Torsional Resonance in Feedback Control Systems

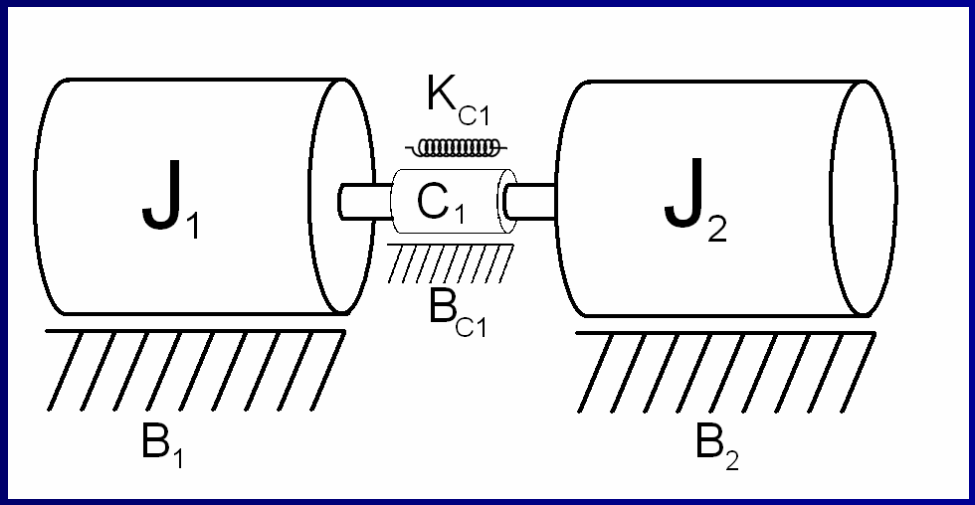
By Daniel M. Lofaro

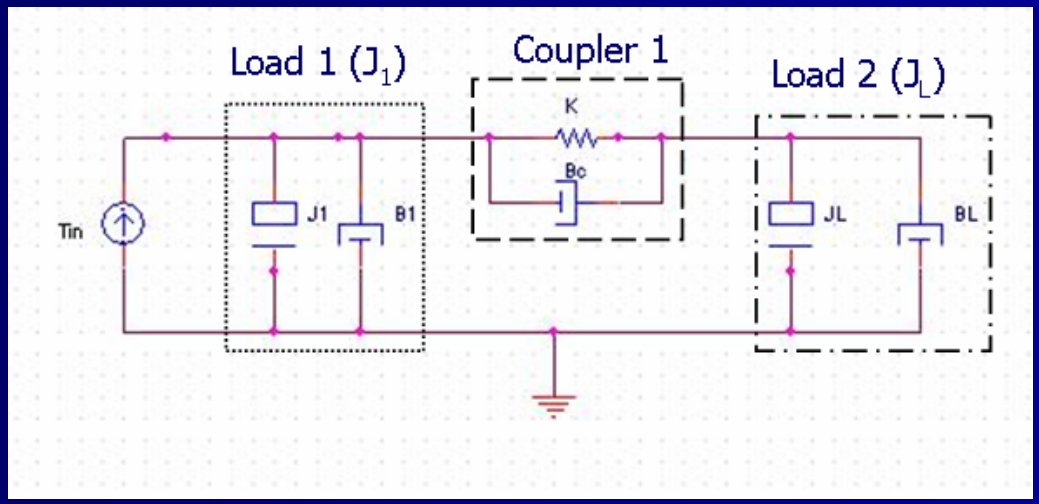
Advisors: Dr. Paul Kalata
Co Advisor: Dr. Tom Chmielewski

Problem

- “When mechanical resonance frequency occurs near or within the servo bandwidth, loop stability is degraded.” (Resonance Equalization in Feedback Control Systems)
- This reduces the speed of the servo system.

