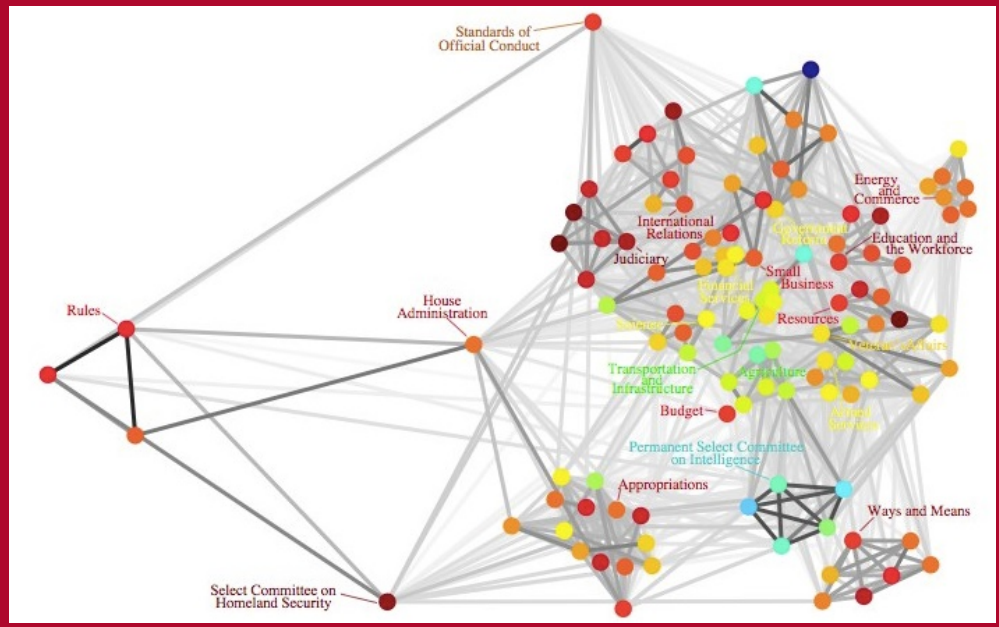
Automatic Control Theory

Chapter 2



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CH2: Mathematical Models of Systems

Main contents

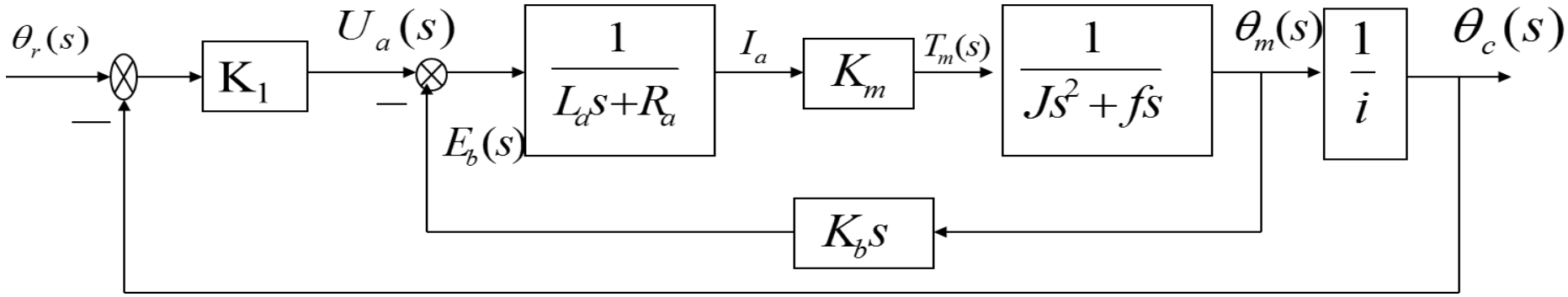
- Differential Equations of Physical Systems.
- The Transfer function of Linear Systems.

