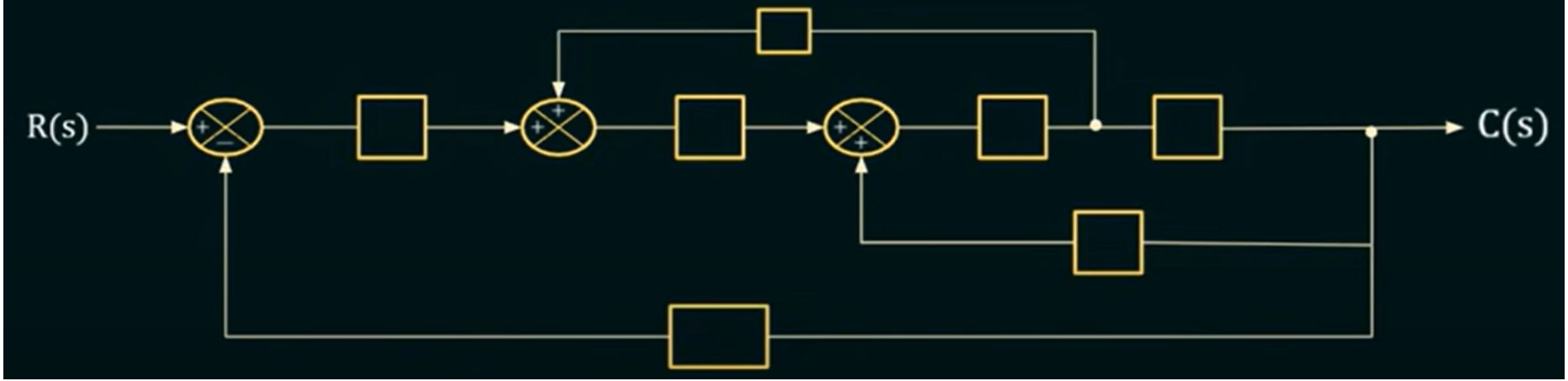
Control System Theory Block Diagram Reduction

https://youtube.com/playlist?list=PLBlnK6fEyqRineUwP-HPdkQvowXqq5IxA&si=1dXffwOVbx4EpPoL

Block Diagrams are pictorial representation of a control system.

Block Diagram Representation is used to build a mathematical model of a control system which can be emulated on a computer.

Block diagram Representation is used to calculate the overall transfer function of the system.



Block Diagrams

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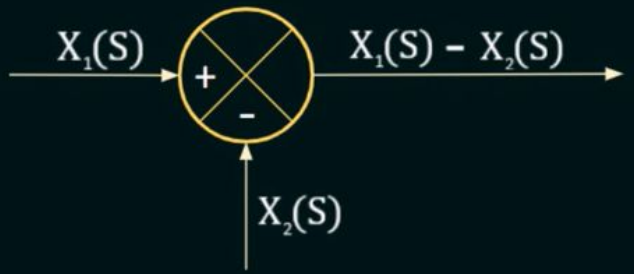
Elements of a Block Diagram:

- The signal into the block represents the input.
- The signal out of the block represents the output.
- The block itself represents the Transfer Function of the system.

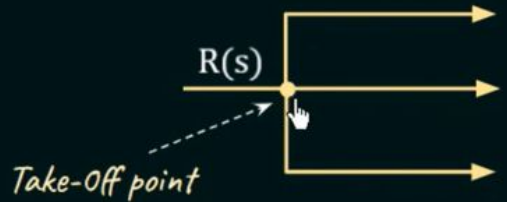
Summing Point:

A Summing Point/Summing Junction in a block diagram represents the dynamic summation of two (or more) signals.



Take–off Point/ Pick–off Point/ Branch point:

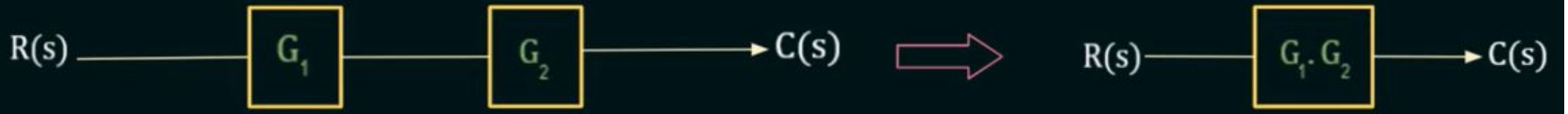
Take-off point in a block diagram represents a point where the signal branches out and goes concurrently to the other blocks or summing points.



