



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-22**  
**An Autonomous Institution**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

### **19ECT212 – CONTROL SYSTEMS**

**II YEAR/ IV SEMESTER**

**UNIT I – CONTROL SYSTEM MODELING**

### **TOPIC 5- BLOCK DIAGRAM REDUCTION TECHNIQUES**



# OUTLINE



- REVIEW ABOUT PREVIOUS CLASS
- INTRODUCTION
- NEED FOR BLOCK DIAGRAM REDUCTION
- BASIC ELEMENTS OF BLOCK DIAGRAM
- BLOCK DIAGRAM REDUCTION TECHNIQUES
- SEVEN RULES
- ACTIVITY
- EXAMPLES
- SUMMARY



# INTRODUCTION



- It consists of a single block or a combination of blocks.
- These are used to represent the control systems in pictorial form.
- Signal into the block represents the **input  $R(s)$**  and signal out of block represents **output  $C(s)$** , while the block itself stands for the **transfer function  $G(s)$** .
- Flow of information is unidirectional, output being equal to input multiplied by the transfer function of the block.



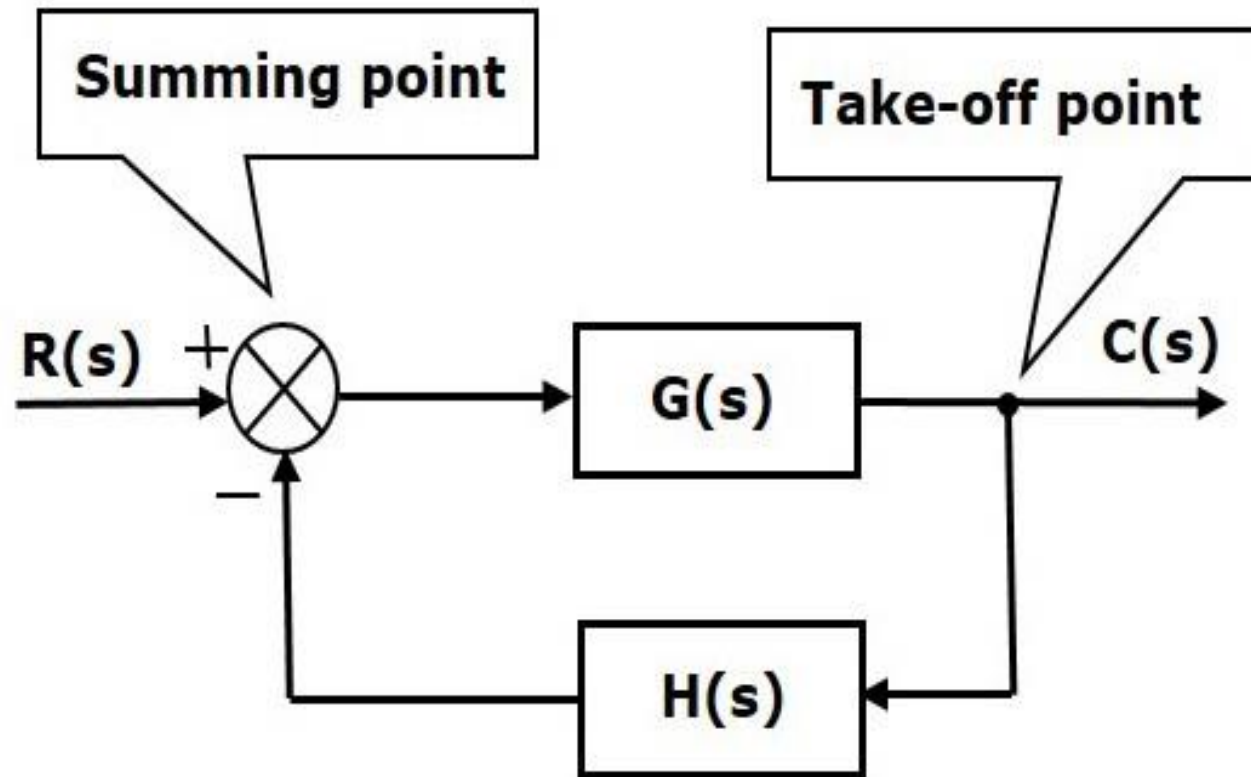
# NEED FOR BLOCK DIAGRAM REDUCTION

It is normally required to reduce multiple blocks into single block or for convenient understanding it may sometimes required to rearrange the blocks from its original order.

For the calculation of Transfer function its required to be reduced.



