Exercise 3 - TTK4130 Modeling and Simulation

Camilla Sterud

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

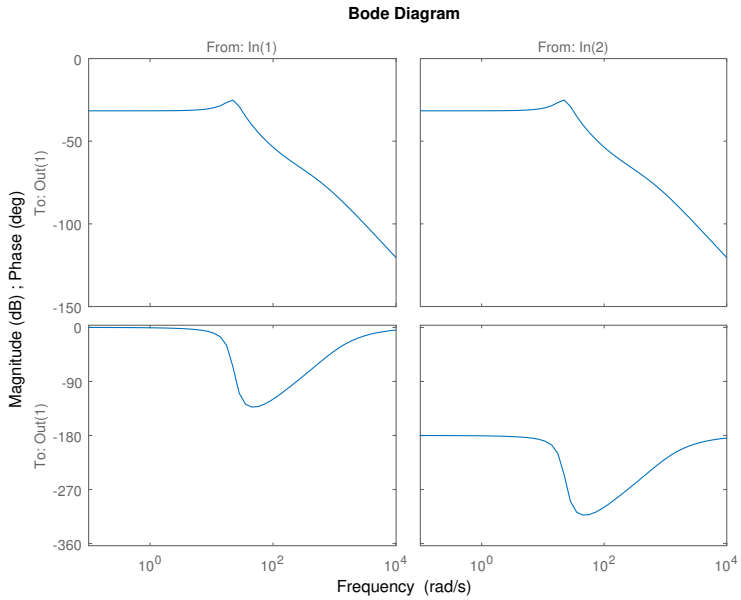
$$\begin{aligned}F_1 v_1 - F_2 v_2 &= F_k v_k \\ F_k &= kx_k, \quad \dot{x} = v_k,\end{aligned}$$

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

From the bode plot in Figure 1.4, we see that the magnitude is the same for the two belts, but that the response of the second belt is phase delayed by 180°.

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
```