  (The Laplace Transform and Inverse Transform)
- Block Diagram.
- Block Diagram Reduction

CH2: Mathematical Models of Systems

Review

- **Block Diagram represented by using Transfer function**

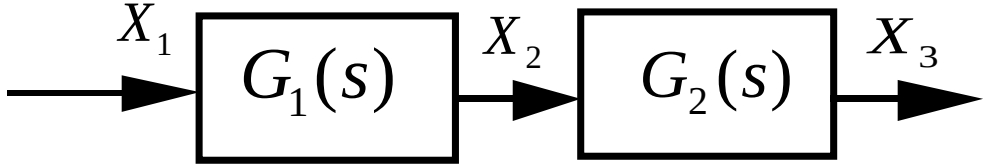


what is next

Block Diagram Reduction by Transformations ！

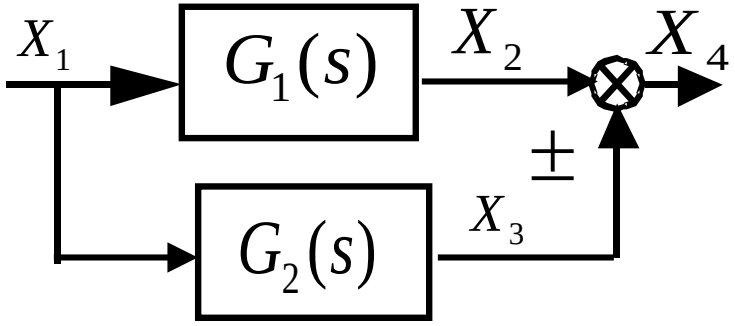
Block Diagram Transformations

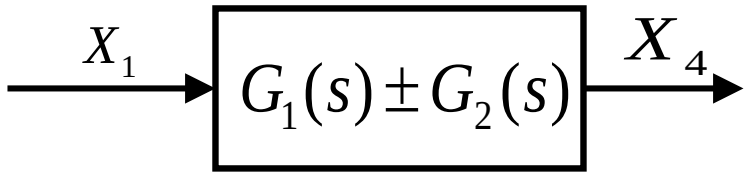
(1) Combining blocks in cascade



$$\frac{X_3(s)}{X_1(s)} = G_2(s)G_1(s)$$

(2) Parallel Connection of Blocks

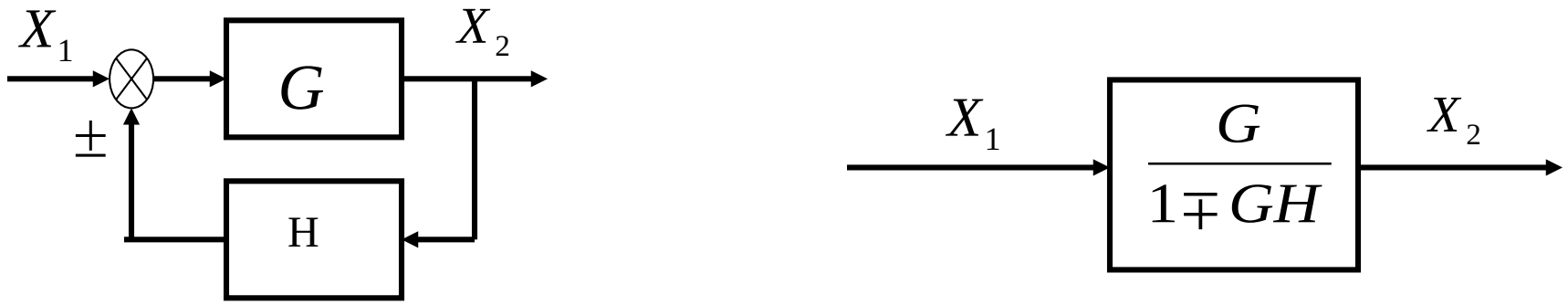




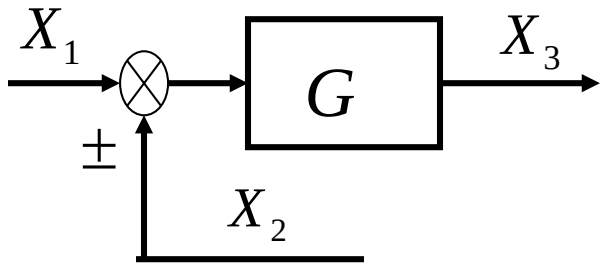
$$\frac{X_4(s)}{X_1(s)} = G_2(s) \pm G_1(s)$$