# BASIC ELEMENTS OF BLOCK DIAGRAM

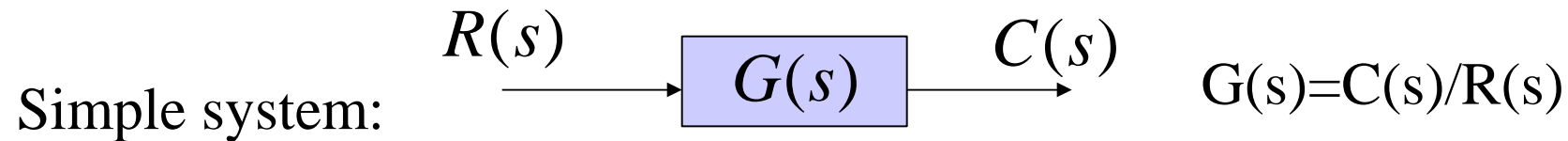




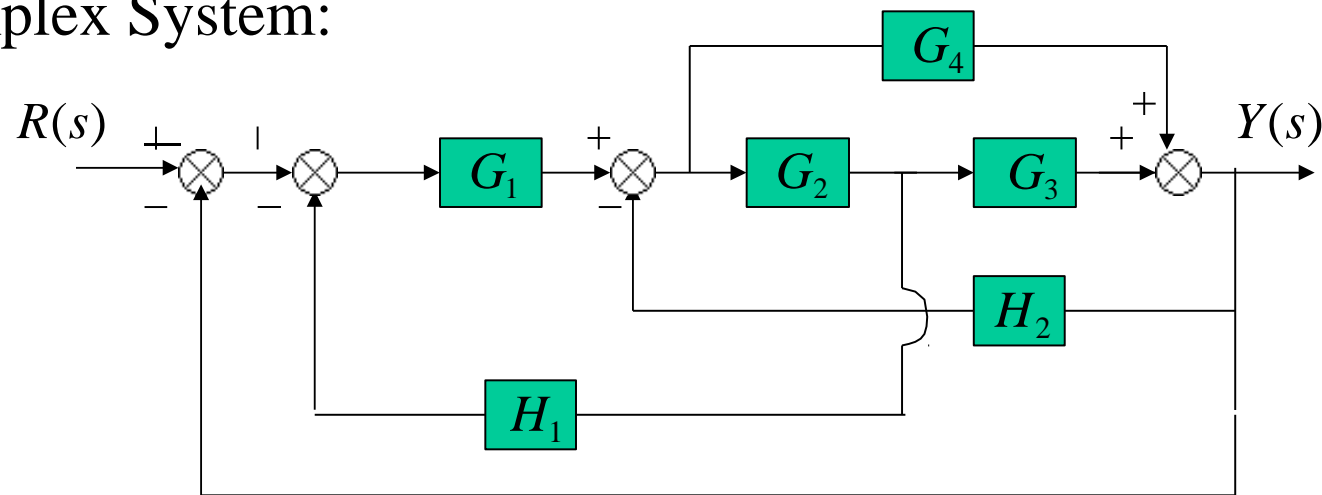
# BLOCK DIAGRAM

A Block diagram is basically modelling of any simple or complex system. It consists of multiple blocks connected together to represent a system to explain how it is functioning

Transfer Function: Ratio between transformation of output to the transformation of input when all the initial conditions are zero.



Complex System:





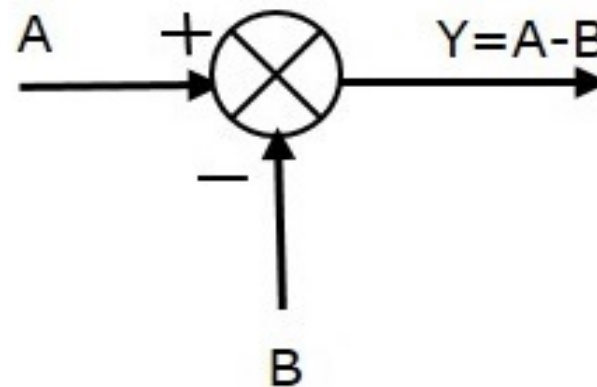
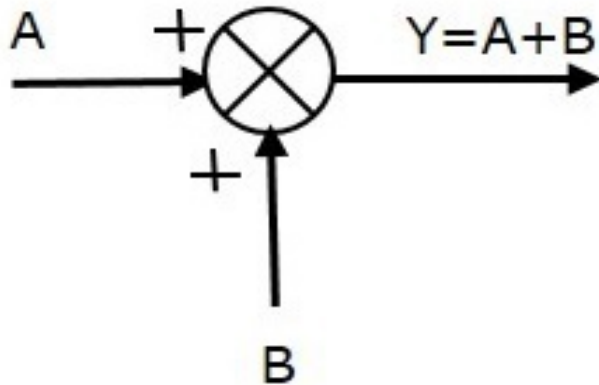
# BASIC ELEMENTS OF BLOCK DIAGRAM

- **Block**



$$Y(s) = G(s) * X(s)$$

- **Summing Point**





# BLOCK DIAGRAM REDUCTION TECHNIQUE

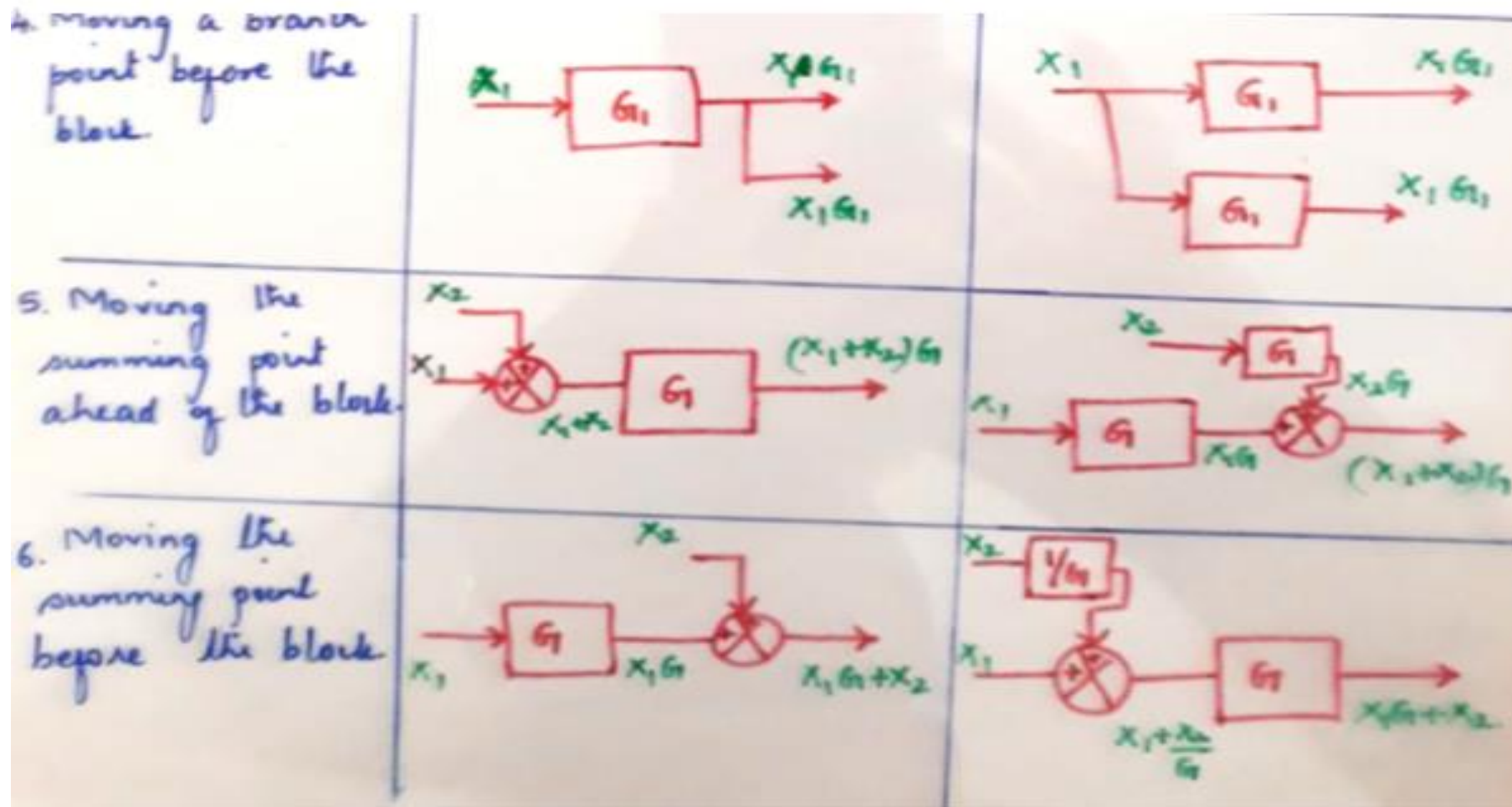


<u>RULE</u>	<u>Original Diagram</u>	<u>Equivalent diagram</u>
(1) Combining blocks in cascade		
2. Combining Parallel blocks.		
3. Moving a branch point ahead of the block.		



