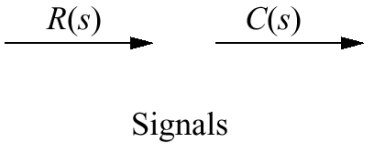
CHAPTER 3 : SYSTEM REPRESENTATION

A) INTRODUCTION

- **A control system consists of the inter-connection of subsystems.**
- **A more complicated system will have many inter-connected subsystems.**
- **For the purpose of analysis, we want to represent the multiple subsystems as a single transfer function.**
- **A system with multiple subsystems can be represented in two ways:**
  - **Block diagrams**
  - **Signal flow graphs**

B) BLOCK DIAGRAMS

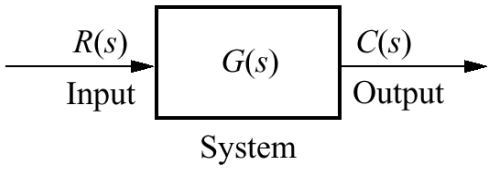
- **The basic components in a block diagram are:**
  - **Signals**



Signals

The direction of signal flow is shown by the arrow

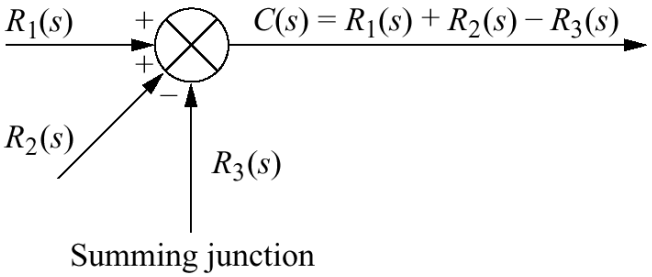
  - **System blocks**



System

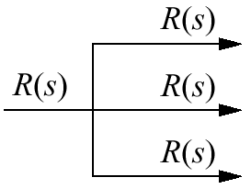
The system block represented by a transfer function

- **Summing junctions**



The signals are added/subtracted algebraically

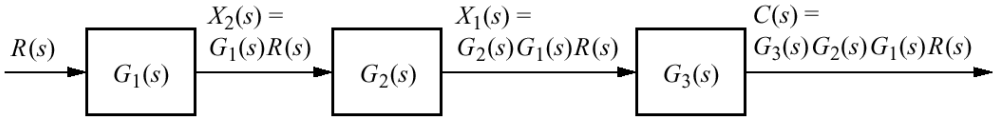
- **Pickoff points**



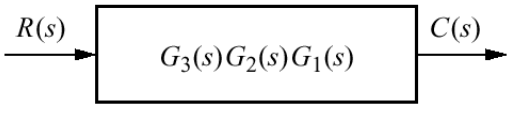
The same signal is distributed to other subsystems

- **The subsystems in a block diagram are normally connected in three forms:**

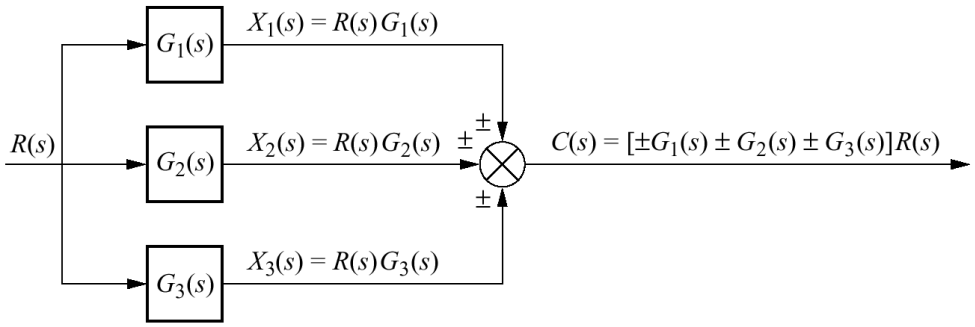
  - **Cascade form**



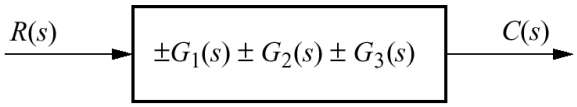
The block diagram can be reduced into a single block by multiplying every block to give:



- **Parallel form**

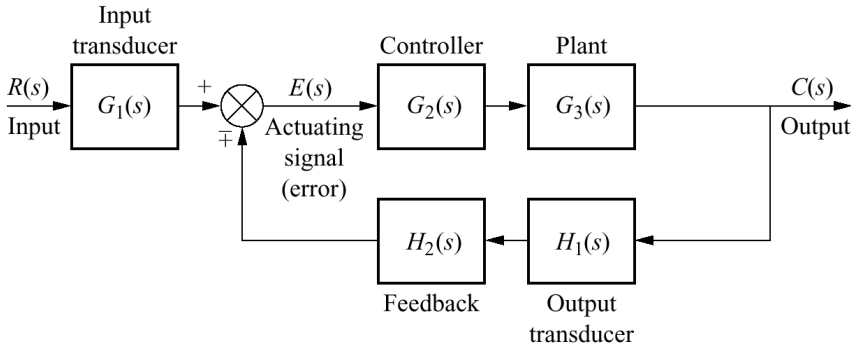


The block diagram can be reduced into a single block by summing every block to give:

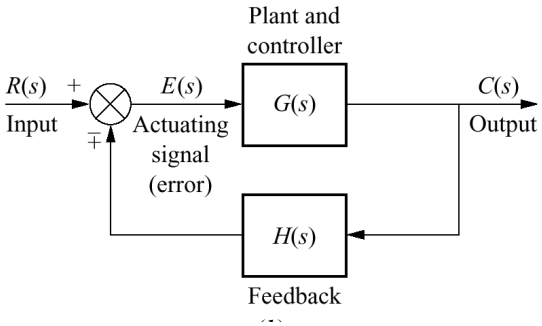


- **Feedback form**

  - **A typical system with feedback form:**



- **Can be simplified into:**



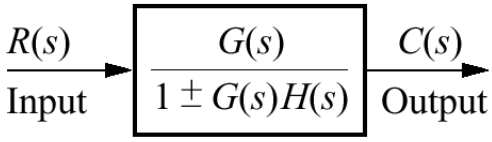
- **C(s) = G(s)E(s), but**

  E(s) = R(s) ∓ H(s)C(s), therefore

  C(s) = G(s)[R(s) ∓ H(s)C(s)], leading to

  C(s) ± G(s)H(s)C(s)=G(s)R(s)

  ➔ $$C(s) = \frac{G(s)}{1 \pm G(s)H(s)}.R(s)$$

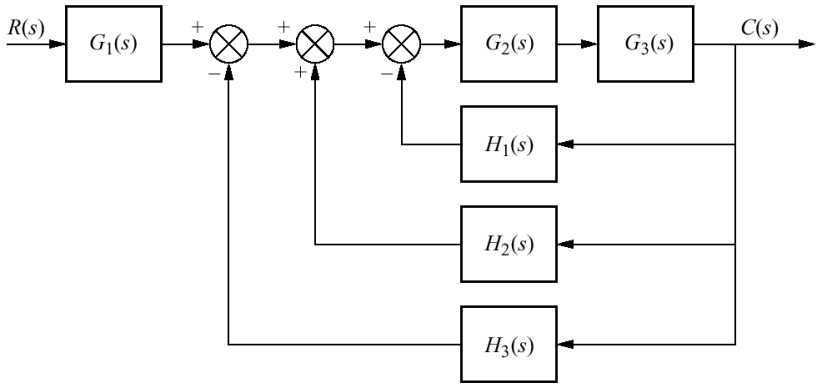


- $\frac{C(s)}{R(s)} = \frac{G(s)}{1 \pm G(s)H(s)}$ **is known as the closed-loop transfer function**

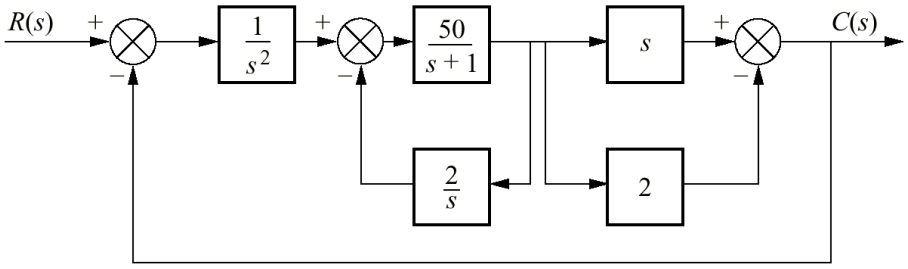
- $G(s)H(s)$ **is known as the open-loop transfer function**