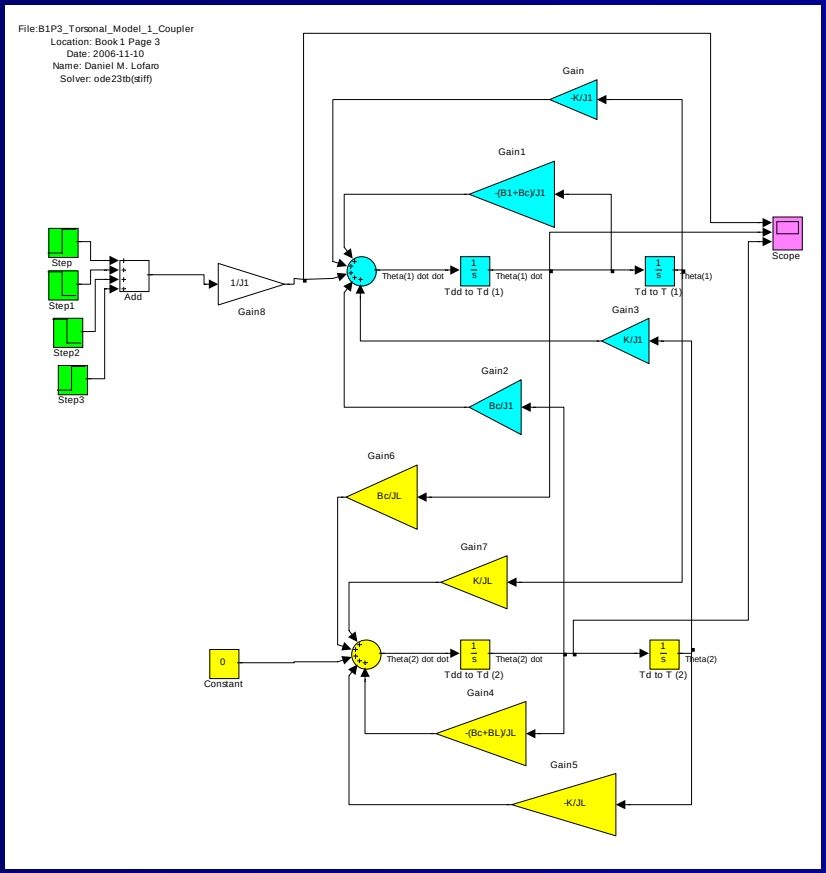
Problem Model (Single Coupler)





Problem Model (Simulink)

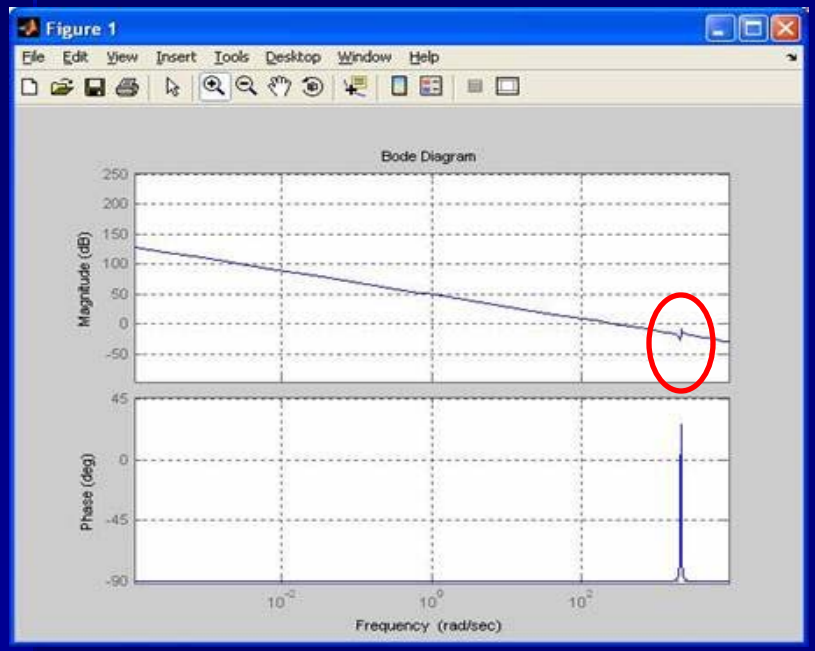
(Single Coupler)