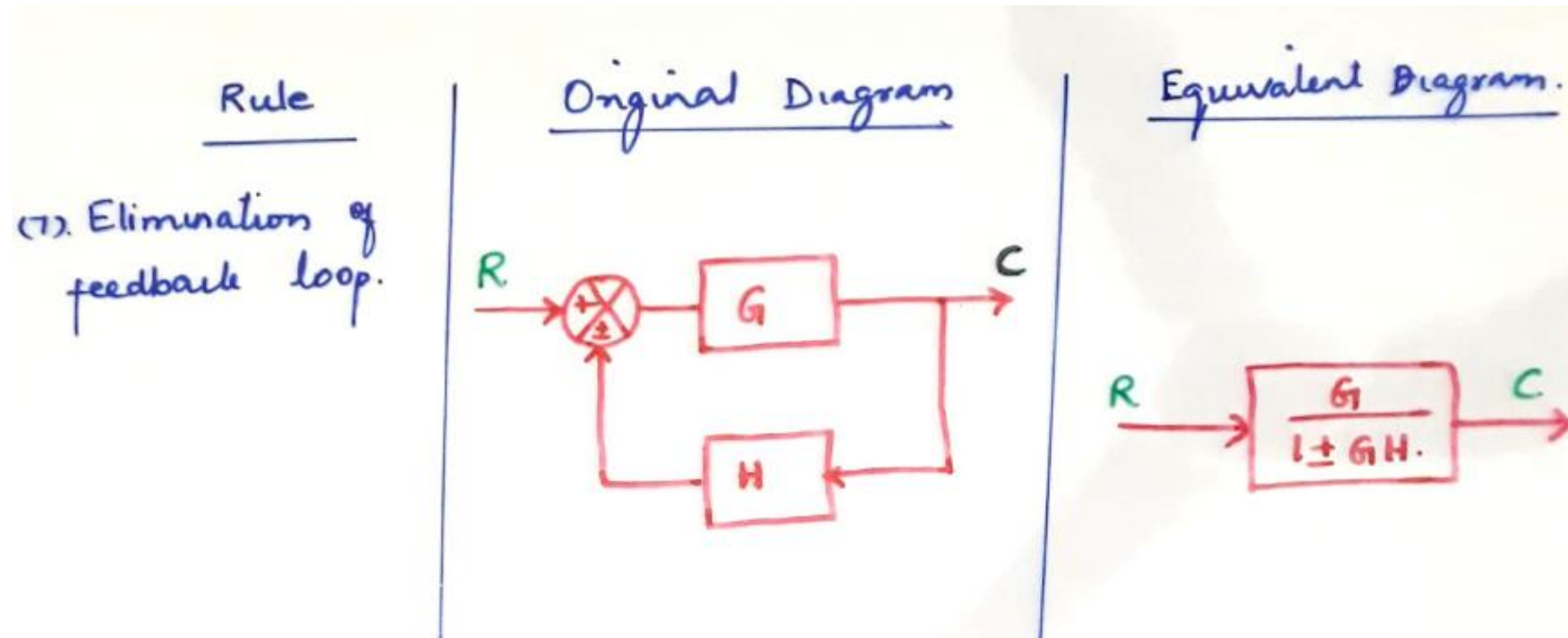


# BLOCK DIAGRAM REDUCTION TECHNIQUE...





# BLOCK DIAGRAM REDUCTION TECHNIQUE...





# ACTIVITY



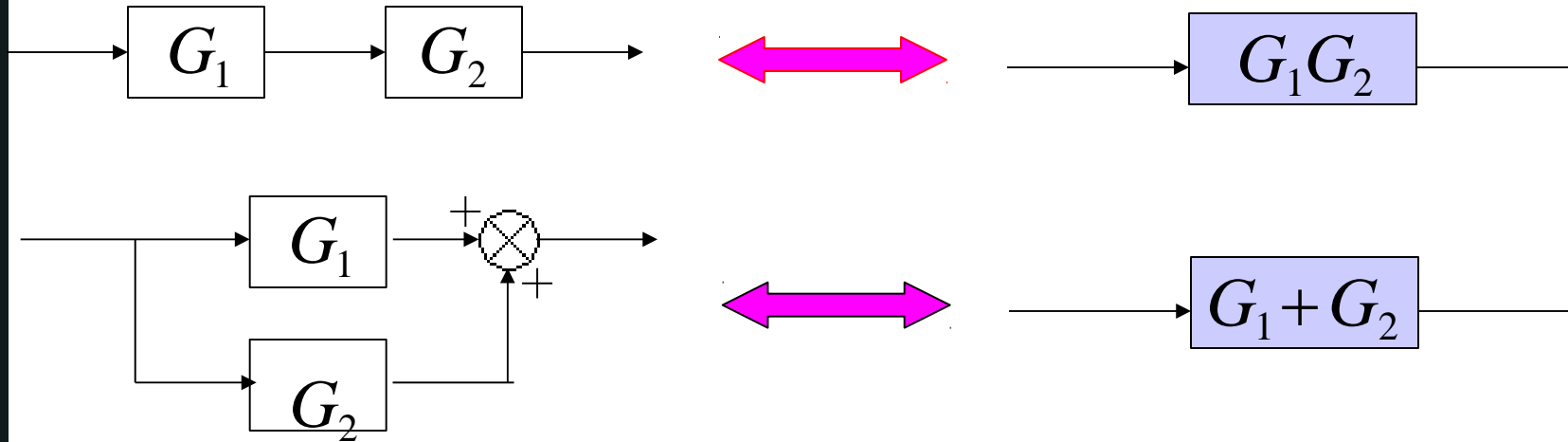
## GROUP DISCUSSION



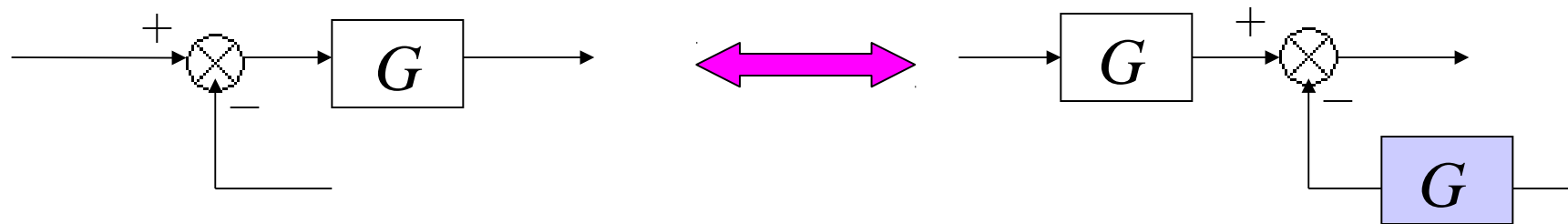