- **Example:**

  - **Reduce the following block diagram into a single transfer function**



  - **P5.1 pg 301**

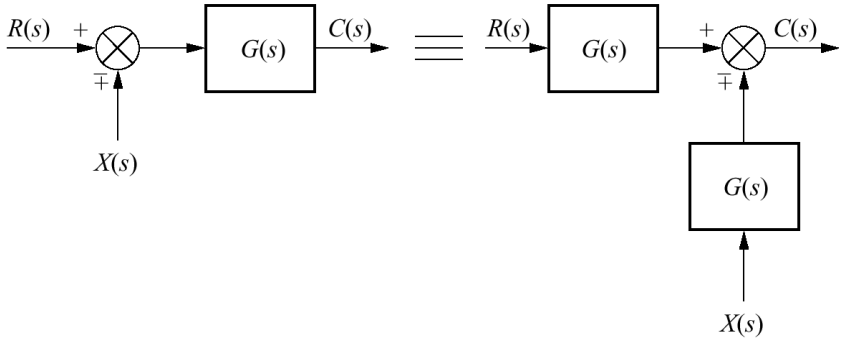


- **Moving blocks to create familiar forms**

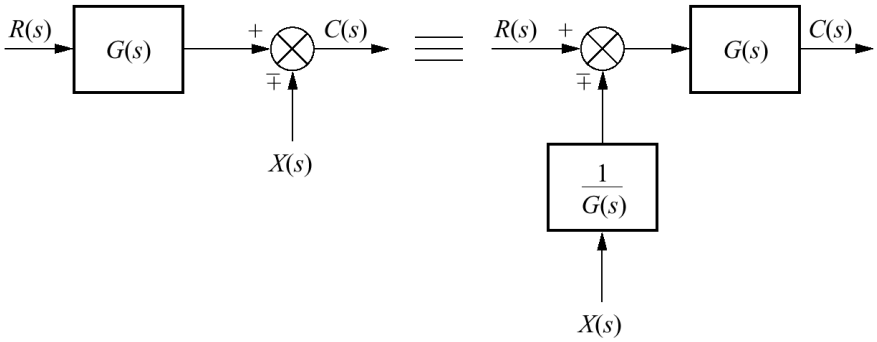
  - **It is not always apparent to get block diagrams in the familiar forms.**

  - **We have to move blocks to get the familiar forms in order to be able to reduce the block diagram into single transfer function.**

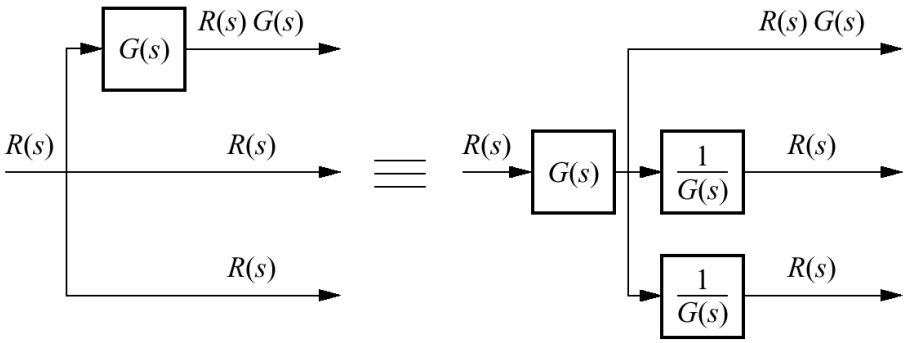
  - **Moving the summing junction to the front of a block**



