



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

DESIGN VIA ROOT LOCUS AND COMPENSATION TECHNIQUES

LAG COMPENSATION

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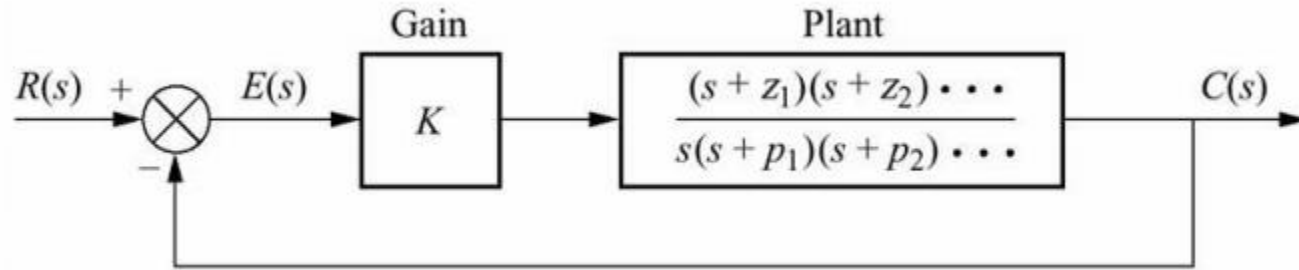


LAG COMPENSATION

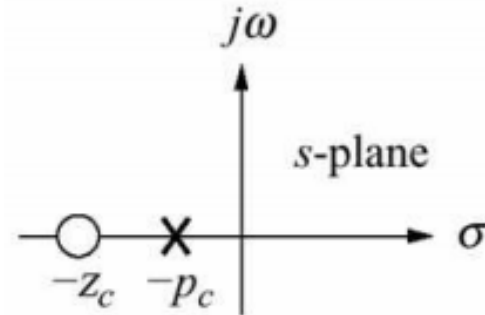
- Ideal integral compensation, with its pole on the origin, requires an active integrator
- If we use passive networks, the pole and zero are moved to the left, close to the origin
- Similar to the Ideal Integrator, however it has a pole not on origin but close to the origin.



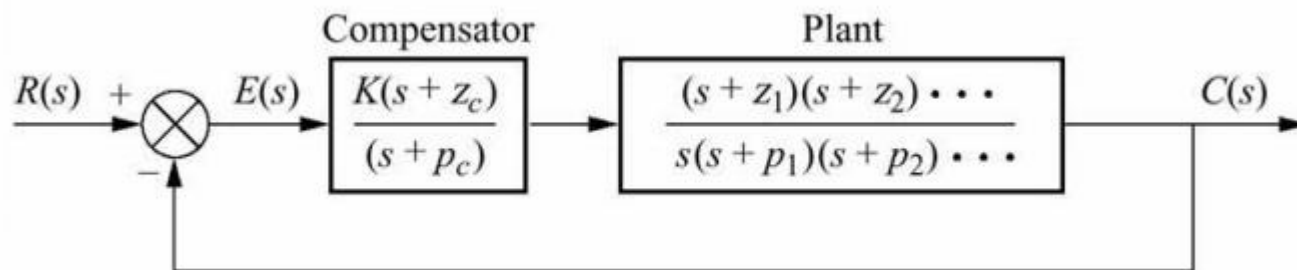
LAG COMPENSATION



$$G_1(s) = \frac{s + z_c}{s + p_c}$$



LAG COMPENSATION



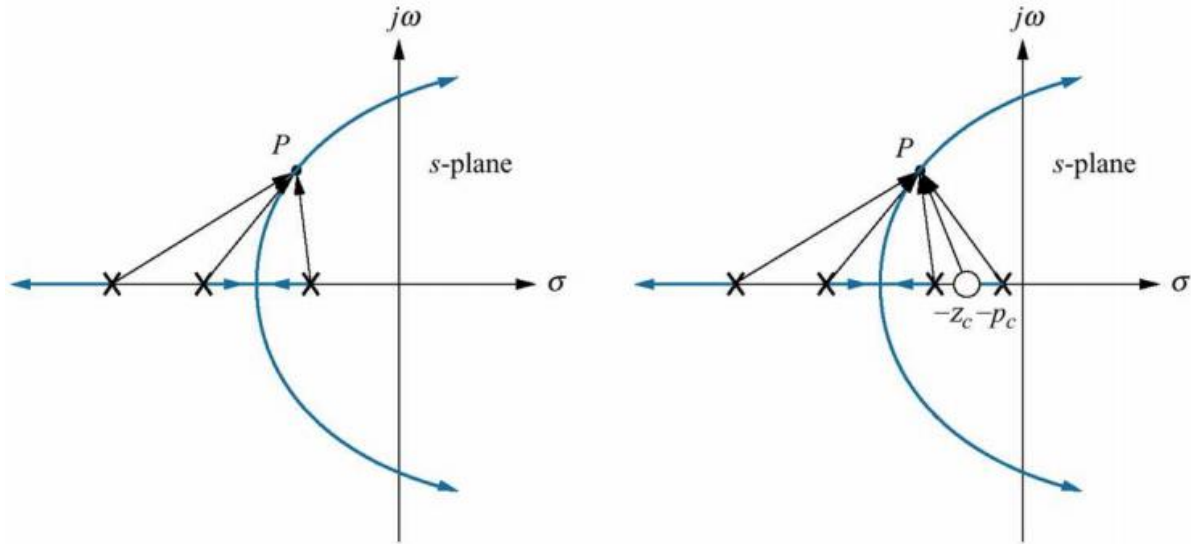
Steady State Improvement:

- Before compensation:

$$K_{v_0} = \lim_{s \rightarrow 0} G(s) = K \frac{z_1 z_2 \cdots}{p_1 p_2 \cdots}.$$

- After compensation: $K_{v_{new}} = \frac{z_c}{p_c} K \underbrace{\frac{z_1 z_2 \cdots}{p_1 p_2 \cdots}}_{K_{v_0}}$

LAG COMPENSATION

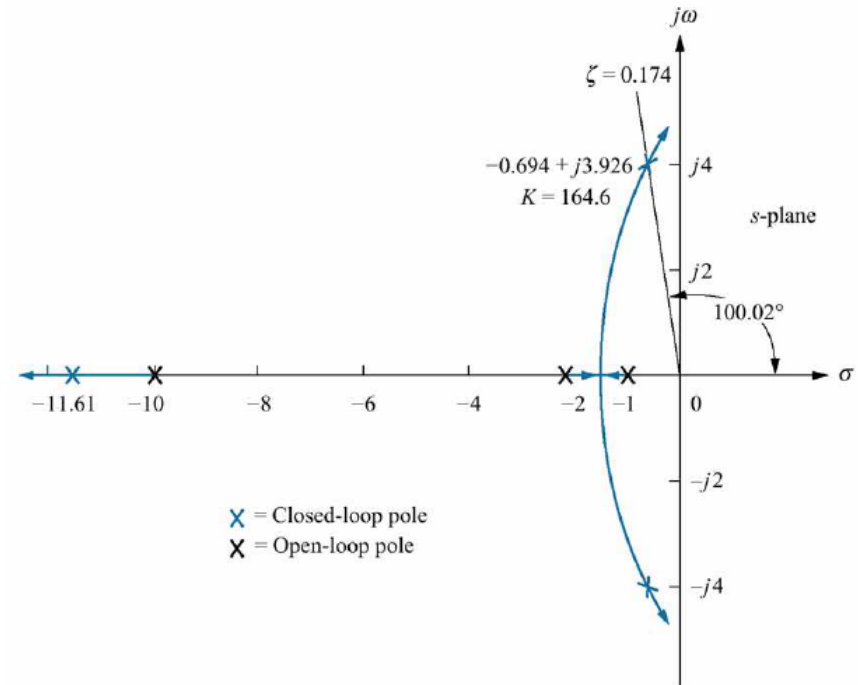
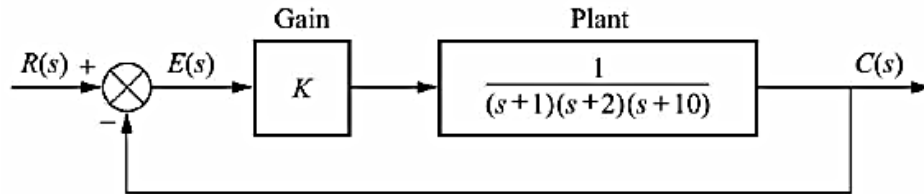


The effect on transient response is negligible

Ref: N. S. Nise: Control Systems Engineering, 6th Ed., Wiley, 2013

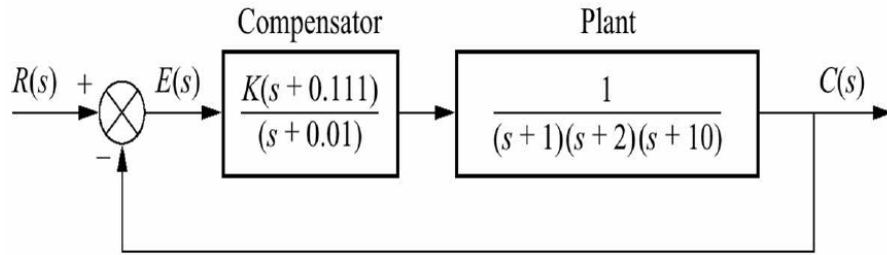
LAG COMPENSATION: EXAMPLE

Compensate the system whose root locus is shown to improve the steady-state error by a factor of 10 if the system is operating with a damping ratio of 0.174.