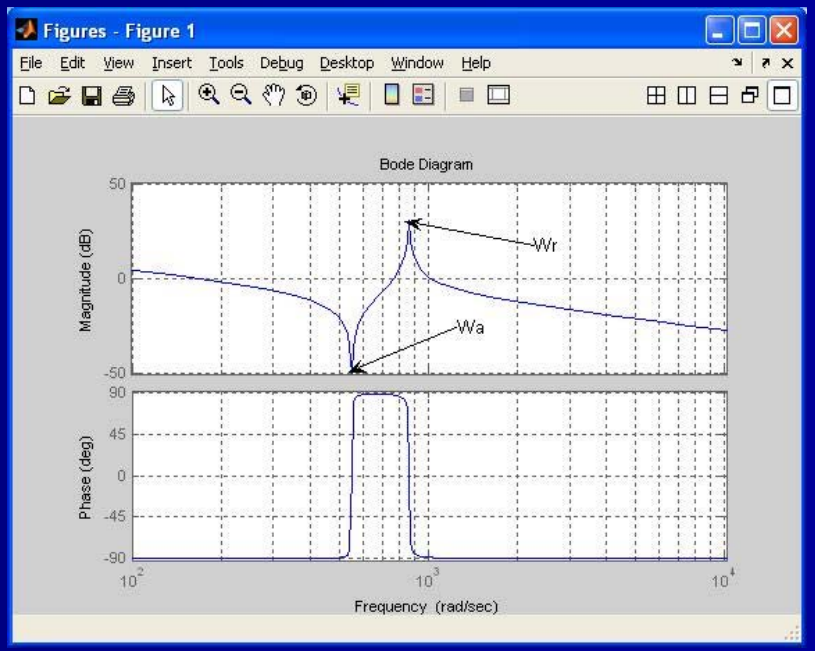


Problem Model (Simulink)

(Single Coupler)