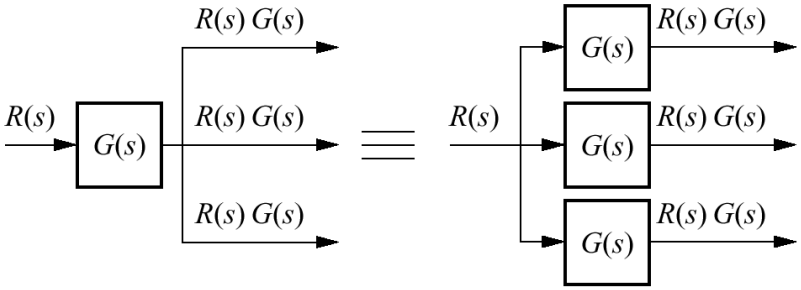
  - **Moving the summing junction to the back of a block**



- **Moving pick-off point to the front of a block**



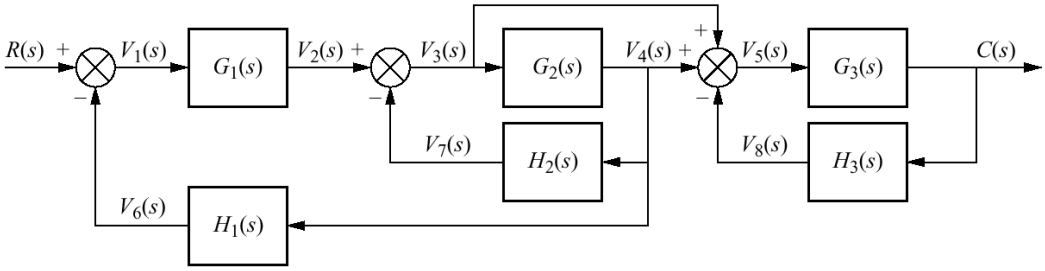
- **Moving pick-off point to the back of a block**



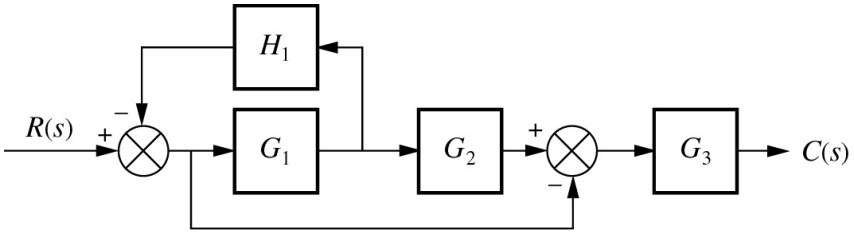
- **<u>NOTE:</u> DO NOT CROSS-OVER BETWEEN A SUMMING JUNCTION AND A PICK-OFF POINT**

- **Example:**

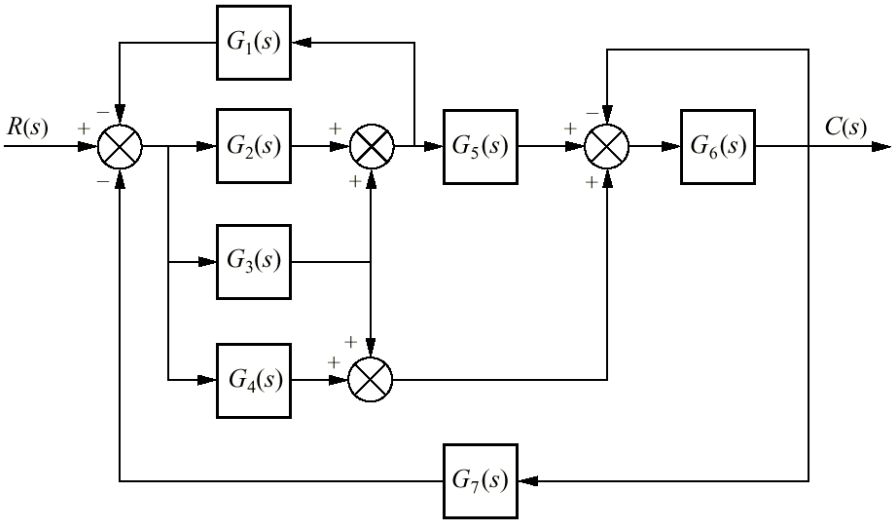
  - **Reduce the following block diagram into a single transfer function**