# BLOCK DIAGRAM REDUCTION TECHNIQUE...



## 1. Combining blocks which are in cascade or in parallel

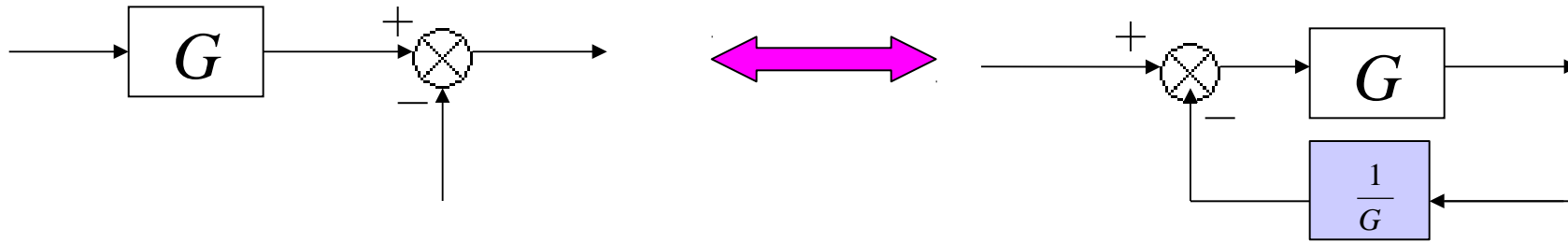


## 2. Moving a summing point behind a block

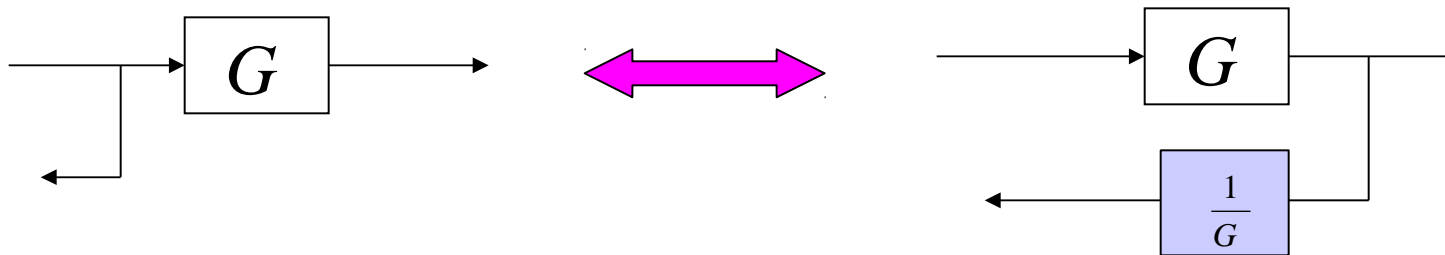




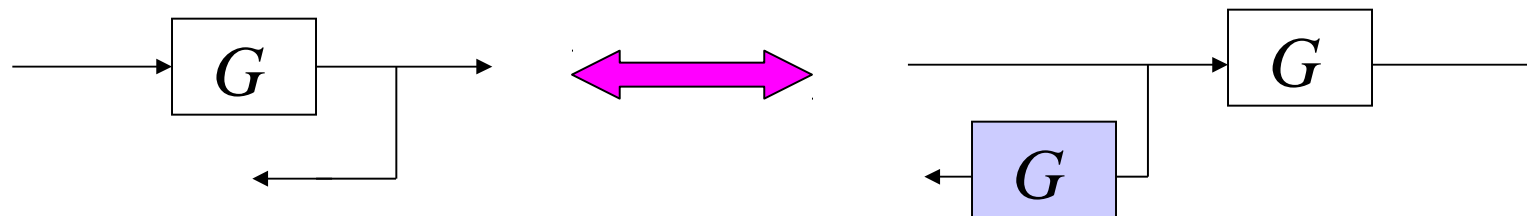
### 3. Moving a summing point ahead of a block