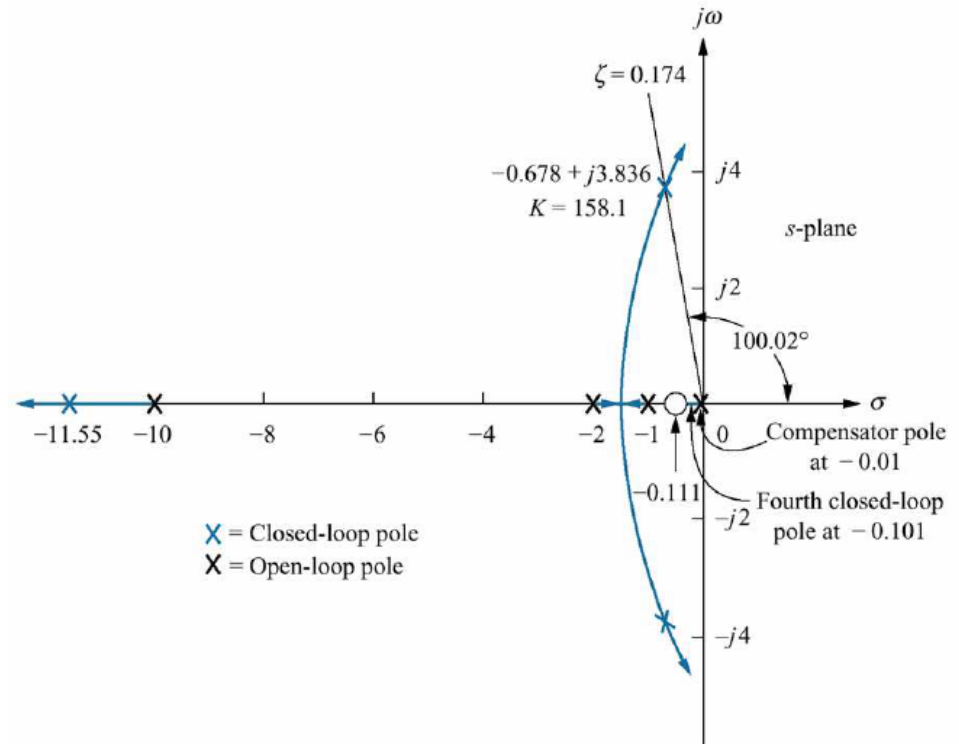


Ref: N. S. Nise: Control Systems Engineering, 6th Ed., Wiley, 2013

LAG COMPENSATION: EXAMPLE



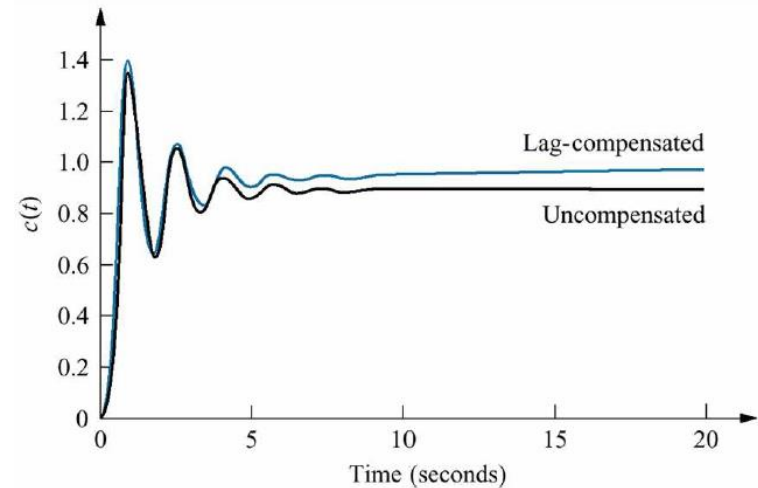
Compensated system



Ref: N. S. Nise: Control Systems Engineering, 6th Ed., Wiley, 2013

LAG COMPENSATION: EXAMPLE

Parameter	Uncompensated	Lag-compensated
Plant and compensator	$\frac{K}{(s+1)(s+2)(s+10)}$	$\frac{K(s+0.111)}{(s+1)(s+2)(s+10)(s+0.01)}$
K	164.6	158.1
K_p	8.23	87.75
$e(\infty)$	0.108	0.011
Dominant second-order poles	$-0.694 \pm j3.926$	$-0.678 \pm j3.836$
Third pole	-11.61	-11.55
Fourth pole	None	-0.101
Zero	None	-0.111



Ref: N. S. Nise: Control Systems Engineering, 6th Ed., Wiley, 2013

REFERENCE BOOKS

- Norman S. Nise, Control Systems Engineering, Wiley, 2013
- Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010.