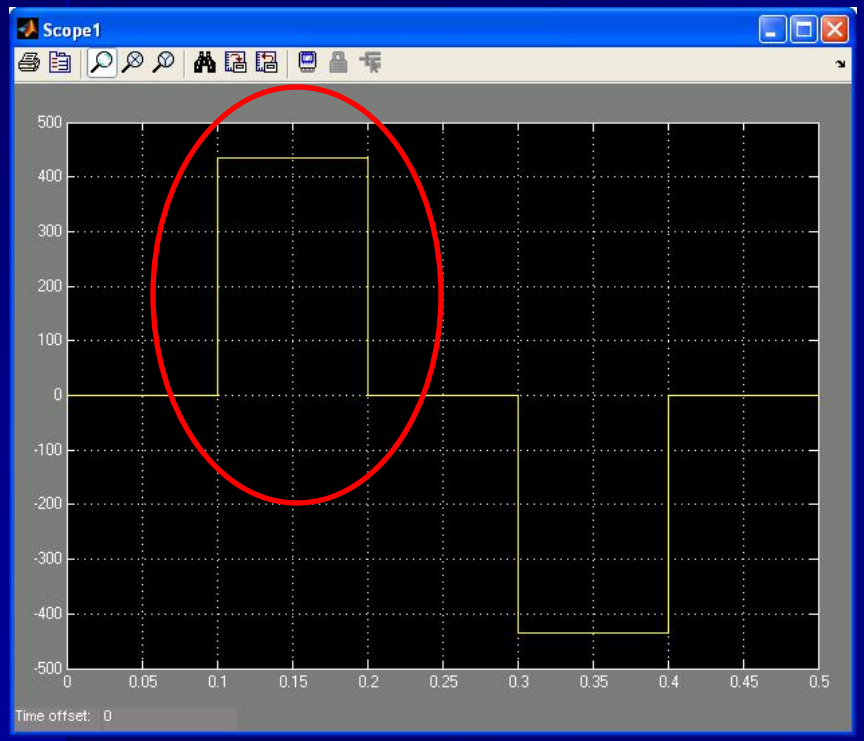
Bode Plot



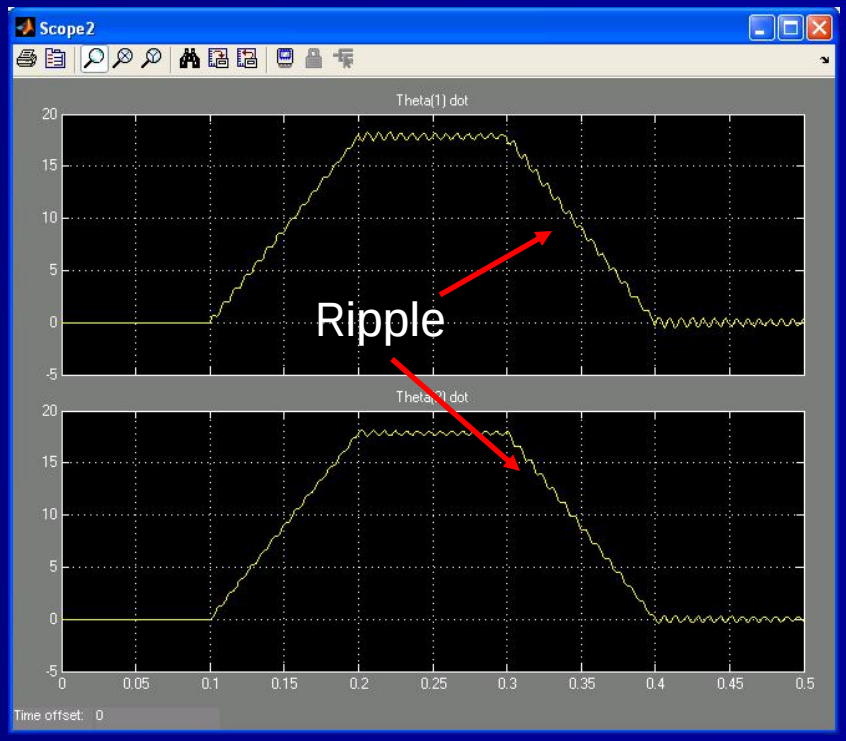


Problem Model (Simulink)
$J_1 < J_L$

Input (Velocity Command)

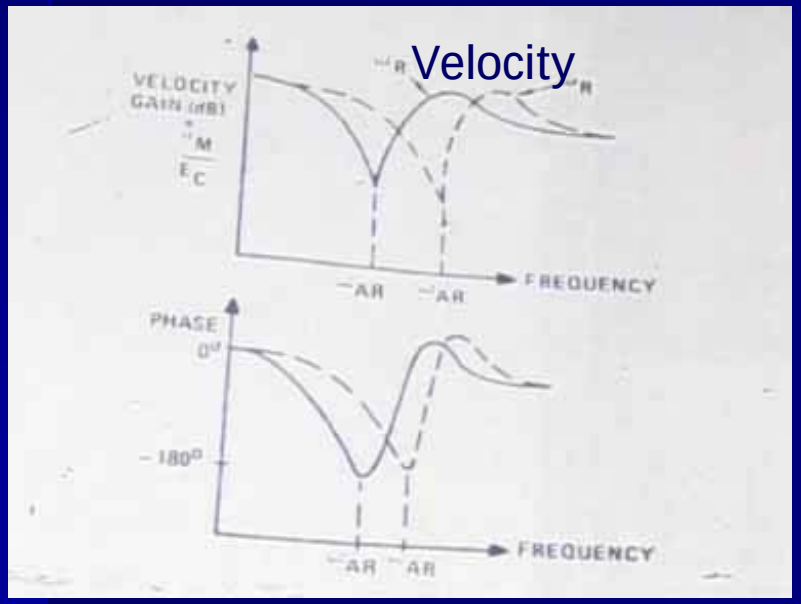


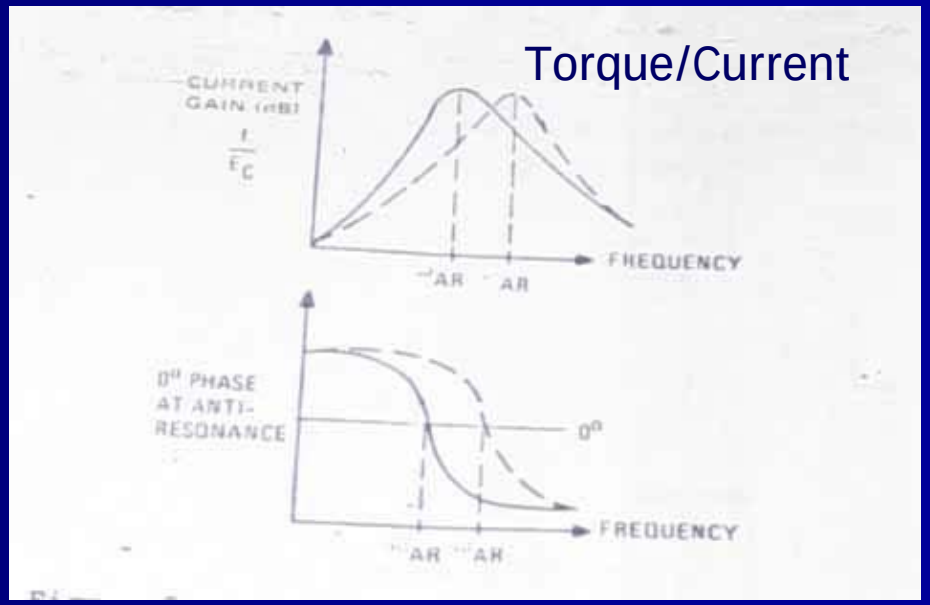
Output (Angular Velocity)