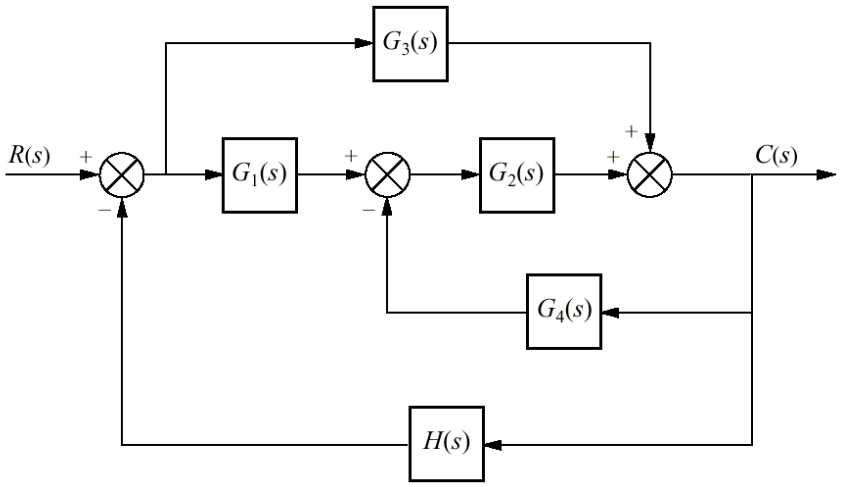
  - **P5.2**



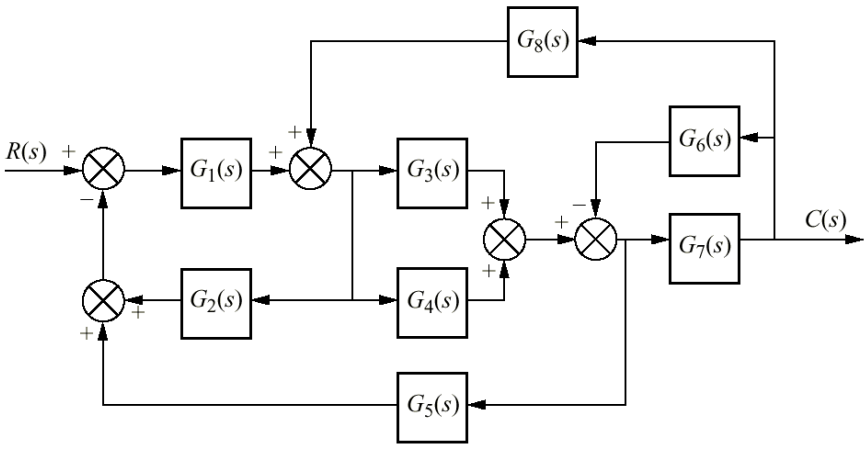
  - **P5.3**



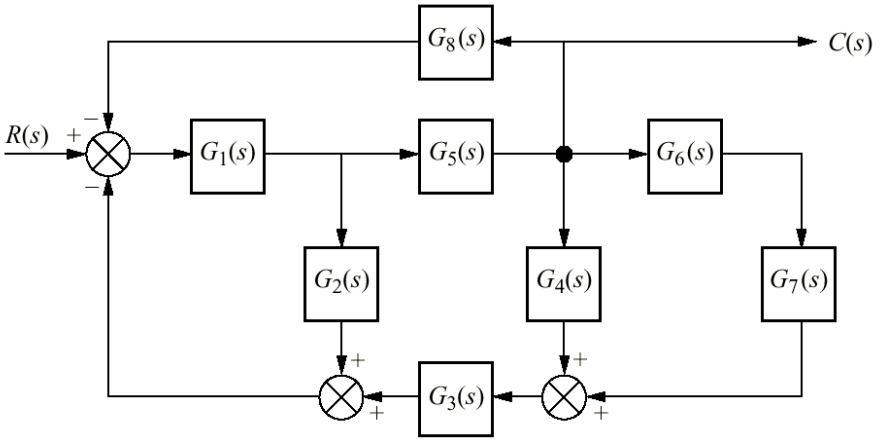
- **P5.4**



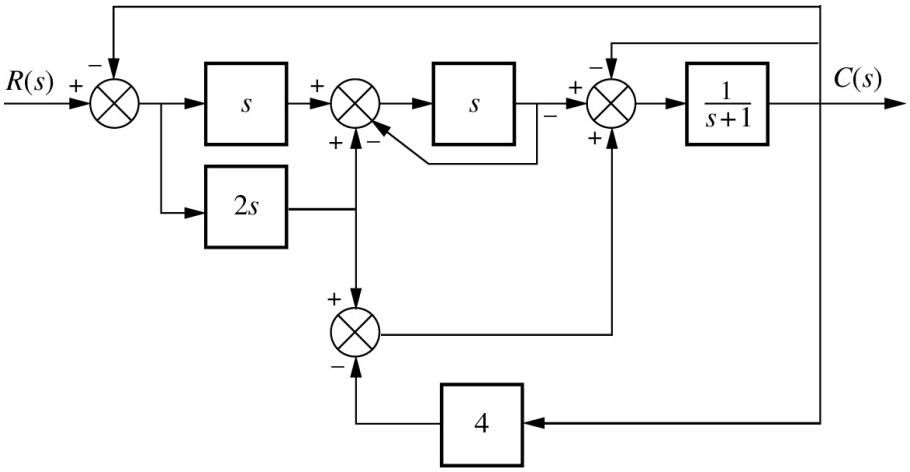
- **P5.5**



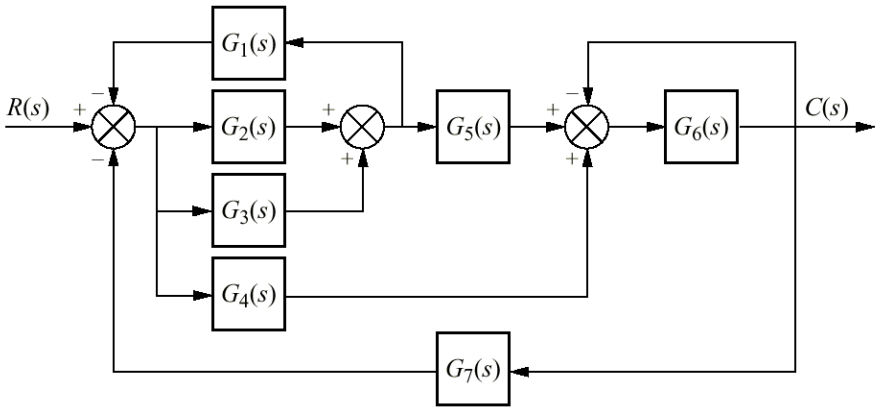
