

# EE C128 / ME C134 – Feedback Control Systems

## Lecture – Chapter 5 – Reduction of Multiple Subsystems

Alexandre Bayen

Department of Electrical Engineering & Computer Science  
University of California Berkeley



September 12, 2013

## *Topics covered in this presentation*

- ▶ Block diagrams
- ▶ Effect of forward-path gain
- ▶ 5 representations of systems in state space
- ▶ Similarity transformations
- ▶ Eigenvalues and eigenvectors

- 5 Reduction of Multiple Subsystems
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - 5.3 Analysis and design of feedback systems
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

- 5 Reduction of Multiple Subsystems
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - 5.3 Analysis and design of feedback systems
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

- 5 Reduction of Multiple Subsystems
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - 5.3 Analysis and design of feedback systems
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

# Cascade form, [1, p. 237]

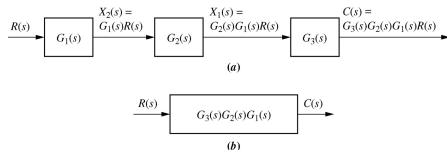
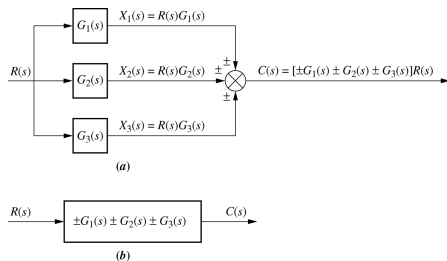


Figure : a. cascaded subsystems; b. equivalent TF

► *Equivalent TF*

$$G_e(s) = G_3(s)G_2(s)G_1(s)$$

# Parallel form, [1, p. 239]



► *Equivalent TF*

$$G_e(s) = \pm G_3(s) \pm G_2(s) \pm G_1(s)$$

Figure : a. parallel subsystems; b. equivalent TF

# FB form, [1, p. 240]

► *OL TF*

$$G(s)H(s)$$

► *CL TF*

$$T(s) = \frac{G(s)}{1 \pm G(s)H(s)}$$

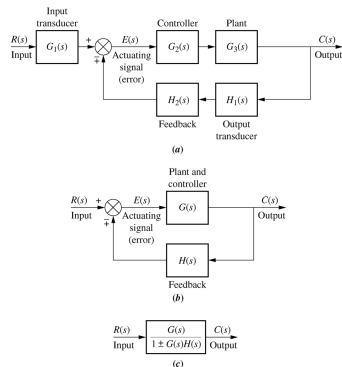
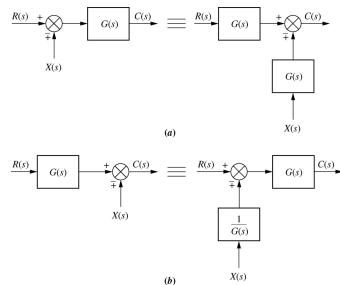


Figure : a. FB control system; b. simplified model; c. equivalent TF



# Moving blocks to create familiar forms, [1, p. 241]



## ► *Summing junctions*

**Figure :** Block diagram algebra for summing junctions—equivalent forms for moving a block a. to the left past a summing junction; b. to the right past a summing junction

- **5 Reduction of Multiple Subsystems**
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - **5.3 Analysis and design of feedback systems**
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

- 5 Reduction of Multiple Subsystems
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - 5.3 Analysis and design of feedback systems
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

- 5 Reduction of Multiple Subsystems
  - 5.1 Introduction
  - 5.2 Block Diagrams
  - 5.3 Analysis and design of feedback systems
  - 5.7 Alternative representations in state space
  - 5.8 Similarity transformations

# Bibliography



Norman S. Nise. *Control Systems Engineering*, 2011.