Problem Solution (REFCS)

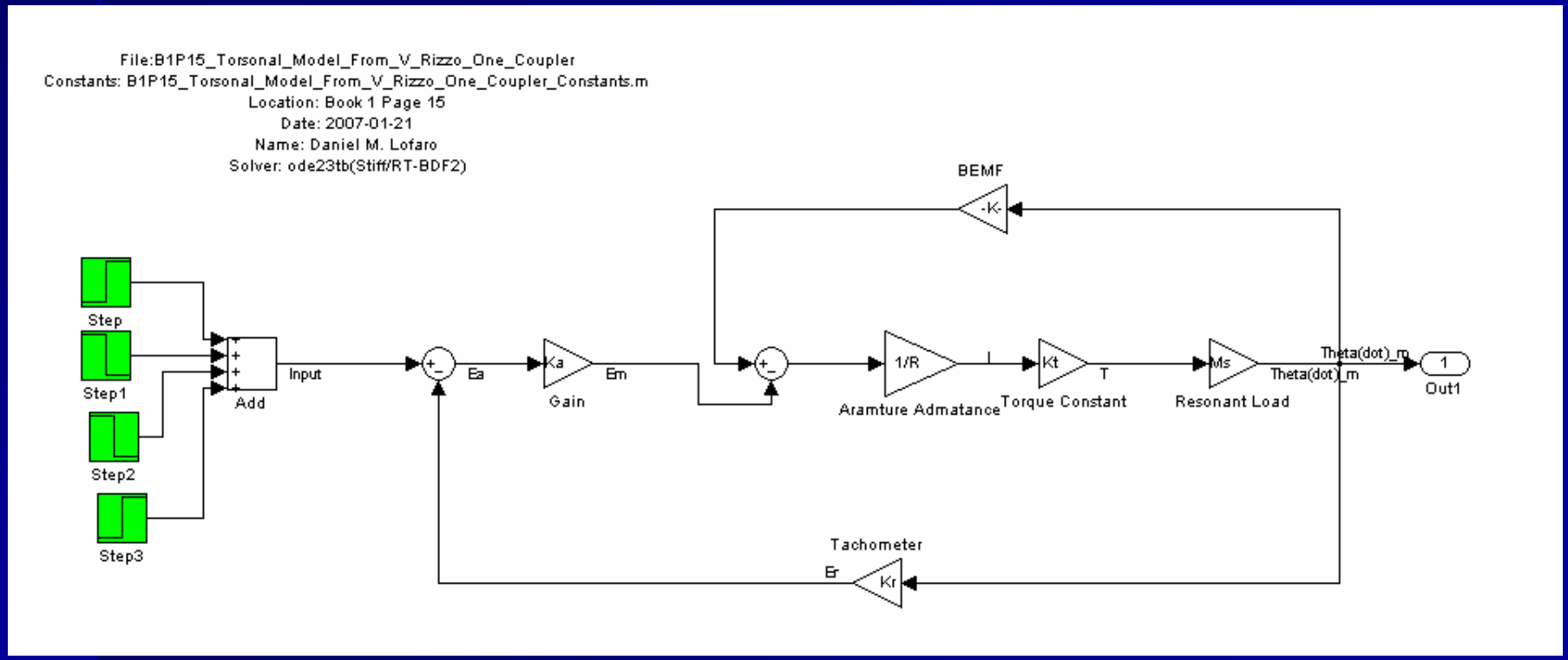
- The *velocity* and *torque/current* curves are 180^0 out of phase thus we can combine them to get rid of the effect of torsional resonance.