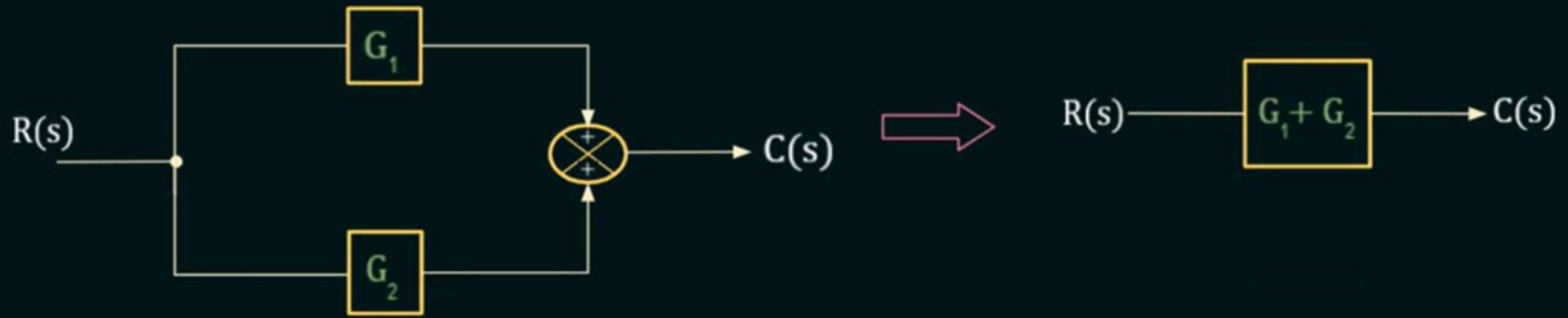
Block Diagram Reduction rule

Rule 1: Representation of a closed loop system

Rule 2: When blocks are connected in series/cascade, their gains are multiplied.

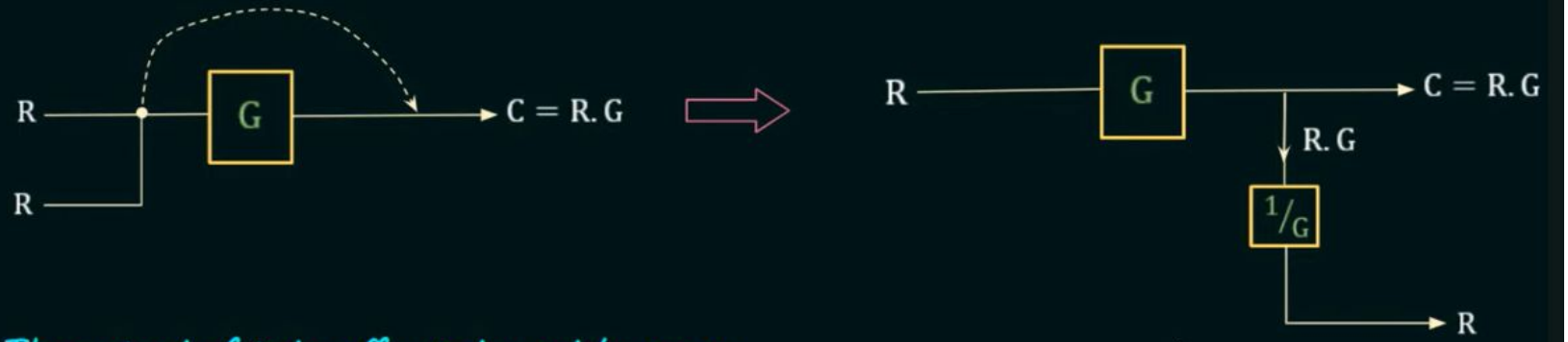


Rule 3: When blocks are connected in parallel, their individual gains are added.