### 4. Moving a pickoff point behind a block

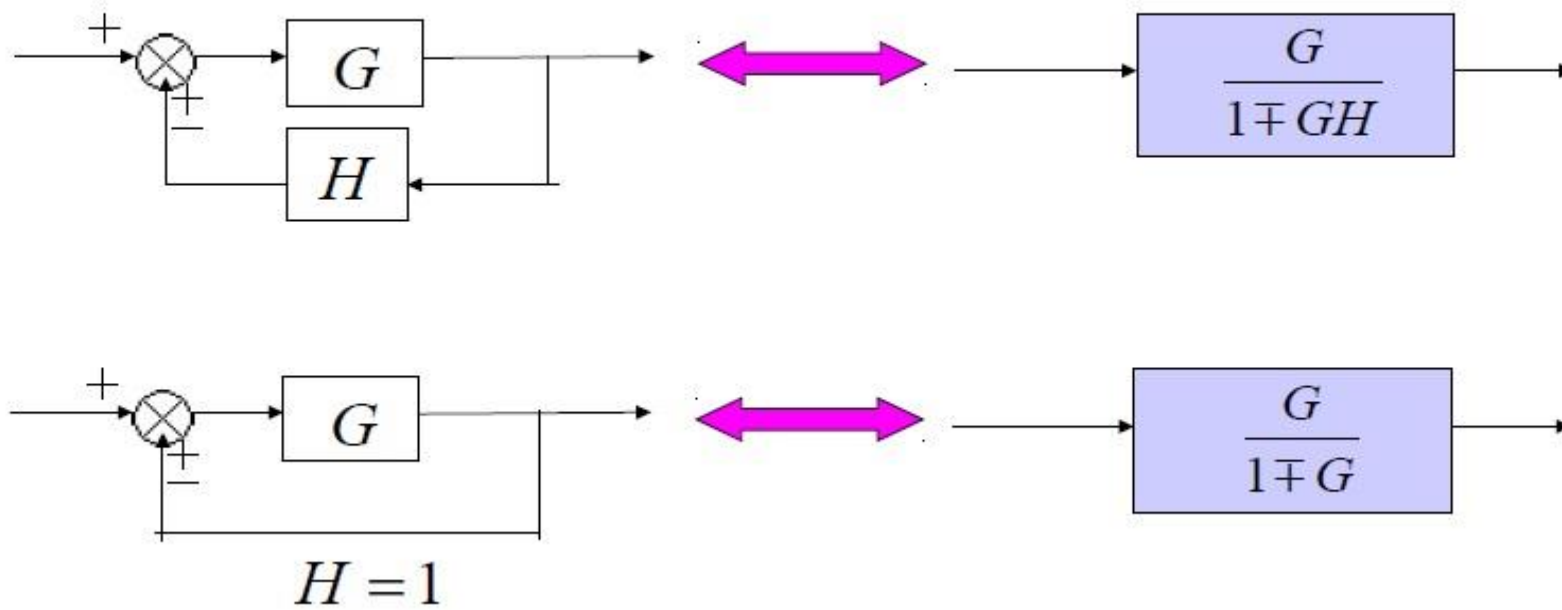


### 5. Moving a pickoff point ahead of a block

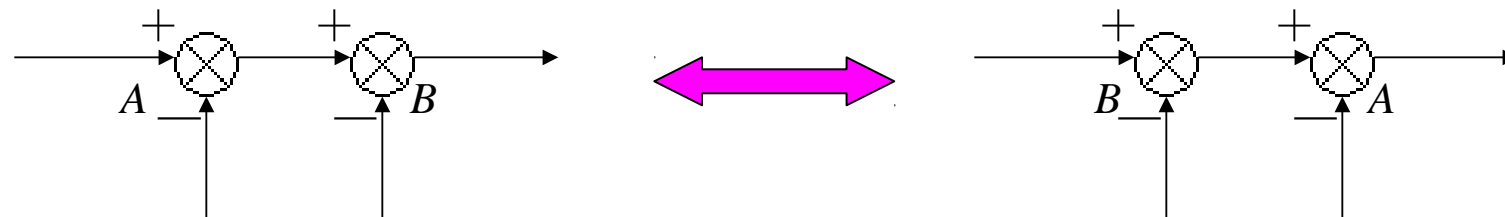




## 6. Eliminating a feedback loop



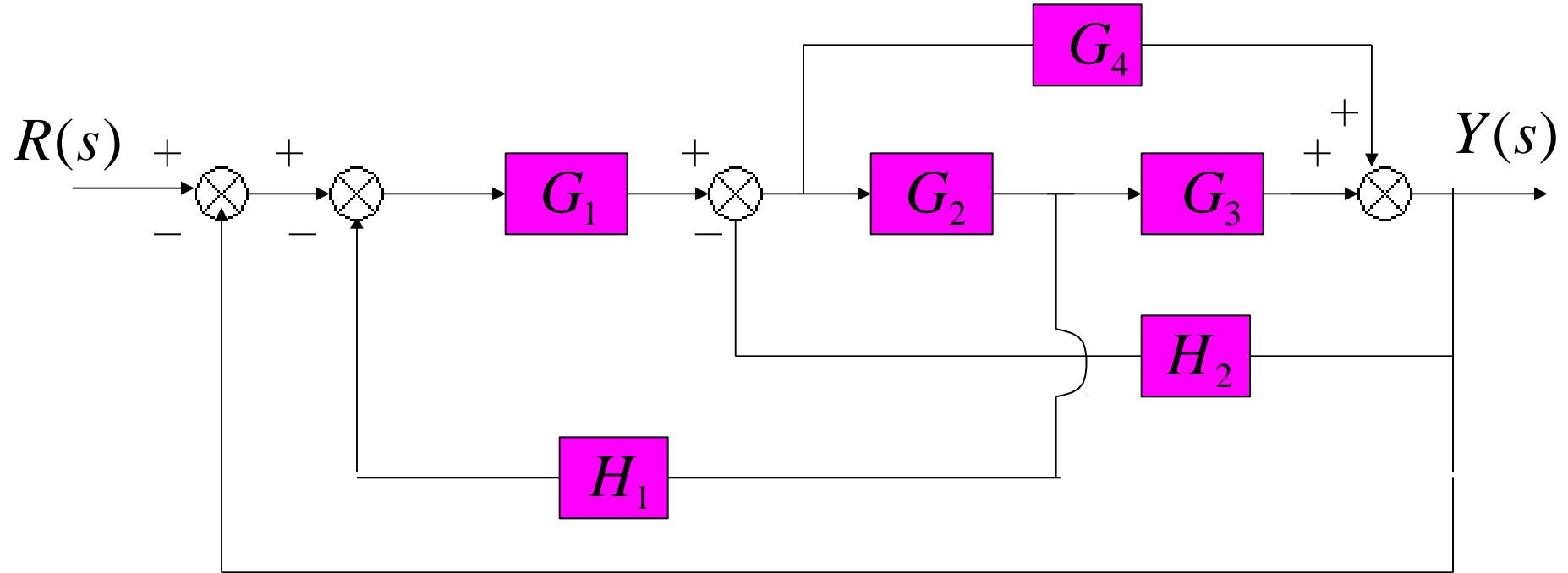
## 7. Swapping with two adjacent summing points