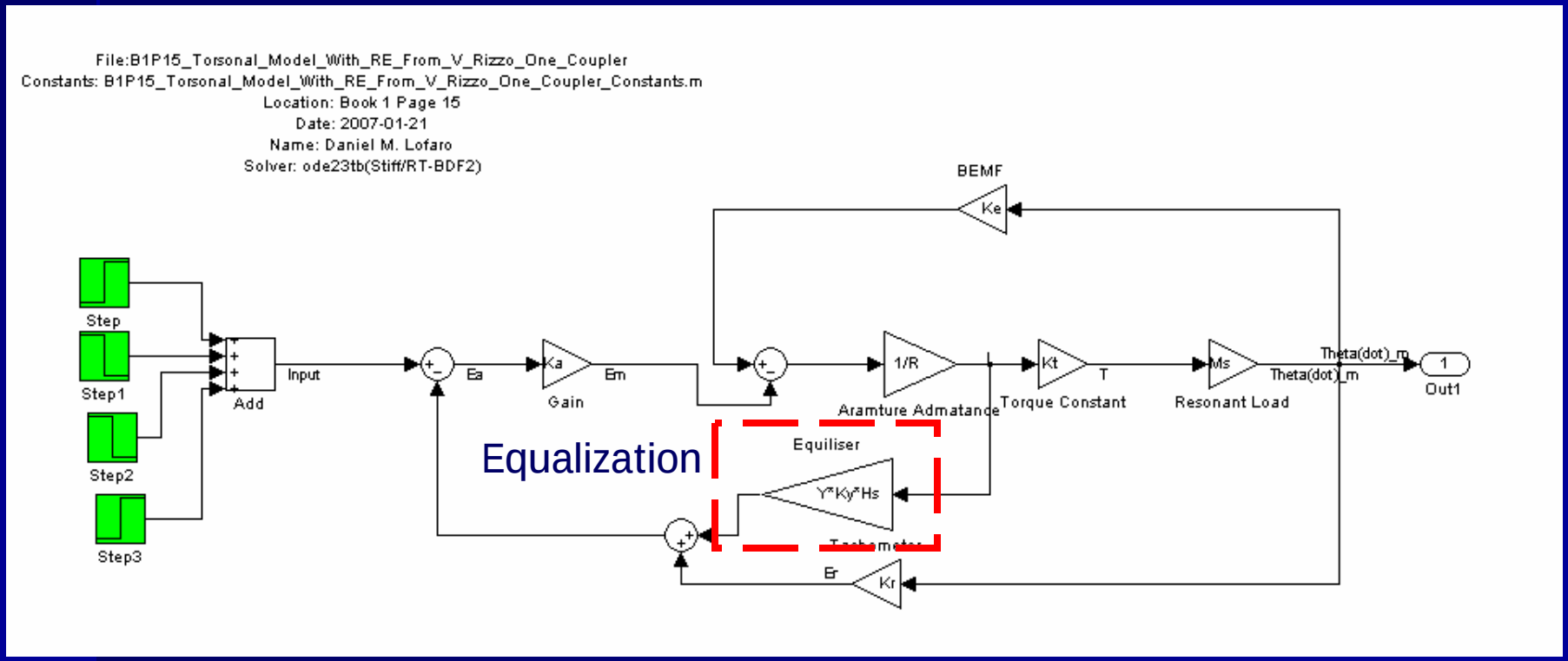
Problem Solution (REFCS)

- TR model with one coupler



Problem Solution (REFCS)

