Faculty of Engineering
Department of Electrical & Computer Engineering

Control Systems (ECE 331)

Block Reduction Techniques - II

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Block Reduction Techniques:

Series or Cascade Form:

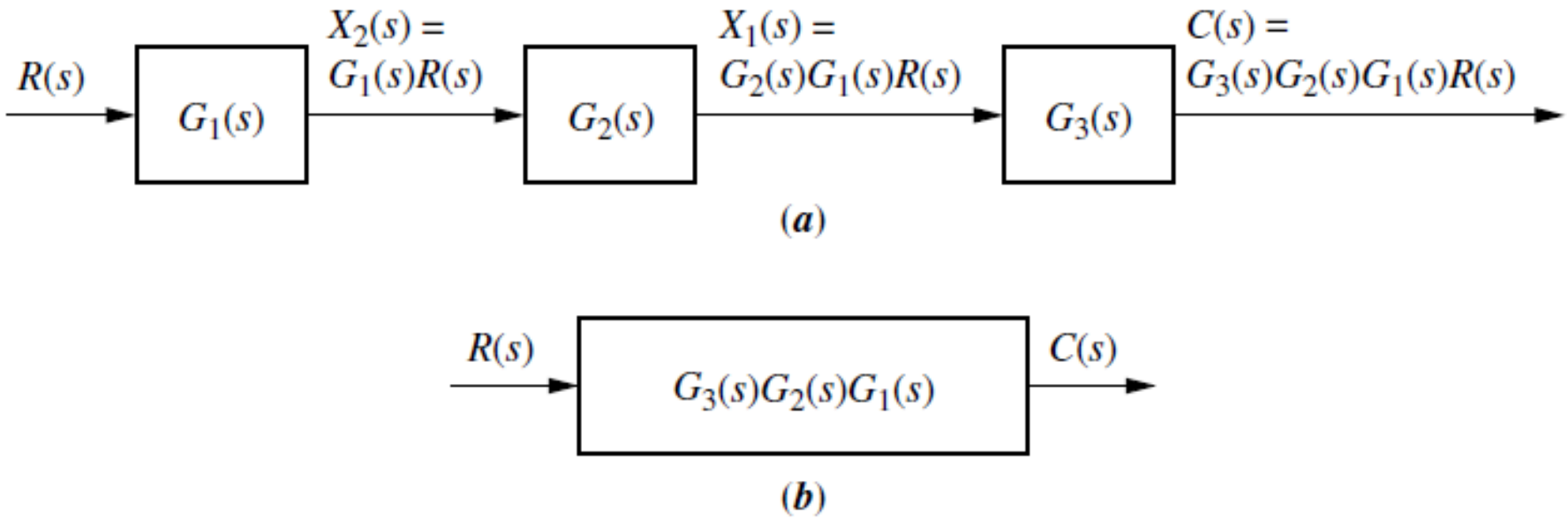


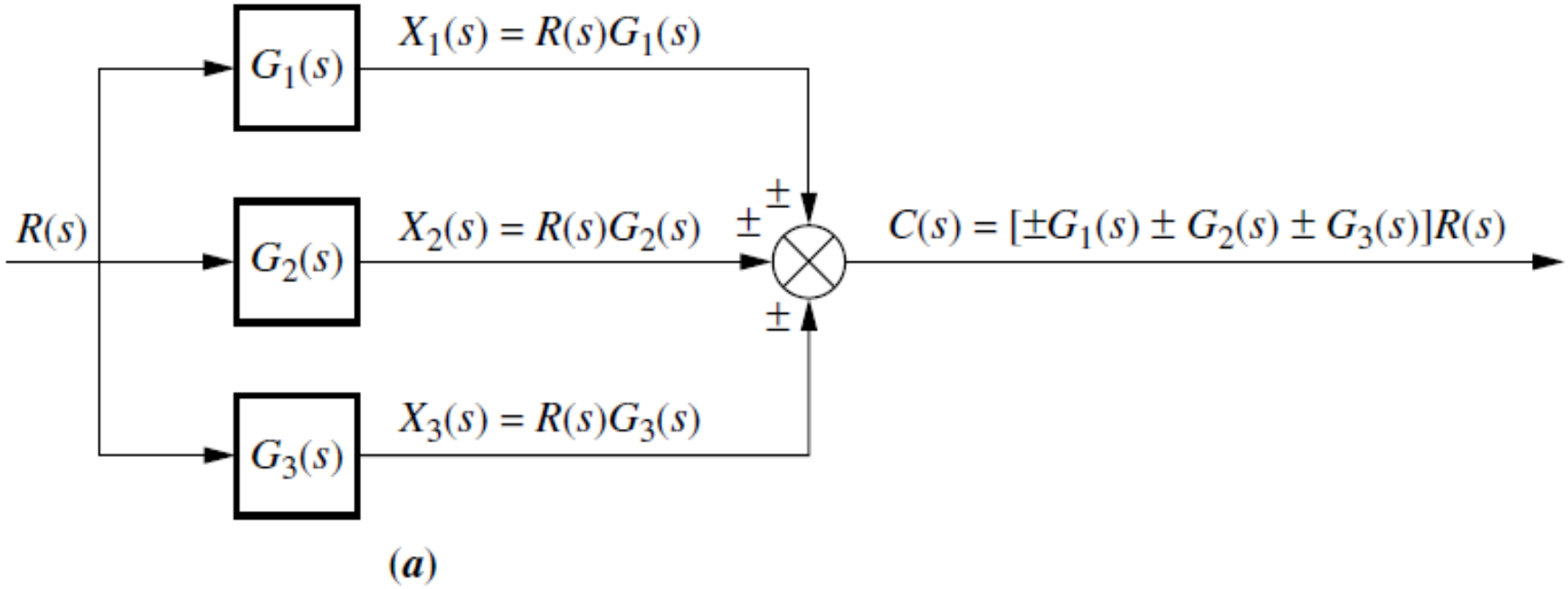
Figure shows example of series subsystems. Intermediate signal values are shown at the output of each subsystem. Each signal is derived from the product of the input times the transfer function. The equivalent transfer function $G_{eq}(s)$, is the output Laplace transform divided by the input Laplace transform.

