



IIT ROORKEE



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CERTIFICATION COURSE

# ROOT LOCUS TECHNIQUE

## NUMERICAL EXAMPLES AND SECOND ORDER APPROXIMATION

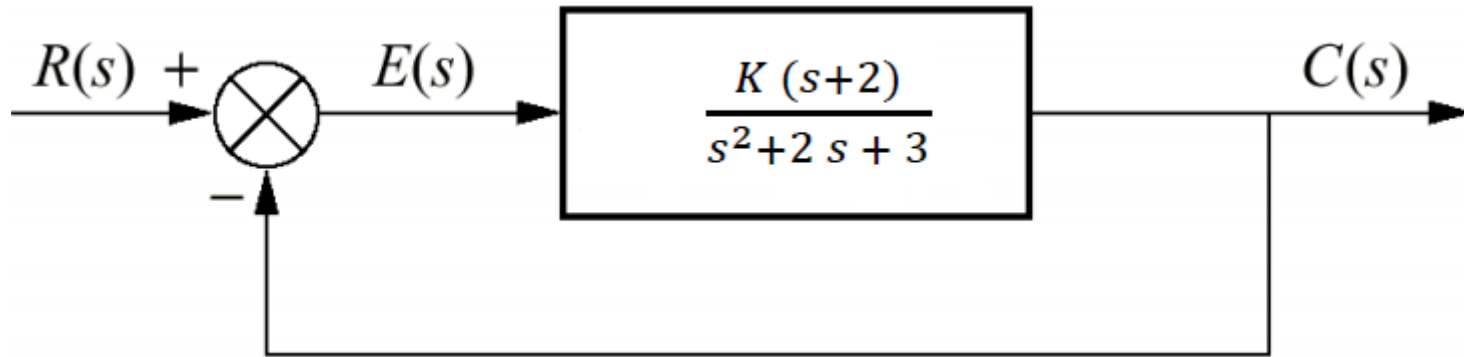
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## NUMERICAL EXAMPLE

- Plot the root locus for the following system

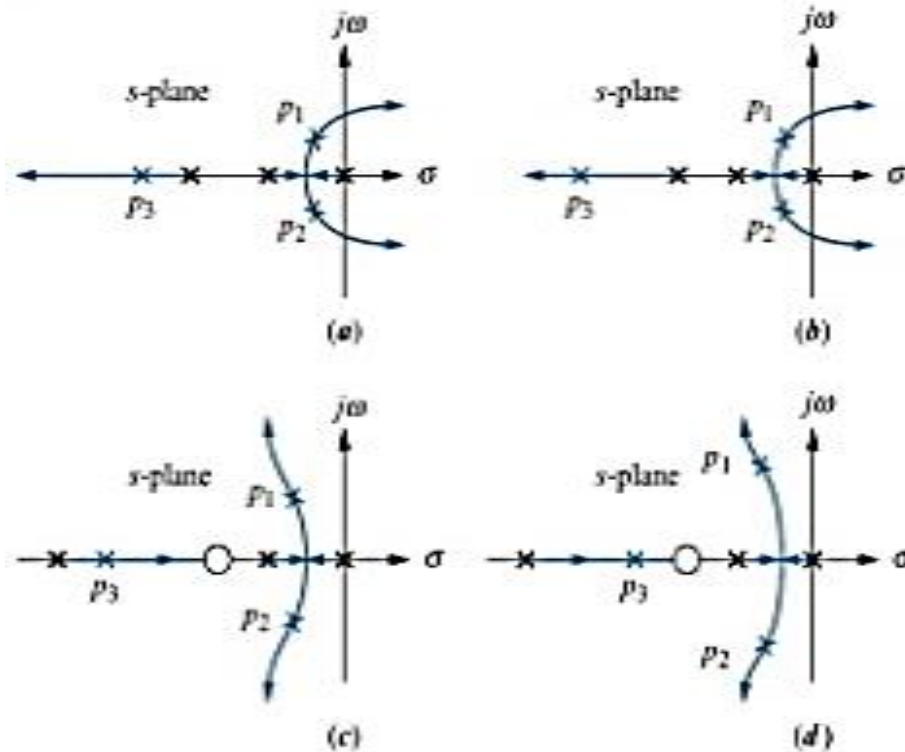


## SECOND ORDER APPROXIMATION

The conditions justifying a second-order approximation are

- Higher order poles are much farther into the left half of the s-plane than the dominant second order pair of poles
- Closed-loop zeros near the closed-loop second-order pole pair are nearly cancelled by the close proximity of higher-order closed-loop poles
- Closed-loop zeros not cancelled by the close proximity of higher-order closed-loop poles are far removed from the closed-loop second-order pole pair

# SECOND ORDER APPROXIMATION



- × Open-loop pole
- × Closed-loop pole
- Closed-loop zero

## SECOND ORDER APPROXIMATION

- Sketch RL for the given system
- Assume the system is second order without any zeros and then find the gain to meet the transient response specification
- Justify the second order assumption by finding the location of all higher-order poles and evaluating the fact that they are much farther from the  $j\omega$ -axis == five times. Closed-loop zeros are approximately cancelled by higher order poles. If zeros is not cancelled, be sure that the zero is far from the dominant poles
- If the assumptions cannot be justified, solve it as a higher order system

# REFERENCE BOOKS

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

