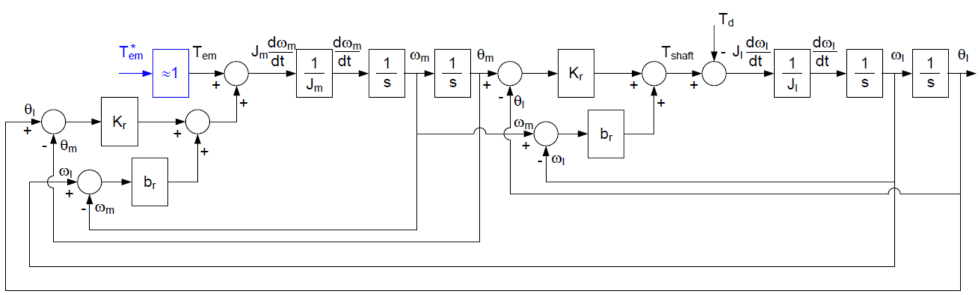
Resonant Load Controller Design: Comparative Robustness & Disturbance Rejection

You are given a torque controlled motor (inertia J_m) connected to a variable load inertia J_l through a compliant coupling of stiffness K_r, which has damping b_r. You are to assume an ideal torque modulator. The load inertia varies up to <u>three times its nominal value</u>.



Nominal Parameters:

$J_m = 0.002$ Kg-m^2
$J_l = 0.002$ Kg-m^2
$b_r = 0.005$ N-m/(rad/sec)
$K_r = 300$ N-m/rad

To do:

You are asked to do a comparative evaluation of four state feedback controller designs.

<u>Controller #1</u>: "**MA**" Closed state feedback loops on the motor with virtual reference state commands for motor velocity, position, and integrated position using b_{ma}, K_{msa}, K_{misa} as gains, respectively. Tune these loops so that the three eigenvalues corresponding to your loops are separated by factors of four, i.e. ≅16, 4, and 1 Hz.

<u>Controller #2</u>: "**LA**" Closed state feedback loops on the load with virtual reference state commands for load velocity, position, and integrated position using b_{la}, K_{lsa}, K_{lisa} as gains, respectively. Tune these loops so that the three eigenvalues corresponding to your loops are separated by factors of four, i.e. ≅16, 4, and 1 Hz.

<u>Controller #3</u>: "**MARA**" Closed state feedback loops on the motor with virtual reference state commands for motor velocity, position, and integrated position using b_{ma}, K_{msa}, K_{misa} as gains, respectively and a closed relative velocity loop using b_{ra} as gain which will critically dampen the structural resonance (remaining two roots will be real and equal). Tune these loops so that the three eigenvalues corresponding to your loops are separated by factors of four, i.e. ≅16, 4, and 1 Hz.

<u>Controller #4</u>: "**LARA**" Closed state feedback loops on the load with virtual reference state commands for load velocity, position, and integrated position using b_{la}, K_{lsa}, K_{lisa} as gains, respectively and a closed relative velocity loop using b_{ra} as gain which will critically dampen the structural resonance (remaining two roots will be real and equal). Tune these loops so that the three eigenvalues corresponding to your loops are separated by factors of four, i.e. ≅16, 4, and 1 Hz.

Base your evaluation on dynamic stiffness FRF $\left|\frac{T_d}{\theta_l}\right|$ characteristics and on eignevalue migration properties.

Hand in:

1. An organized document highlighting the results from controllers the dynamic stiffness and eigenvalue migration plots from controllers 1 through 4 above.

2. An appropriately detailed discussion of important comparative results including your recommendation for controller selection criteria.

3. A neatly organized appendix listing derivations and code.