MAE 106 Laboratory Exercise #5 Post-Quiz
PD Motor Position Control System

100 pts possible

In this lab you built a control system to make a motor shaft move to a commanded position.

10 1. What do "P" and "D" stand for in "PD Motor Position Control"?

Proportional Derivative

10 2. Write a PD control law in the box, where

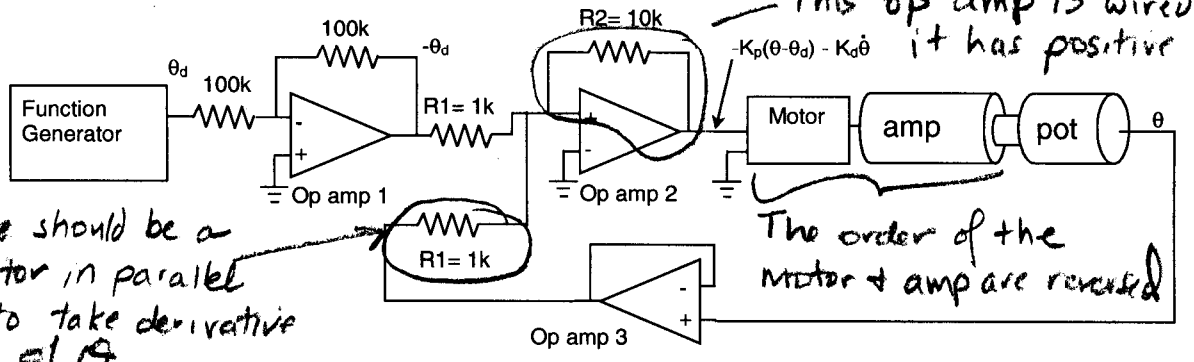
Where θ = actual motor angular position
θ_d = desired motor angular position
$\dot{\theta}$ = actual motor angular velocity
K_p = position error gain ($K_p>0$)
K_d = derivative gain ($K_d>0$)
τ = desired motor torque

$\tau = -K_p(\theta-\theta_d) - K_d\dot{\theta}$
or
$\tau = -K_p(\theta-\theta_d) - K_d(\dot{\theta}-\dot{\theta}_d)$

or $\tau = K_p(\theta_d-\theta) - K_d\dot{\theta}$

or $\tau = K_p(\theta_d-\theta) + K_d(\dot{\theta}_d-\dot{\theta})$

15 3. Identify three errors in this attempt at a PD control circuit:



This op amp is wired wrong – it has positive feedback

There should be a Capacitor in parallel w/ R1 to take derivative of θ

The order of the motor & amp are reversed

10 4. A key point of the lab was that the controlled system acted dynamically like what kind of a mechanical system?

Mass-spring-damper system

10 5. The gains K_p and K_d determined the equivalent stiffness and damping of the mechanical system.

10 6. The desired angular position of the motor (θ_d) is equivalent to the spring rest length

