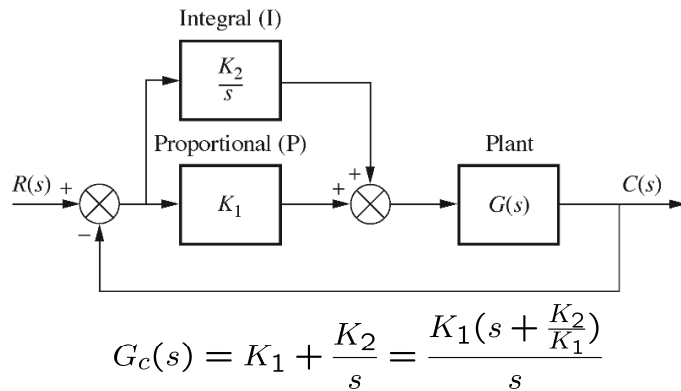


PI Compensator – Improves Steady-State Response



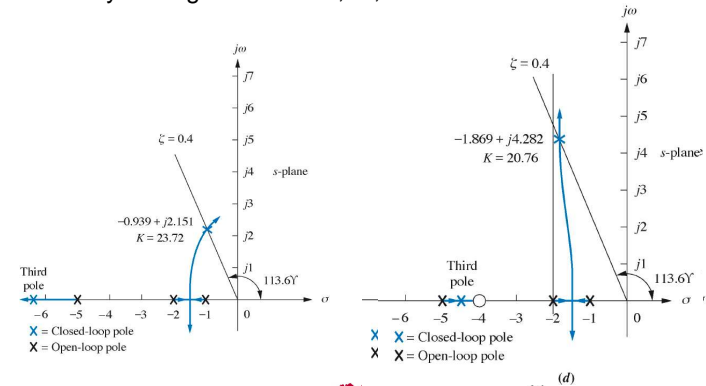
- Careful where you place your zero!



1

What About Transient Response?

- Consider the system with the following RL
- Let's try adding a zero @ -2, -3, and -4



2

Summarizing Our Results

TABLE 9.2 Predicted characteristics for the systems of Figure 9.15

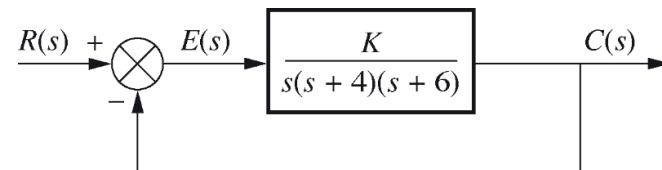
	Uncompensated	Compensation b	Compensation c	Compensation d
Plant and compensator	$\frac{K}{(s+1)(s+2)(s+5)}$	$\frac{K(s+2)}{(s+1)(s+2)(s+5)}$	$\frac{K(s+3)}{(s+1)(s+2)(s+5)}$	$\frac{K(s+4)}{(s+1)(s+2)(s+5)}$
Dom. poles	$-0.939 \pm j2.151$	$-3 \pm j6.874$	$-2.437 \pm j5.583$	$-1.869 \pm j4.282$
K	23.72	51.25	35.34	20.76
zeta	0.4	0.4	0.4	0.4
omega_n	2.347	7.5	6.091	4.673
%OS	25.38	25.38	25.38	25.38
T_s	4.26	1.33	1.64	2.14
T_p	1.46	0.46	0.56	0.733
K_p	2.372	10.25	10.6	8.304
e(infinity)	0.297	0.089	0.086	0.107
Third pole	-6.123	None	-3.127	-4.262
Zero	None	None	-3	-4
Comments	Second-order approx. OK	Pure second-order	Second-order approx. OK	Second-order approx. OK



3

Example 1

- PD compensator w/ %OS = 16%
- 1/3 T_s of uncompensated system

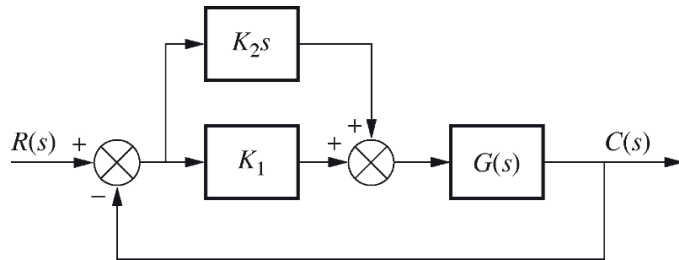


- Note 16% overshoot, corresponds to zeta = 0.504, i.e. slope of 1.714



4

PD Compensator – Improves Transient Response



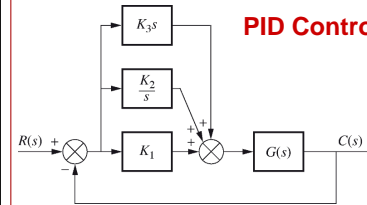
$$G_c(s) = K_1 + K_2s = K_2\left(s + \frac{K_1}{K_2}\right)$$

- Assume K_1 is constant, what happens if we increase K_2 ?