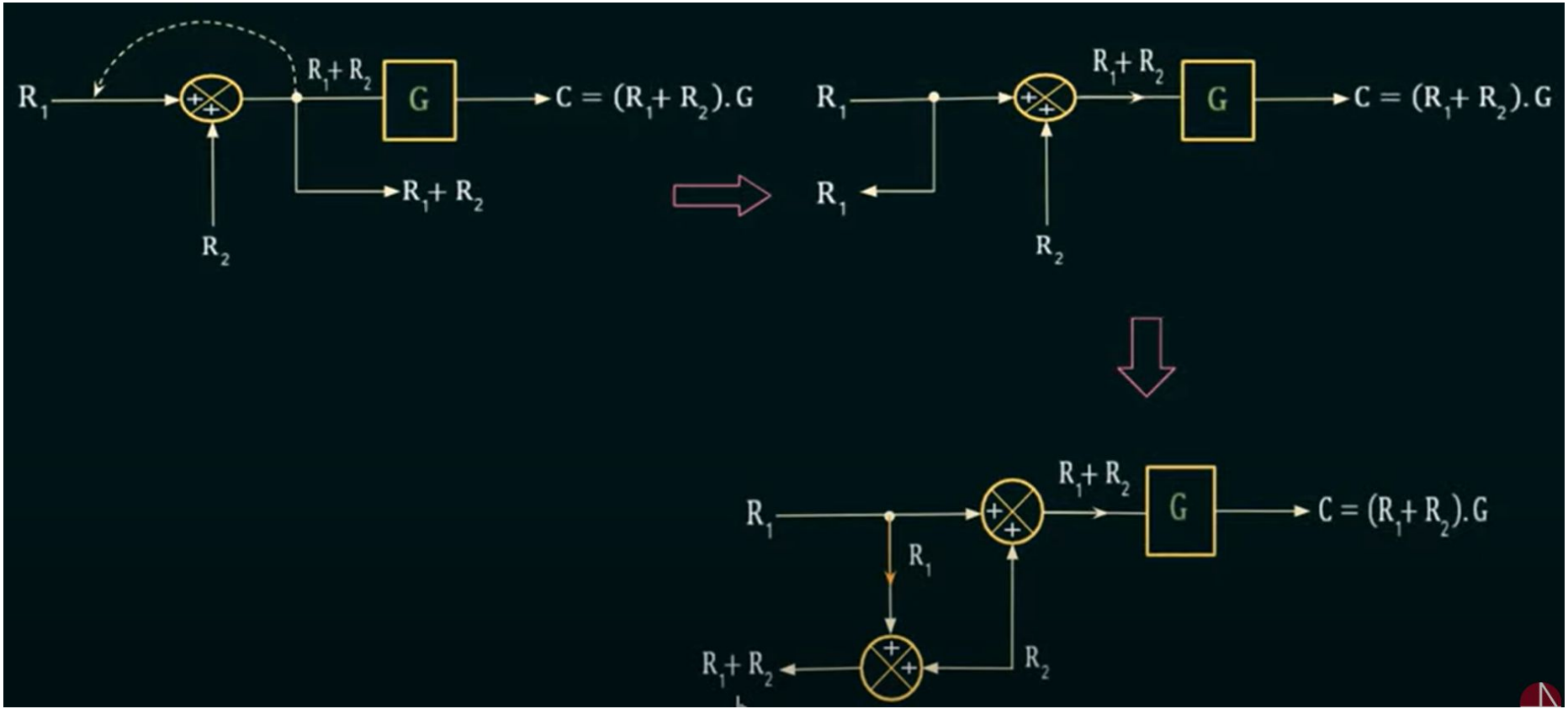
Rule 4: Shifting of take-off point before a block.

Rule 5: Shifting of take-off point after a block.