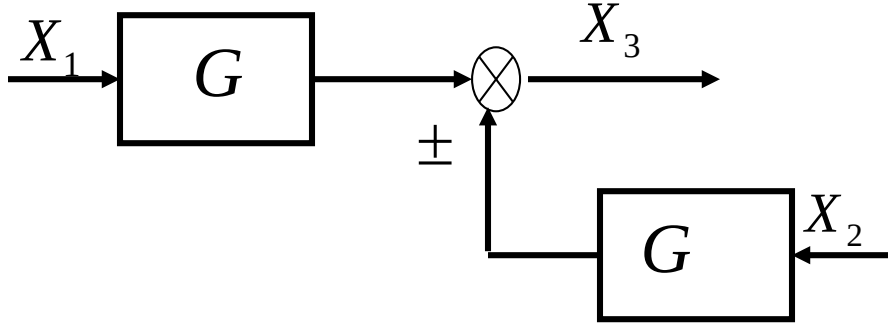
Block Diagram Transformations

(3) Eliminating a feedback loop



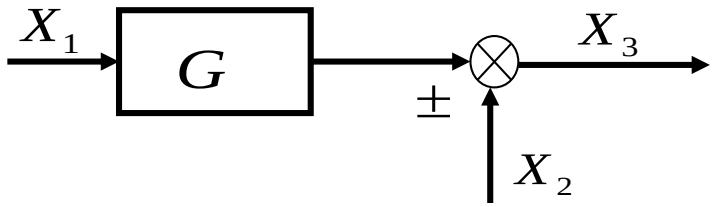
(4) Moving a summing point behind a block

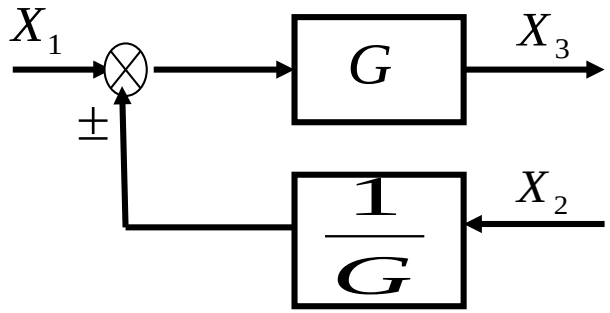




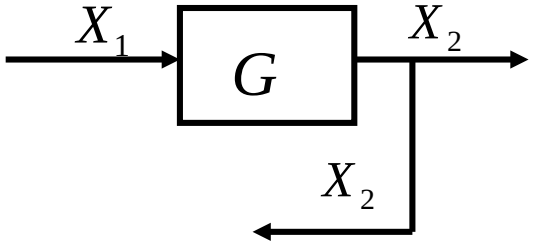
Block Diagram Transformations

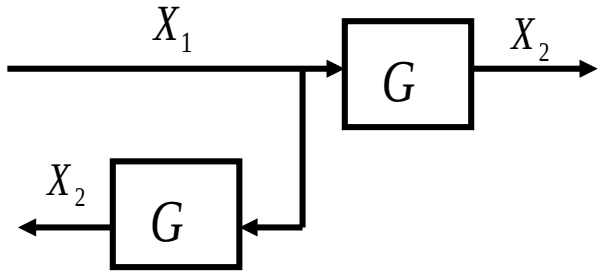
(5) Moving a summing point ahead a block