5

PID Controller Design



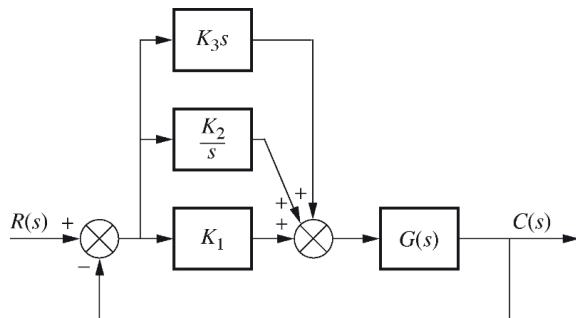
$$G_c(s) = K_1 + \frac{K_2}{s} + K_3s$$

- Evaluate uncomp sys to get determine desired transient
- Design PD controller
- Simulate to check
- Redesign if necessary
- Design PI controller to yield desired steady-state error
- Determine K_1 , K_2 , and K_3
- Simulate to check
- Redesign if necessary



6

A Few More Words

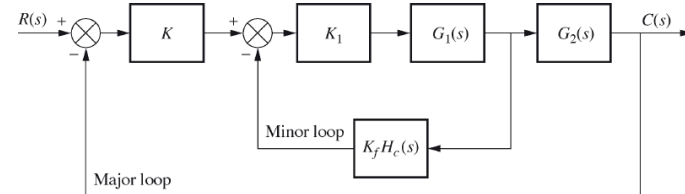


- What if we don't know what $G(s)$ looks like?



7

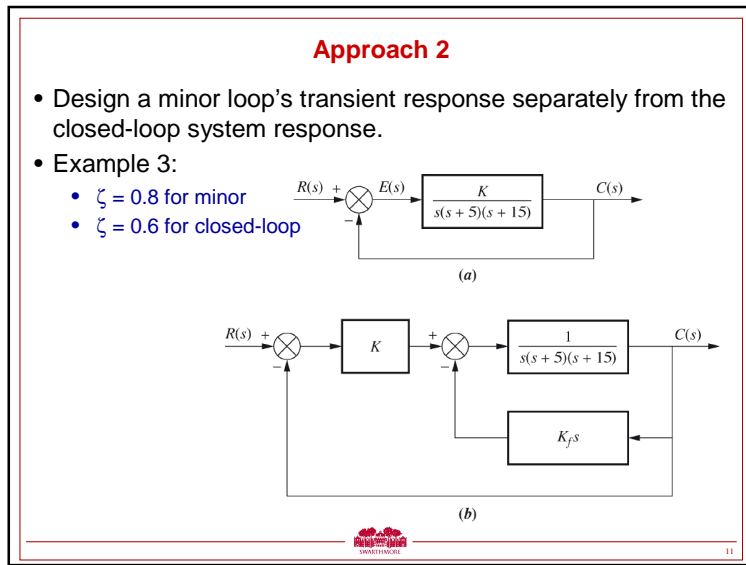
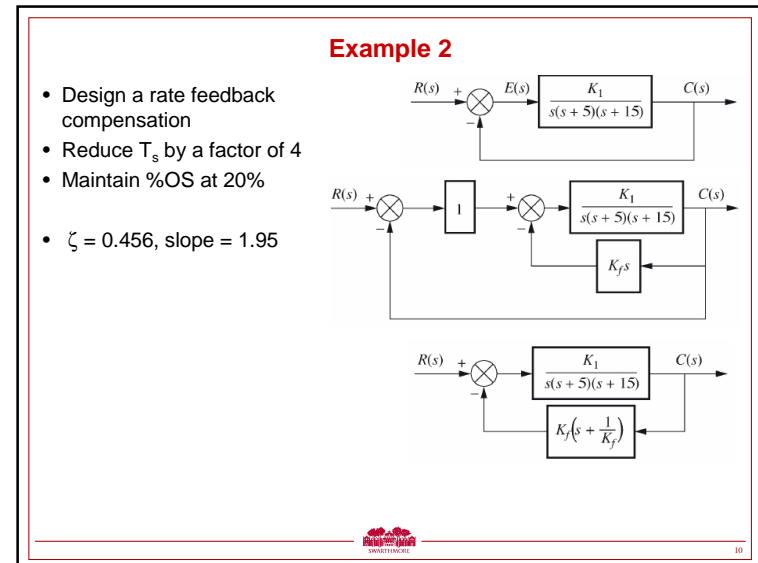
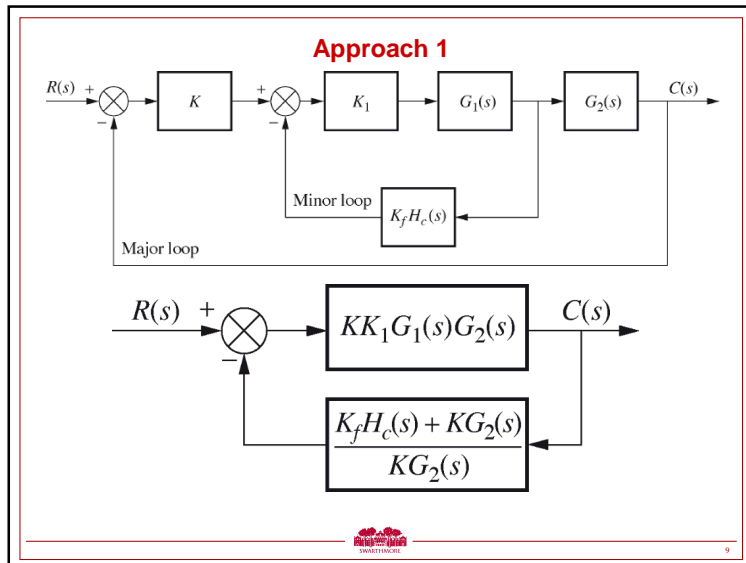
Feedback Compensation



- Disadvantage: More complicated
- Advantage: Faster response
 - Sometimes physical system characteristics does not allow us to use cascade compensators
 - Often does not require additional amplification
 - Two Approaches



8



A Few Final Words

- Active components vs. passive components
- Analog vs. Digital