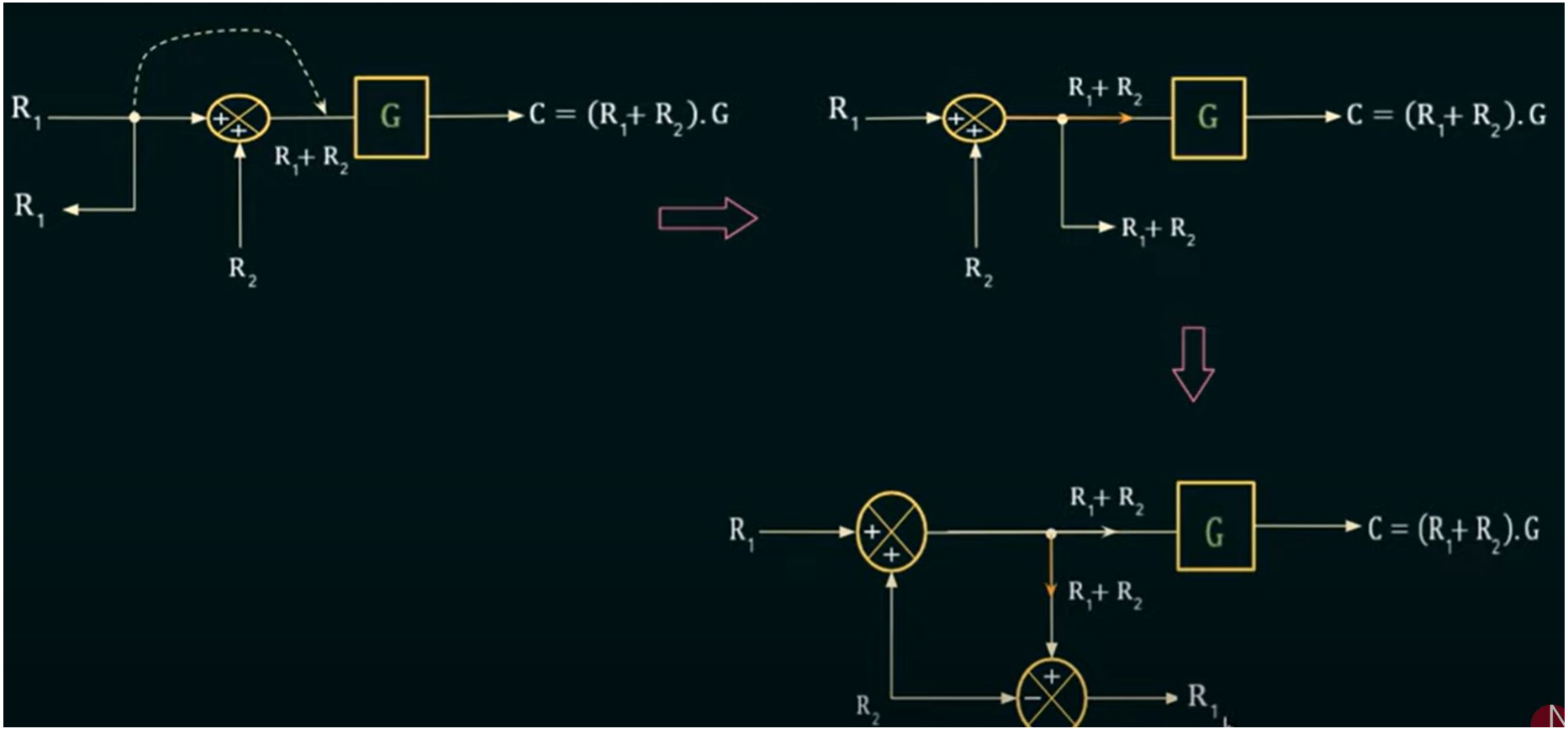


The output of take-off point must be same.

Rule : 6


R1
R1+ R2
G
C = (R1+ R2).G
R1+ R2
R2
R1
R1+ R2
G
C = (R1+ R2).G
R1
R2
R1
R1+ R2
G
C = (R1+ R2).G
R1
R1+ R2
R2

Rule : 7


R1
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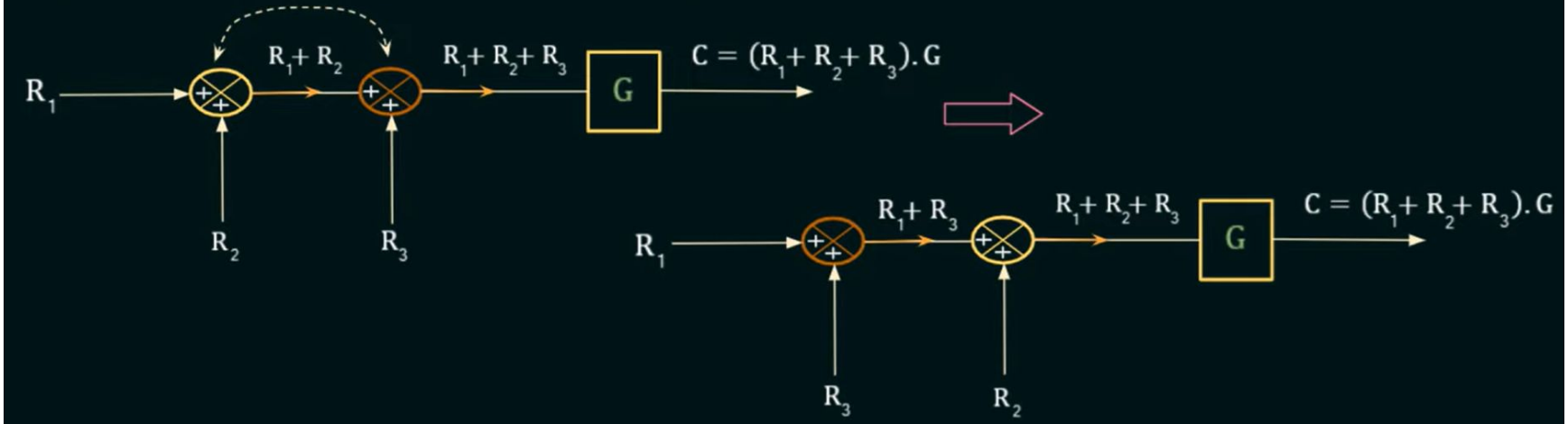
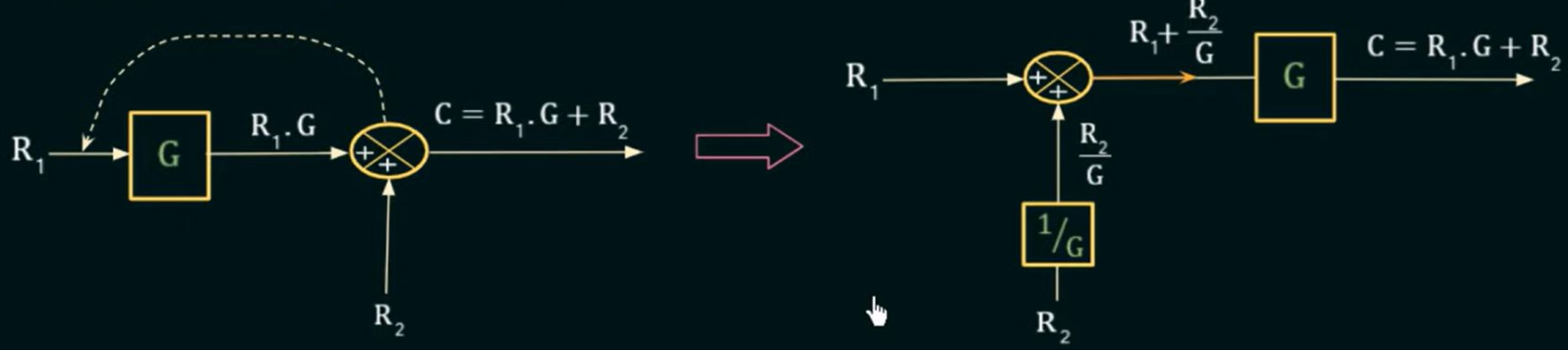
R1+ R2
R1+ R2
R1
G
C = (R1+ R2).G
R1+ R2
R2
R1