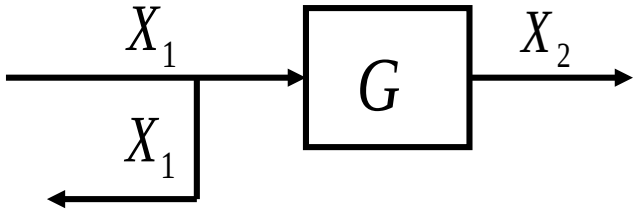


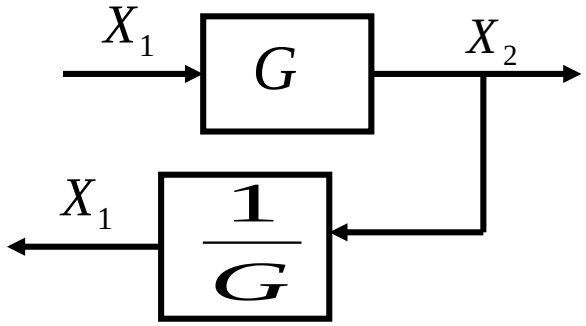
(6) Moving a pickoff point ahead a block





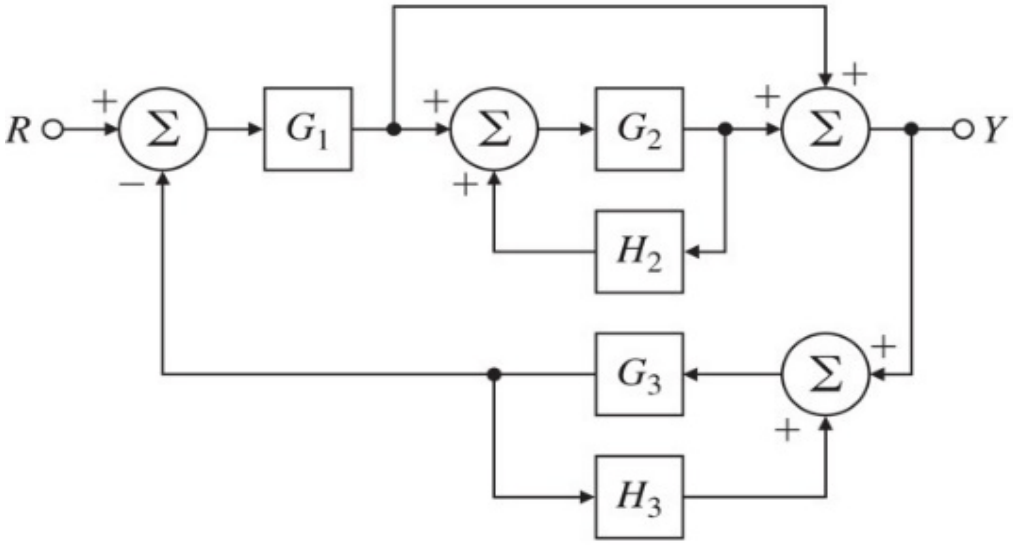
(7) Moving a pickoff point behind a block





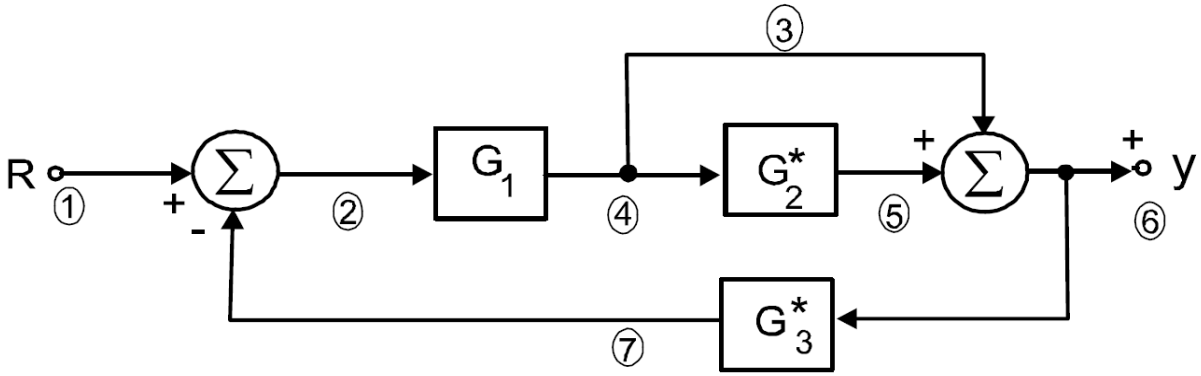
Block diagram reduction

Example 1



(a)