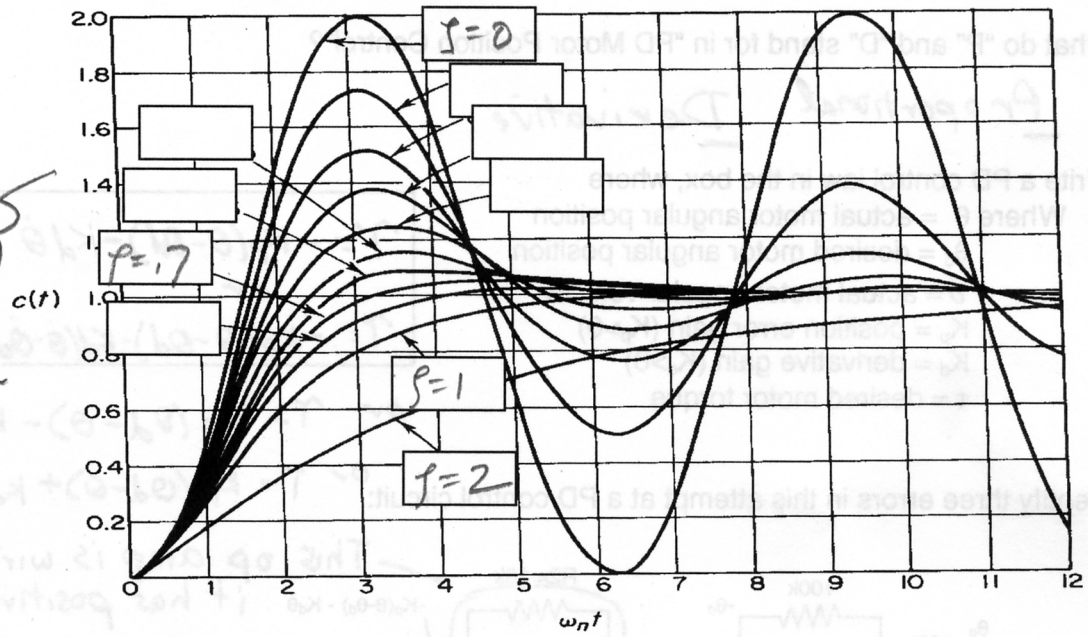
10 7. In the lab, you measured the step or time response and the frequency or sinusoidal response of the system.

5 8. In lab, what type of circuit element did you change to increase the damping of the system?

Capacitor

10

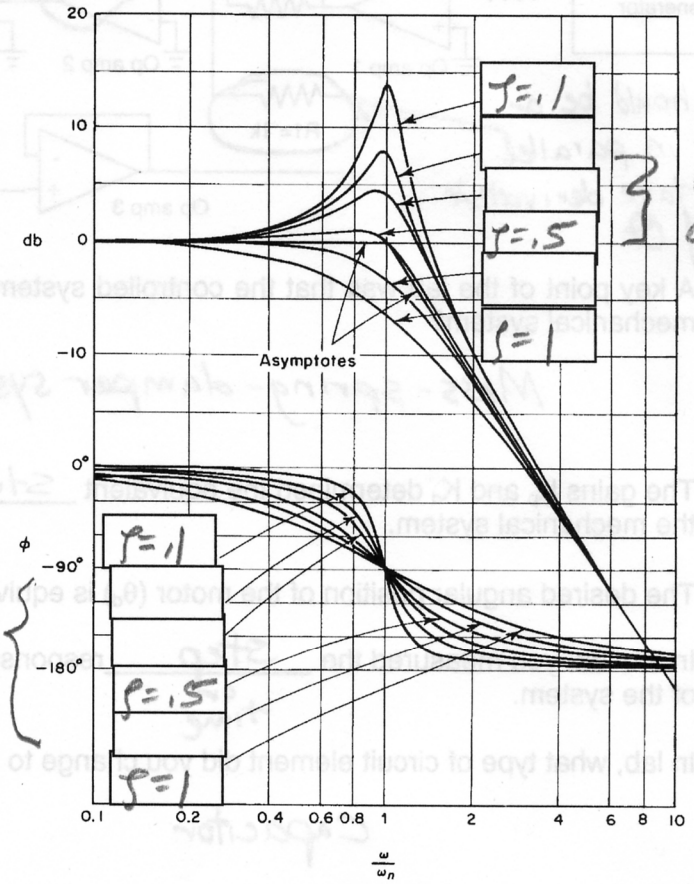
9. Shown below is the predicted response of the system to a step change in θ_d. In four of the boxes provided, label which response corresponds to $\zeta = 0$, $\zeta = 0.7$, $\zeta = 1$, $\zeta = 2$.



Any of these three is OK for ζ=.7

10

10. Shown to the right is the predicted scaling and phase shift for a sinusoidal input, for $0.1 \leq \zeta \leq 1$. In three of the boxes provided, label which response corresponds to $\zeta = 0.1$, $\zeta = 0.5$, $\zeta = 1$.



either is OK for ζ=.5

any of these is OK for ζ=.5