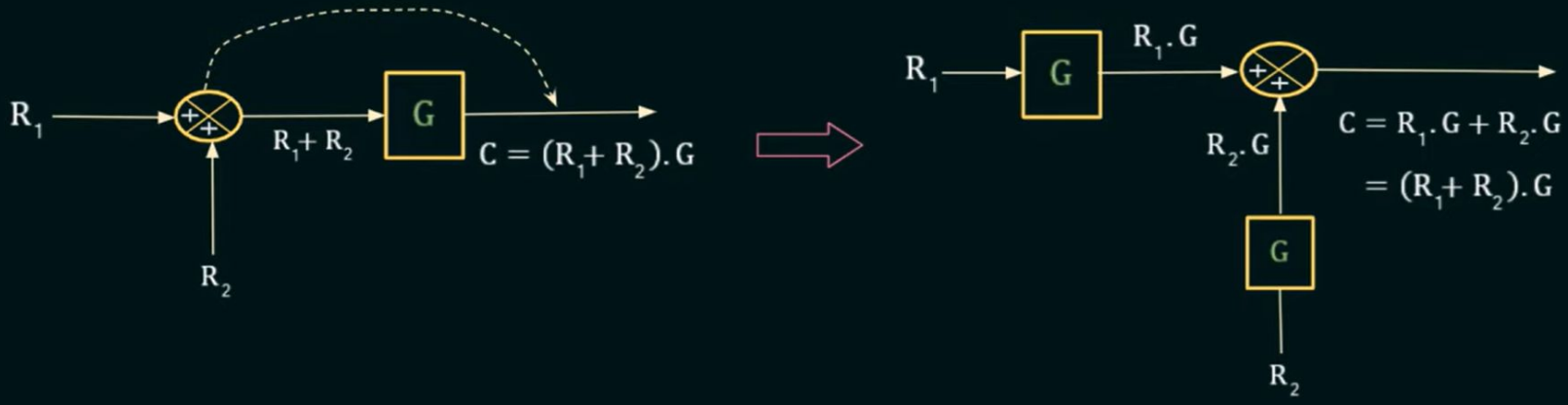
Rule 8: Rearrangement of adders.



Rule 9: Shifting of adder before a block.



Rule 10: Shifting of adder after a block.

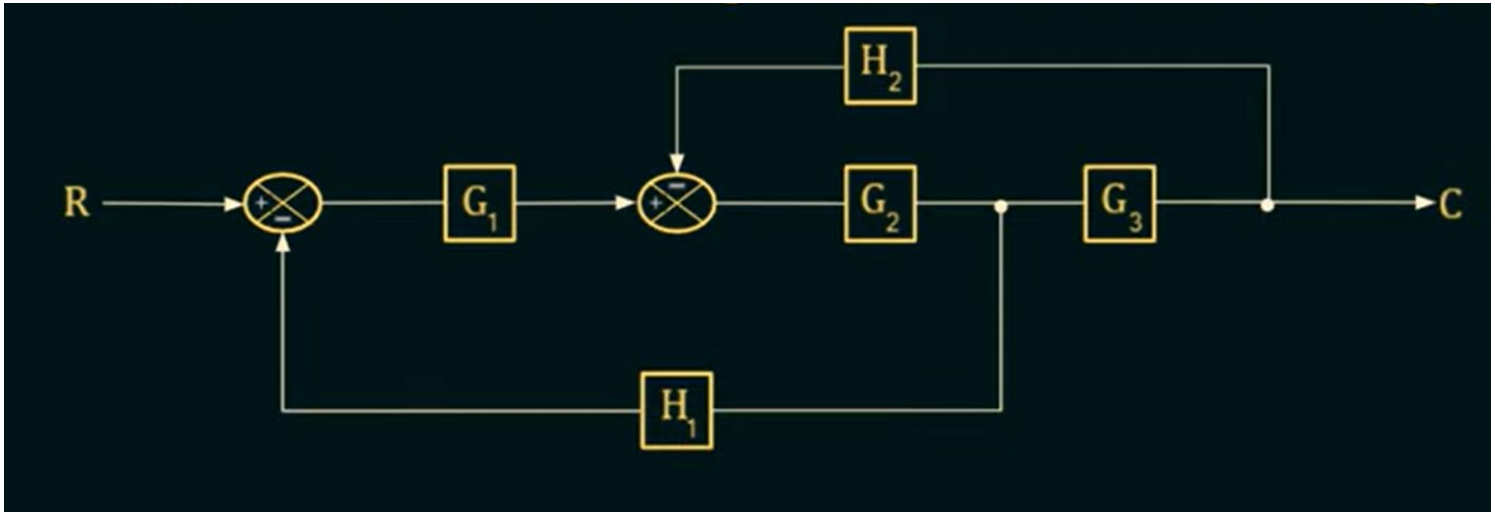


- If we shift the adder before a block, then we need to divide the gain of block from the input which is shifted.
- If we shift the adder after a block, then we need to multiply the gain of the block with the input which is shifted.