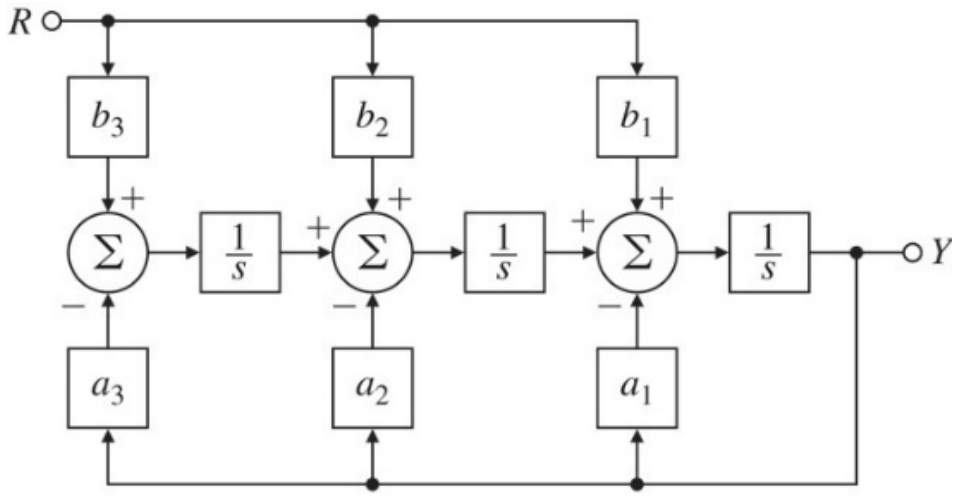
Solution 1



$$\frac{G_1(1-G_2H_2)(1-G_3H_3)+G_1G_2(1-G_3H_3)}{1+(1-G_2H_2)(1-G_3H_3)+G_1G_3(1-G_2H_2)+G_1G_2G_3}$$

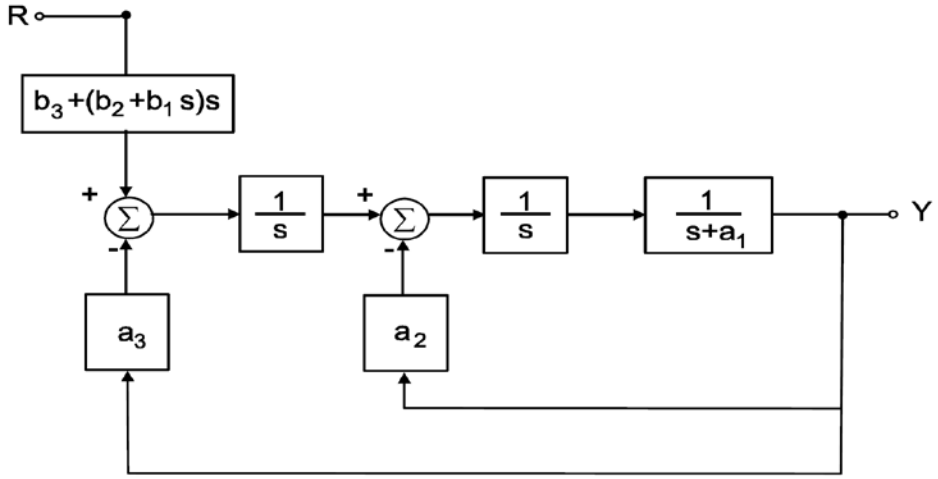
Block diagram reduction

Example 2



(b)

