



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

STATE SPACE METHOD

CONTROLLER DESIGN AND CONTROLLABILITY

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NUMERICAL EXAMPLE

- Given the plant, $G(s) = \frac{20(s+5)}{s(s+1)(s+4)}$
- Design the phase variable feedback gains to yield **9.5 %** overshoot and a settling time of **0.74** second.

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



CONTROLLABILITY

- If an input to a system takes every state variable from a desired initial state to a desired final state, the system is said to be controllable; otherwise the system is uncontrollable
- To control the pole location of the closed-loop system, we say that the control signal, u , can control the behavior of each state variable in $\mathbf{x}$
- If any one of the state variable cannot be controlled by u , then we cannot place the poles of the system where we desire
- A system with *distinct eigenvalues* and a *diagonal system matrix* is controllable if the input coupling matrix **B** does not have any rows that are zero

CONTROLLABILITY

- The problem of visualizing controllability gets more complicated if the system does not have distinct poles but has multiple poles.
- Compute the controllability matrix for the n^{th} order plant

$$C_M = [B \quad AB \quad A^2B \quad \dots \quad A^{n-1}B]$$

- System is controllable if $\text{rank}(C_M) = n$

REFERENCE BOOKS

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