Block Diagram Reduction Algorithm

- **Rule 1** − Check for the blocks connected in series and simplify.
- **Rule 2** − Check for the blocks connected in parallel and simplify.
- **Rule 3** − Check for the blocks connected in feedback loop and simplify.
- **Rule 4** − If there is difficulty with take-off point while simplifying, shift it towards right.
- **Rule 5** − If there is difficulty with summing point while simplifying, shift it towards left.
- **Rule 6** − Repeat the above steps till you get the simplified form, i.e., single block.

Problem 1:



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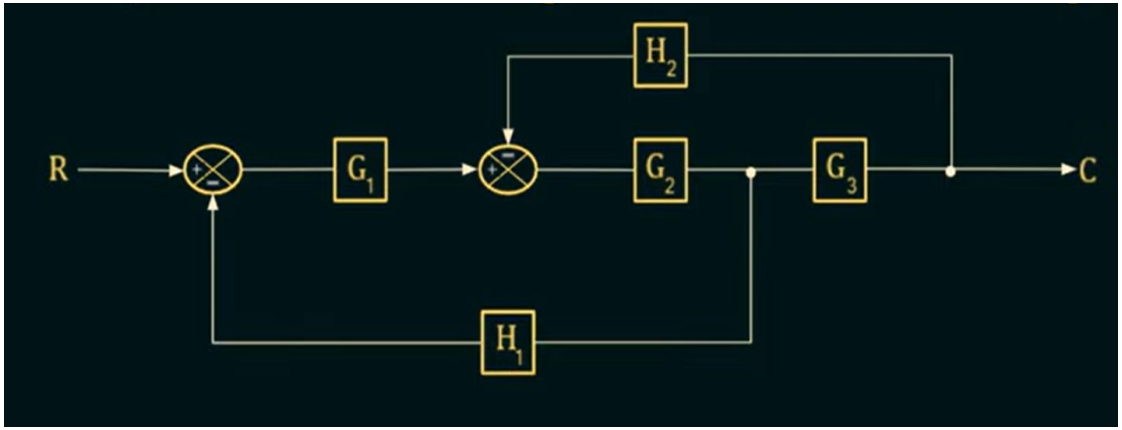

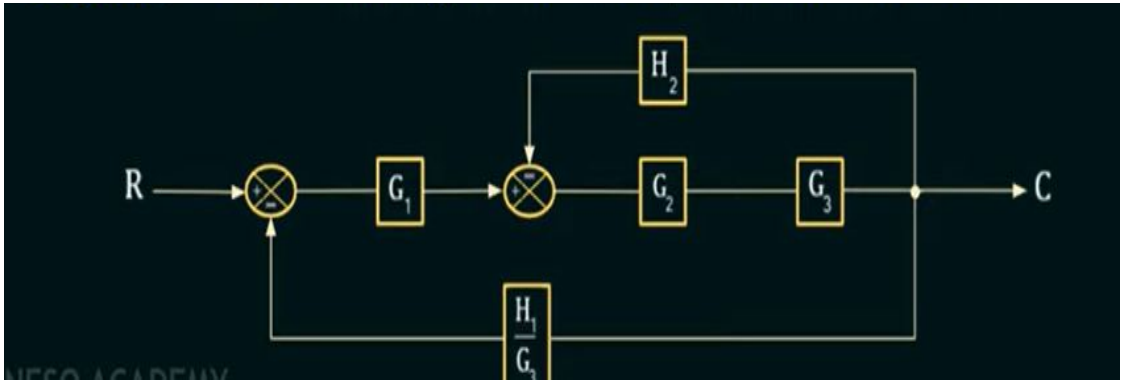

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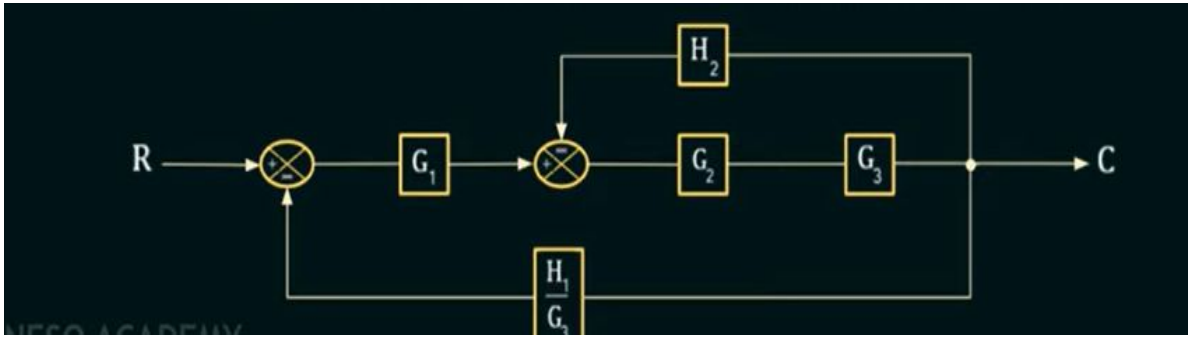