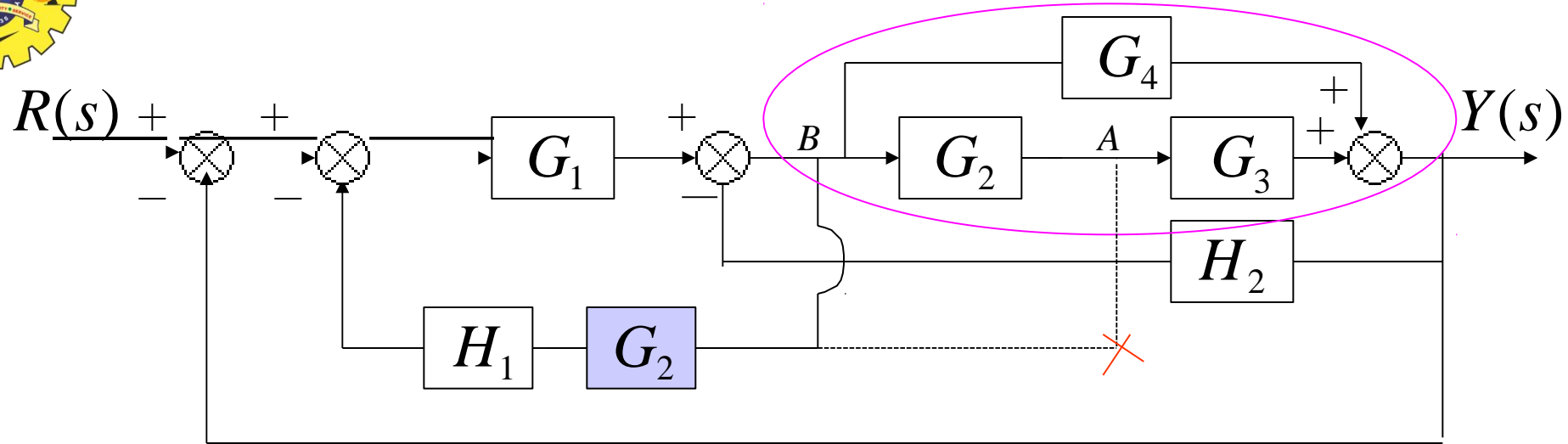
# EXAMPLE 1

(a) Find the transfer function of the following block diagrams



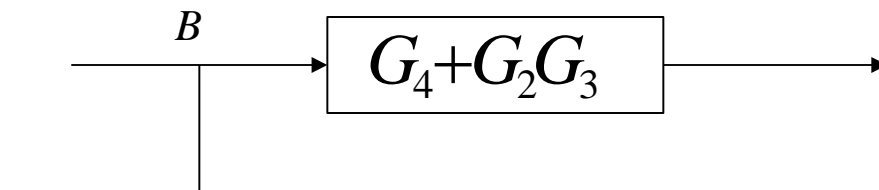


# EXAMPLE 1

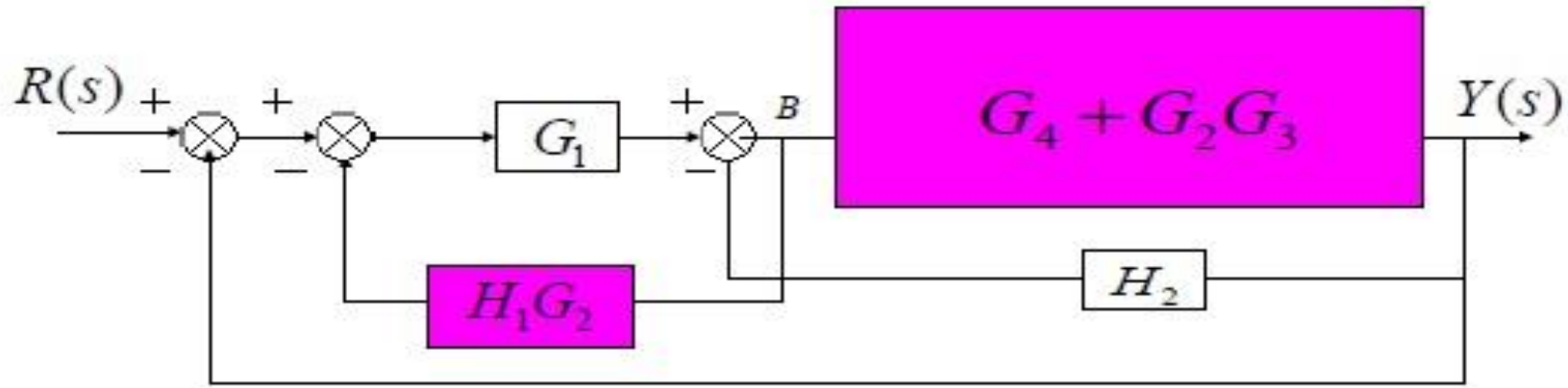


Solution:

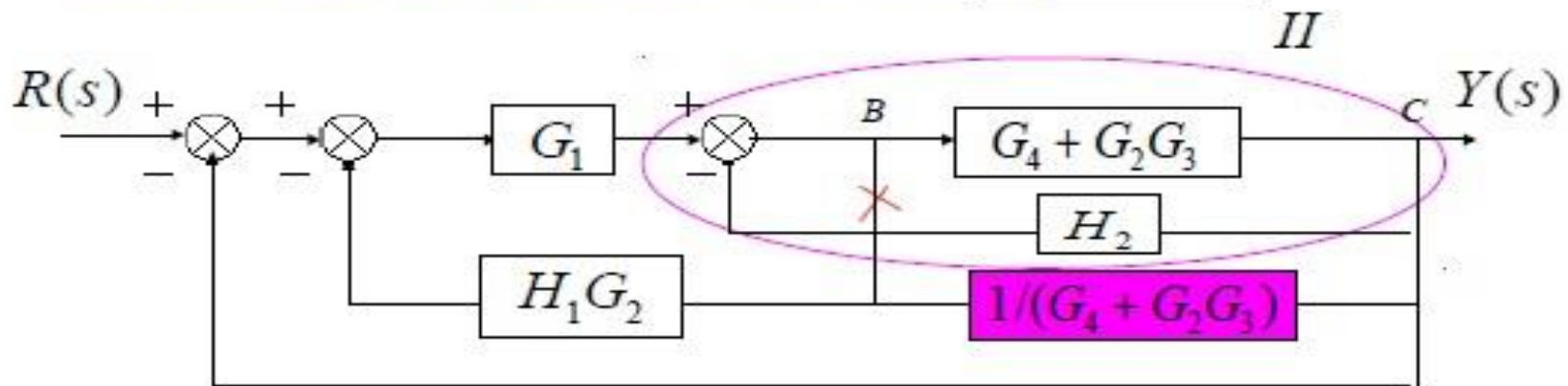
1. Apply the rule that Moving pickoff/takeoff point ahead of block  $G_2$
2. Eliminate loop I & simplify as