- **P5.6**



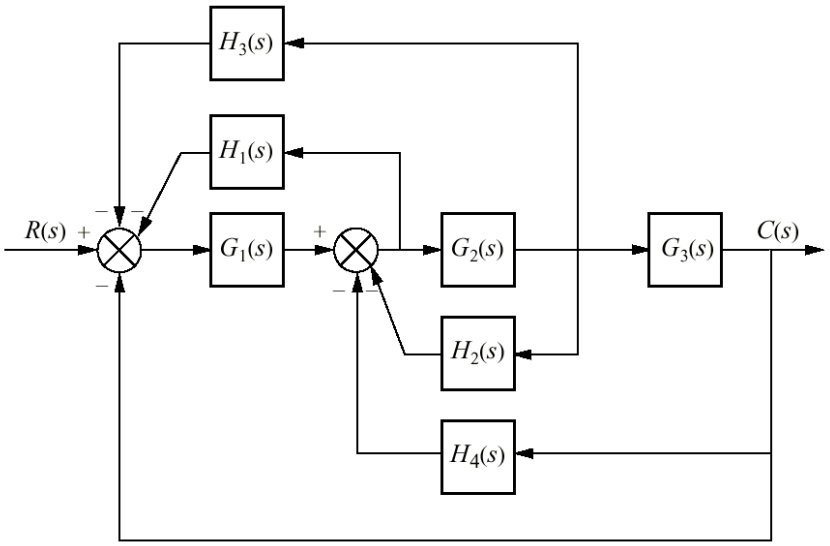
- **P5.7: Find the equivalent unity feedback system for the following system,**



- **P5.9**


R(s)
C(s)
G1(s)
G2(s)
G3(s)
G4(s)
G5(s)
G6(s)
G7(s)

- **P5.10**


R(s)
C(s)
H3(s)
H1(s)
G1(s)
G2(s)
G3(s)
H2(s)
H4(s)