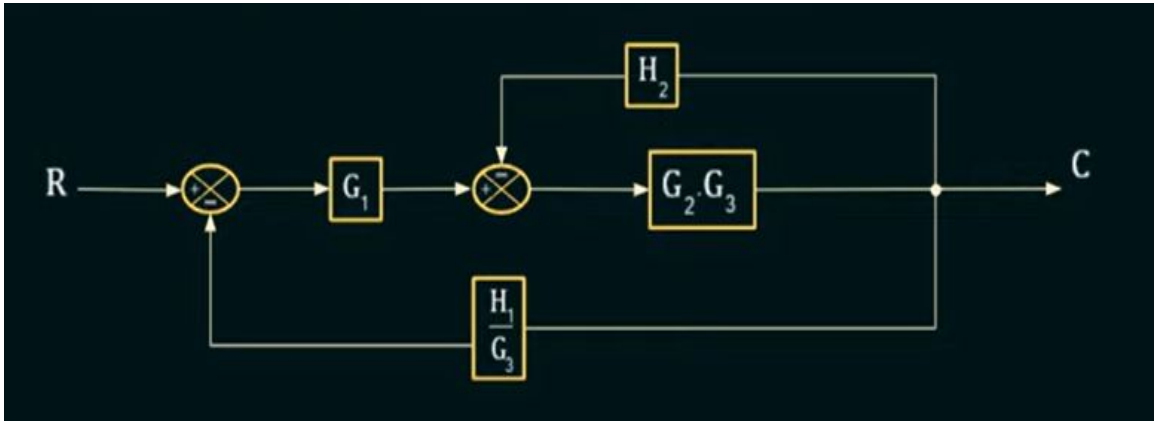

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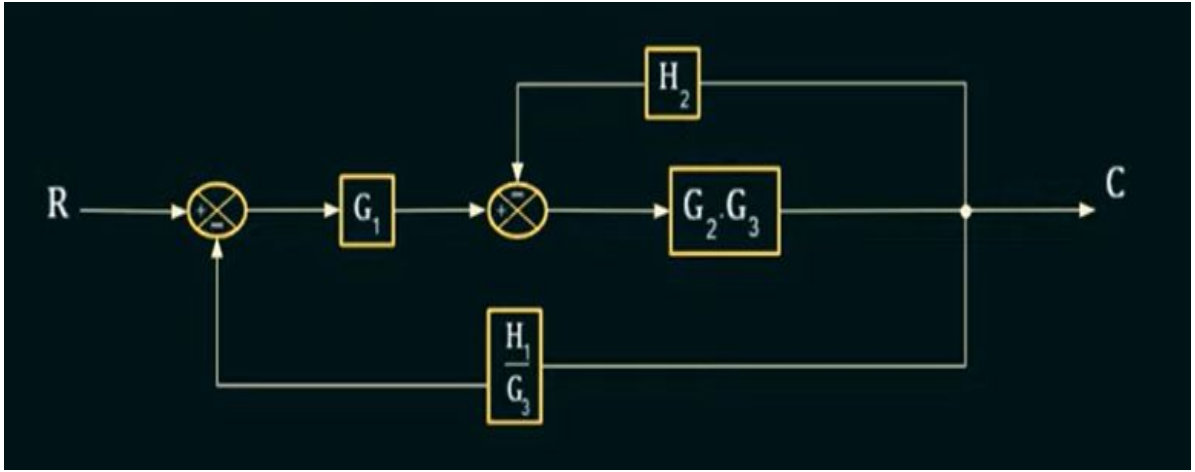