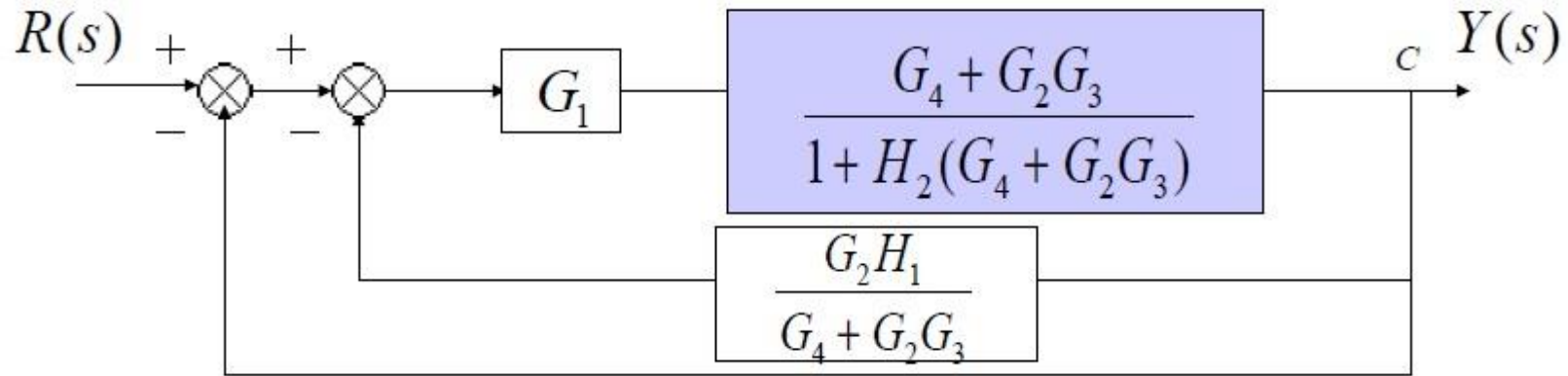


3. Moving pickoff point B behind block  $G_4 + G_2G_3$

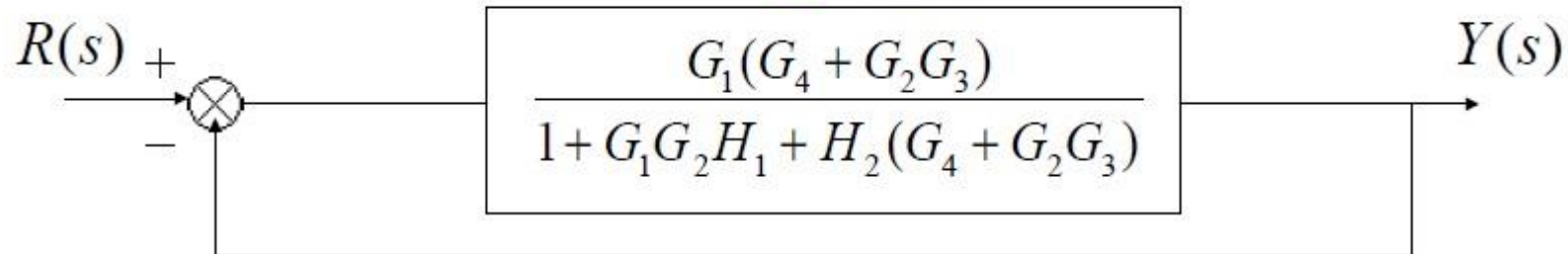




#### 4. Eliminate loop III



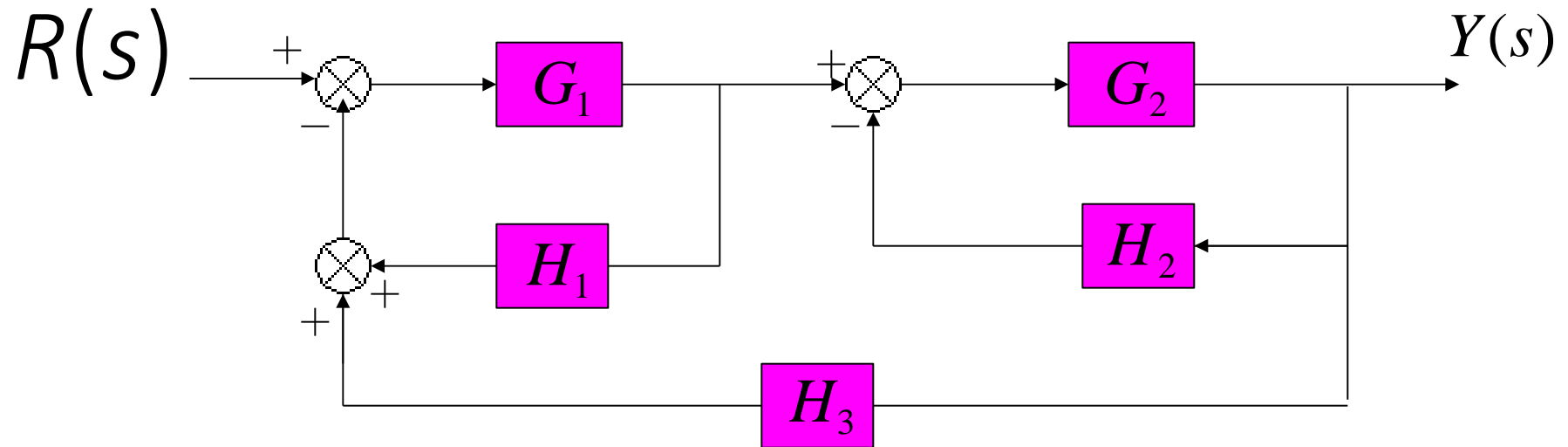
↓ Using rule 6



$$T(s) = \frac{Y(s)}{R(s)} = \frac{G_1(G_4 + G_2G_3)}{1 + G_1G_2H_1 + H_2(G_4 + G_2G_3) + G_1(G_4 + G_2G_3)}$$