Solution 2



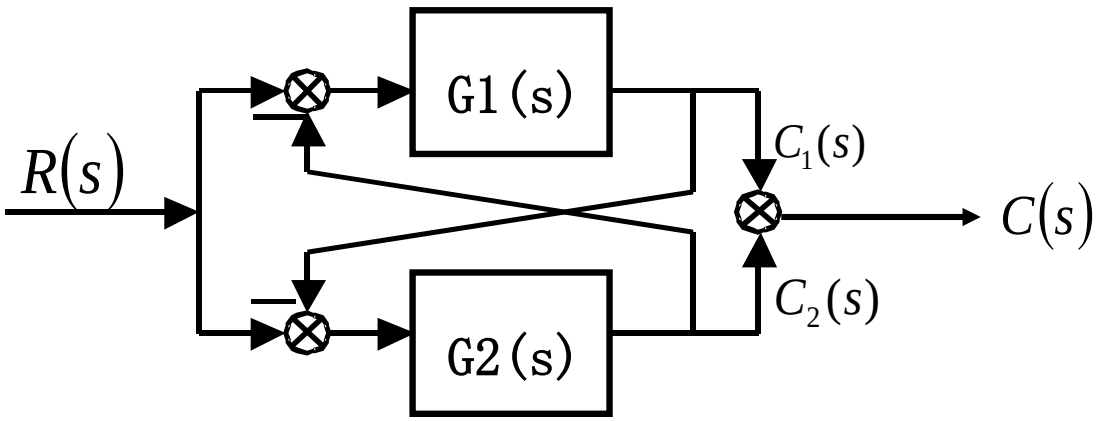
$$\frac{b_1 s^2 + b_2 s + b_3}{s^3 + a_1 s^2 + a_2 s + a_3}$$

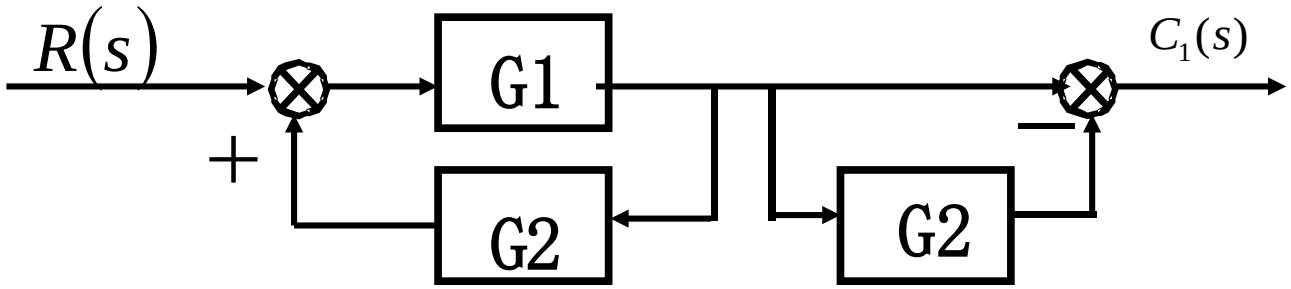
Tips: Moving a summing point ahead a block !