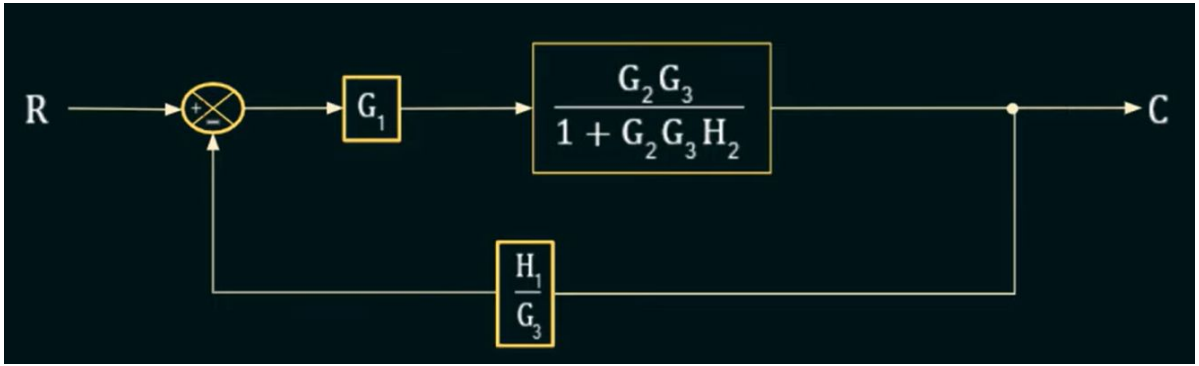

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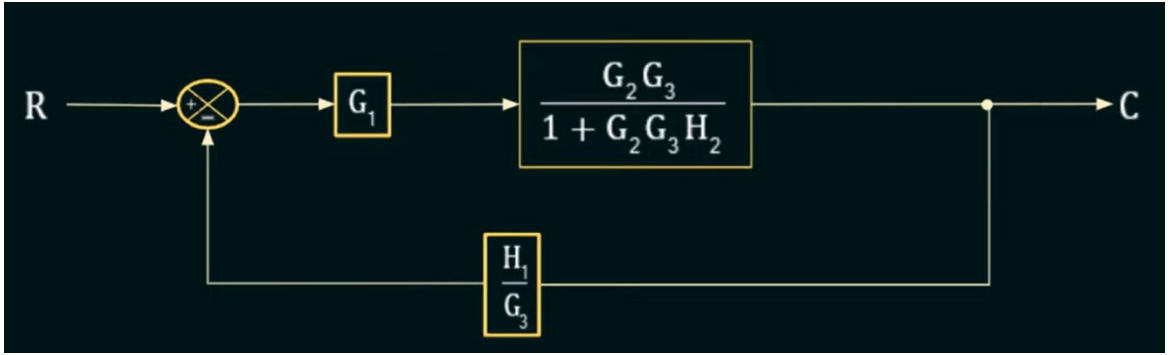

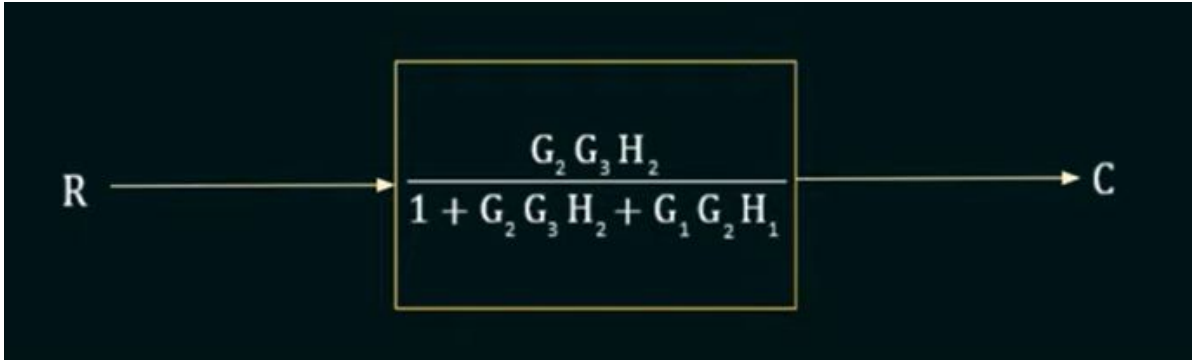

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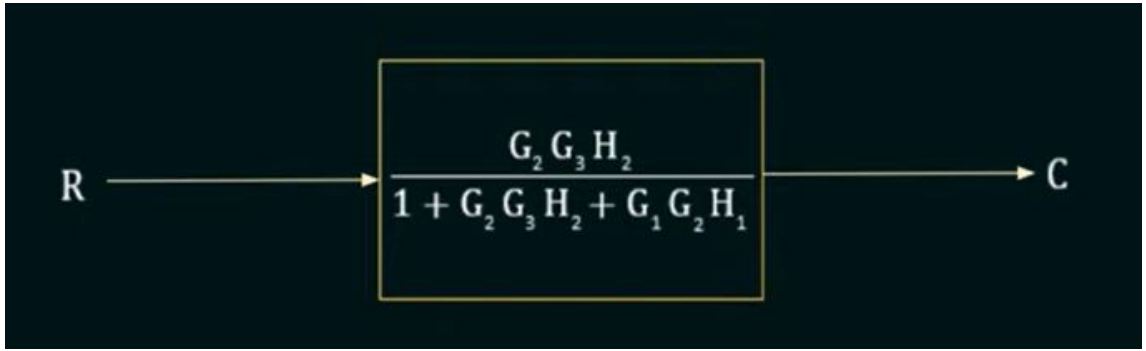
Result



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Next Class

PID Control

Thank You