- TR model with one coupler and RE



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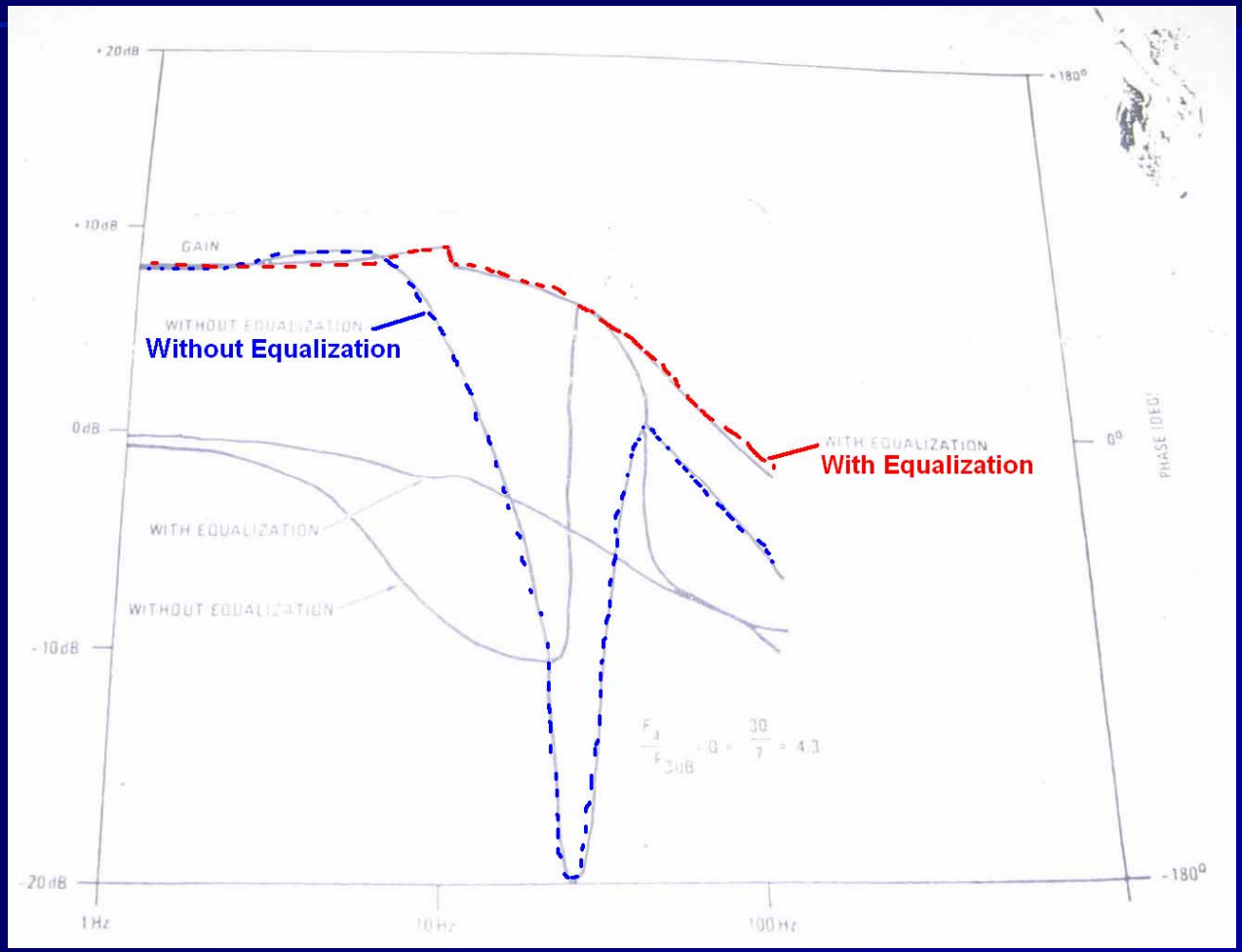

Why Fix This Problem?

- Increase the speed of the servo system.
  - Make our bipedal robot able to react faster
  - No other robot will be using this method
- Saves Money and Weight
  - Can use **lighter** and **cheaper** plastic gears
    - If lighter we can move faster and have more capacity for electronics, sensors, and batteries.
  - Fix the problem in software

Proposal/Future Work

- Make motor fixture to handle up to two (2) loads in series.
- Make a Labview VI that will get the bode data from the actual system.
- Construct an observer in the motor controller to and fix the problem in software.
- Test on metal and plastic geared systems with one and two couplers.

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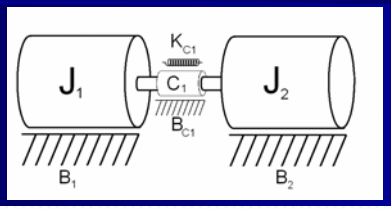

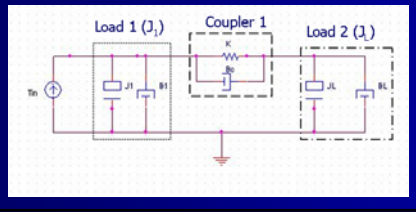

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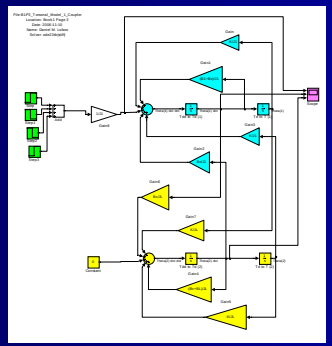

