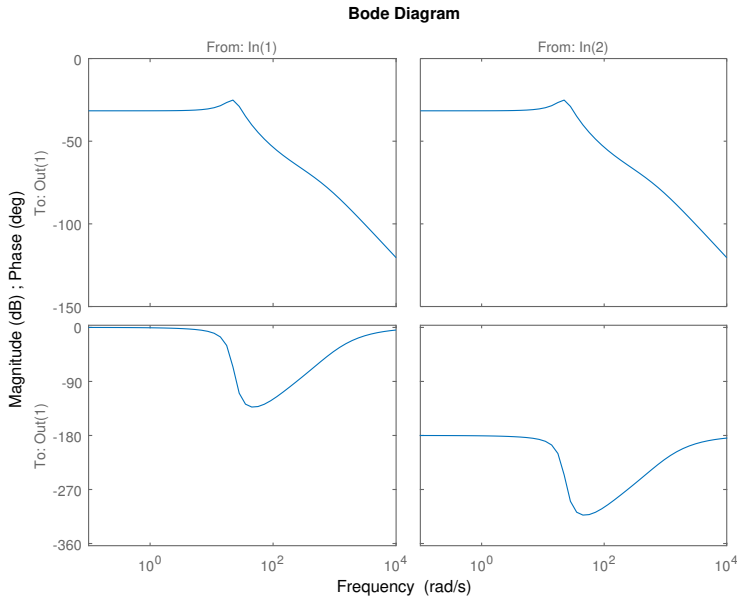
$$\begin{aligned}F_1 v_1 - F_2 v_2 &= F_k v_k \\ F_k &= kx_k, \quad \dot{x} = v_k,\end{aligned}$$

and from the figure in the exercise we see that

$$\begin{aligned}F_k &= F_1\cos(\theta) + F_2\cos(\theta) \\ F_1\sin(\theta) &= F_2\sin(\theta).\end{aligned}$$

From this it is easy to derive that

$$\begin{aligned}v_1 - v_2 &= 2v_k\cos(\theta) \\ F_1 = F_2 &= \frac{F_k}{2\cos(\theta)}\end{aligned}$$



Figur 1: The bode plot for the system. The code for generating this plot can be seen in Listing 1.

1.4 g

Listing 1: Code for making the Bode plot in MATLAB

```
% load output from Dymola linearize
load dslin
% ABCD is A, B, C and D matrix stacked into one matrix
% nx is number of states (dimension of the A matrix)
A = ABCD(1:nx,1:nx); B = ABCD(1:nx,nx+1:end);
C = ABCD(nx+1:end,1:nx); D = ABCD(nx+1:end,nx+1:end);
sys = ss(A,B,C,D);
% Plot Bode response
w = logspace(-1,4,50);
bode(sys,w)

print -depsc modsim_ex5_bode.eps
```