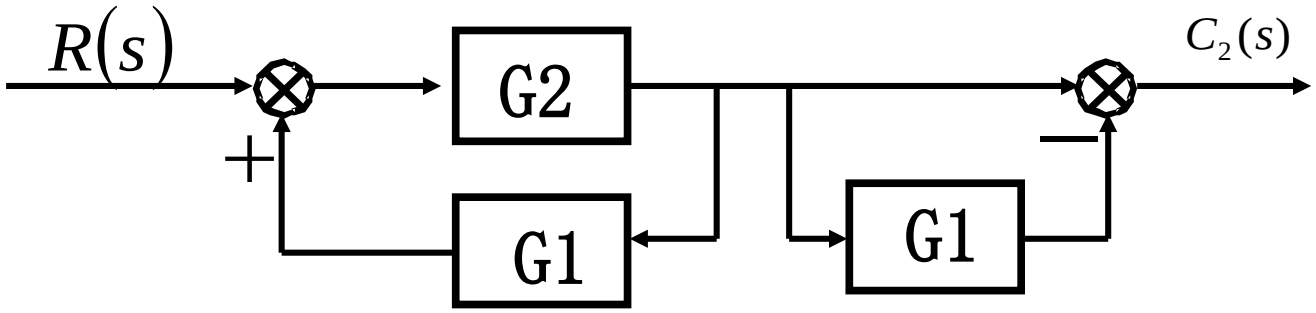
Block diagram reduction

Example 3

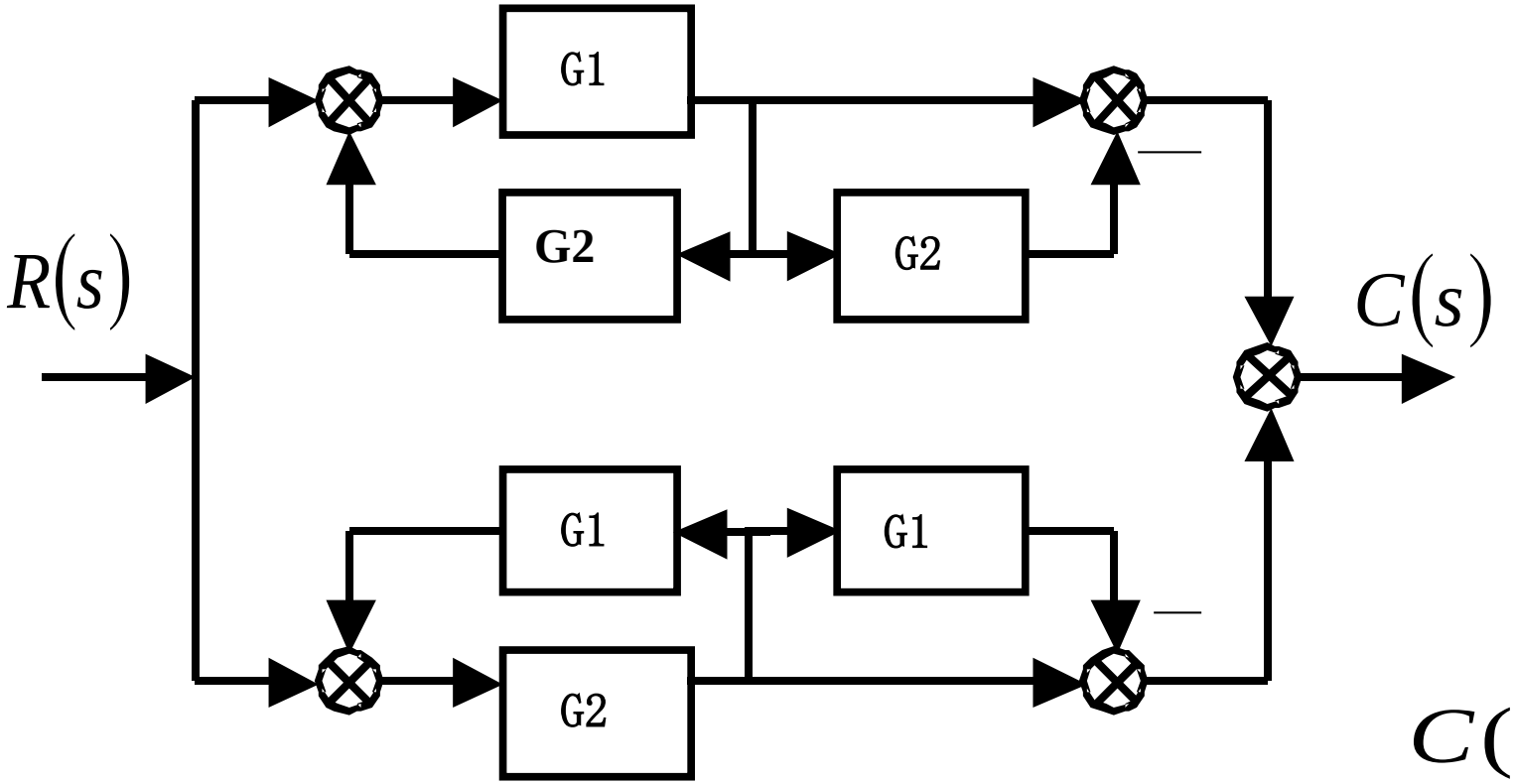
可以分开讨论的原因：线性
满足叠加







Block diagram reduction



Solution 1

$$\frac{C(s)}{R(s)} = \frac{G_1 + G_2 - 2G_1G_2}{1 - G_1G_2}$$

Block diagram reduction

核心