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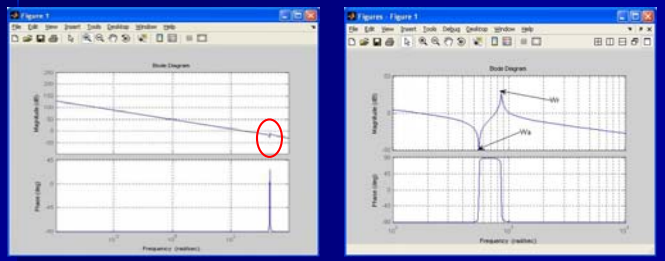

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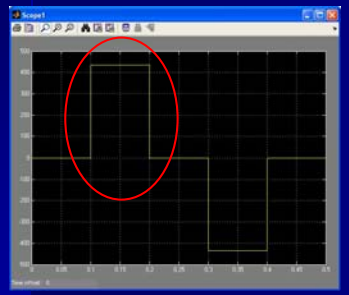

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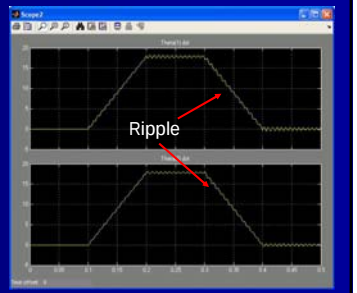

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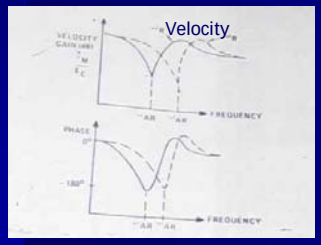

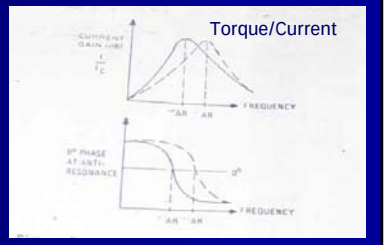

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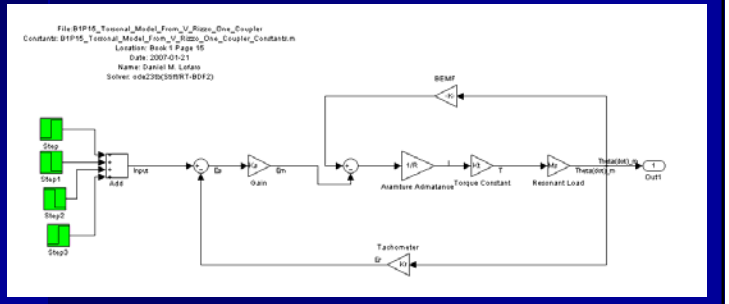

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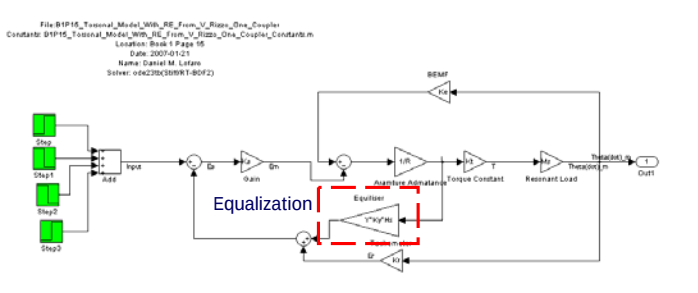

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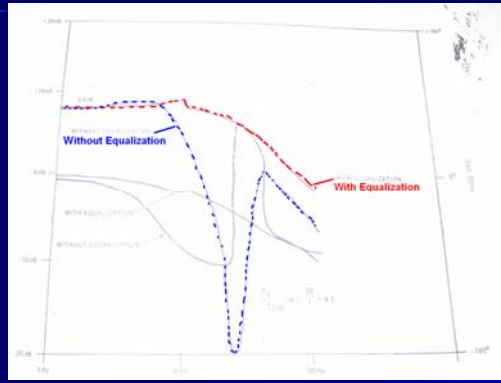

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