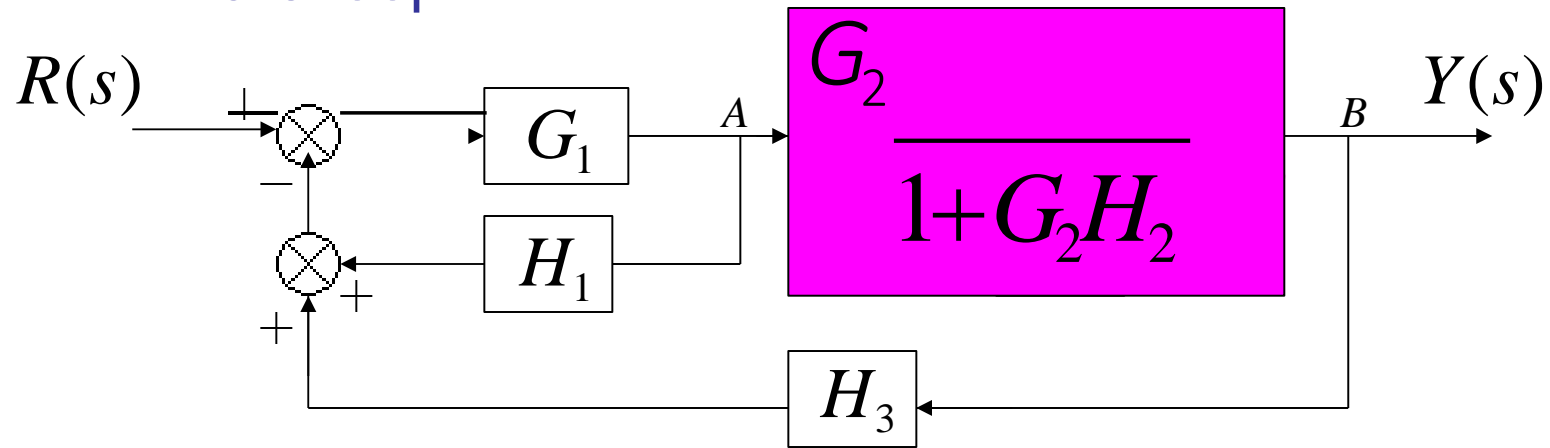
(b)



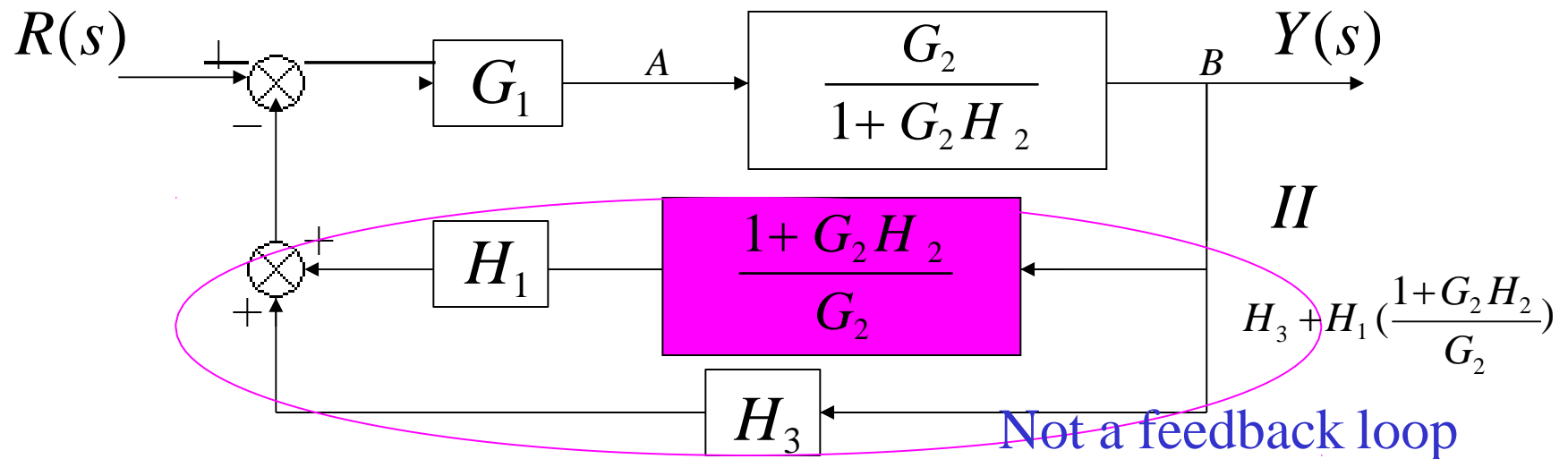


Solution:

## 1. Eliminate loop I

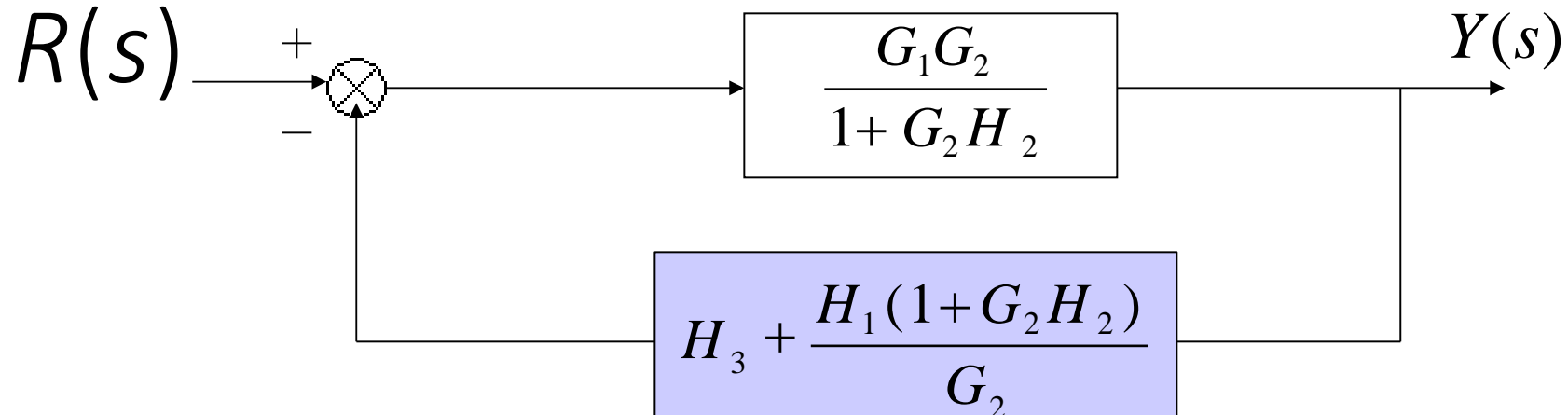


## 2. Moving pickoff point A behind block $\frac{G_2}{1+G_2H_2}$





### 3. Eliminate loop II



↓ Use rule 6

$$T(s) = \frac{Y(s)}{R(s)} = \frac{G_1 G_2}{1 + G_2 H_2 + G_1 G_2 H_3 + G_1 H_1 + G_1 G_2 H_1 H_2}$$



# SUMMARY