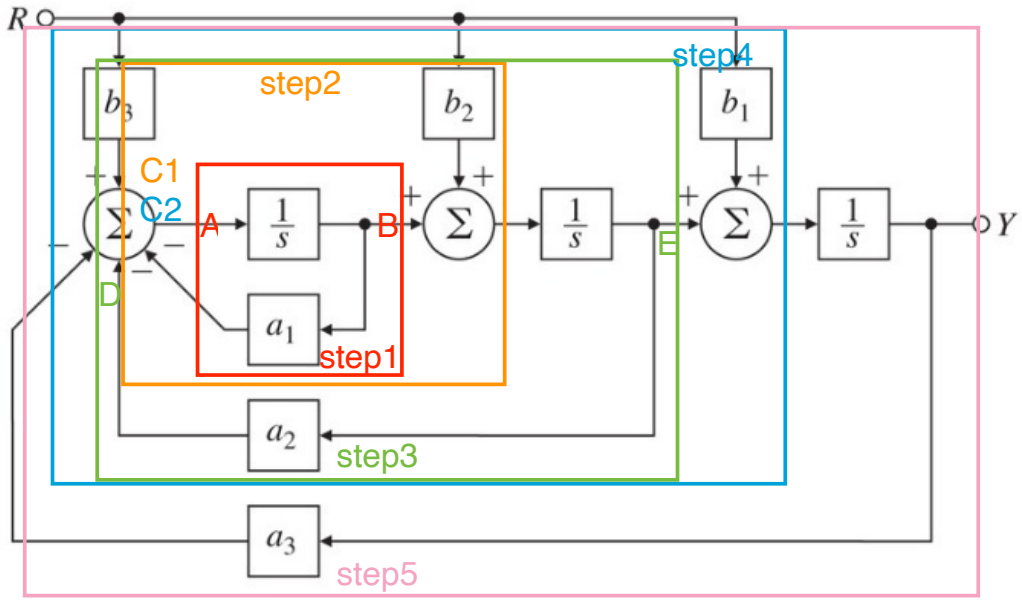
- **Differential Equations**
- **Transfer Function**
- Moving a summing point ahead a block
- Moving a pickoff point behind a block

续

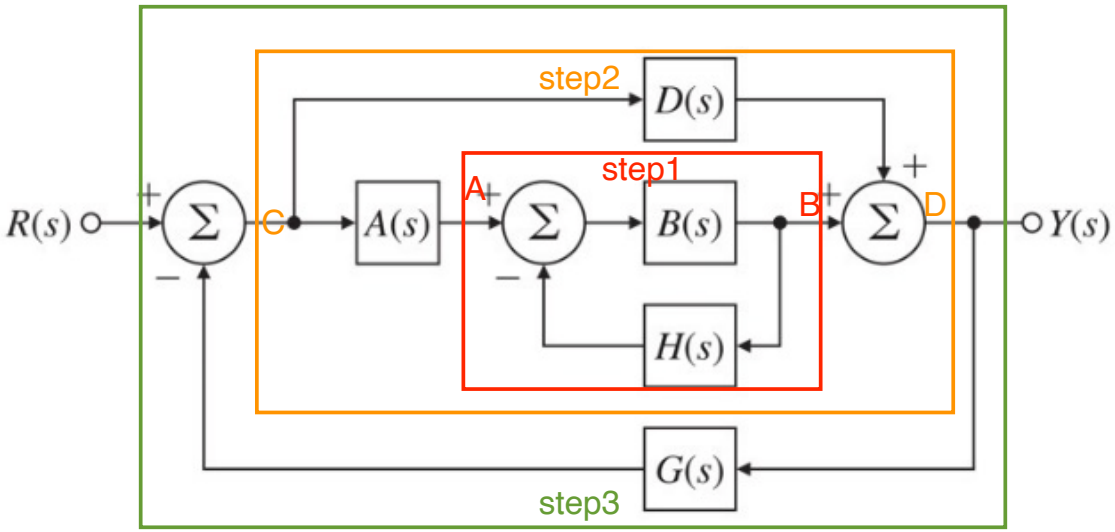
Block Diagram Reduction (Mason’s gain formula) !

Block diagram reduction

Homework



(c)



(d)