$$G_{eq} = G_1(s)\, G_2(s)\, G_3(s)$$

Block Reduction Techniques:

Parallel Form:

Parallel subsystems have a common input and an output formed by the algebraic sum of the outputs from all of the subsystems. The Equivalent transfer Function G_{eq} is given by



$$G_{eq} = \pm G_1(s) \pm G_2(s) \pm G_3(s)$$

Block Reduction Techniques:

Feedback Form:

It is clear from figure,

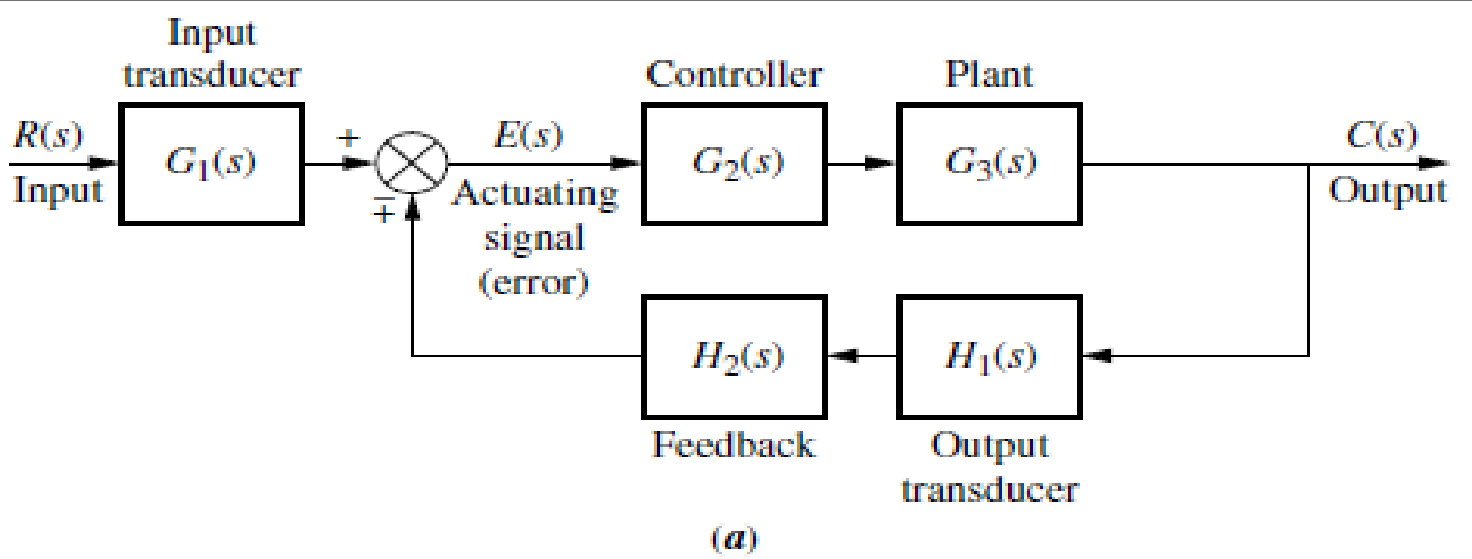
$$E(s) = R(s) \pm C(s)H(s) \text{ ---(1)}$$

But, since $C(s) = E(s)G(s)$, so

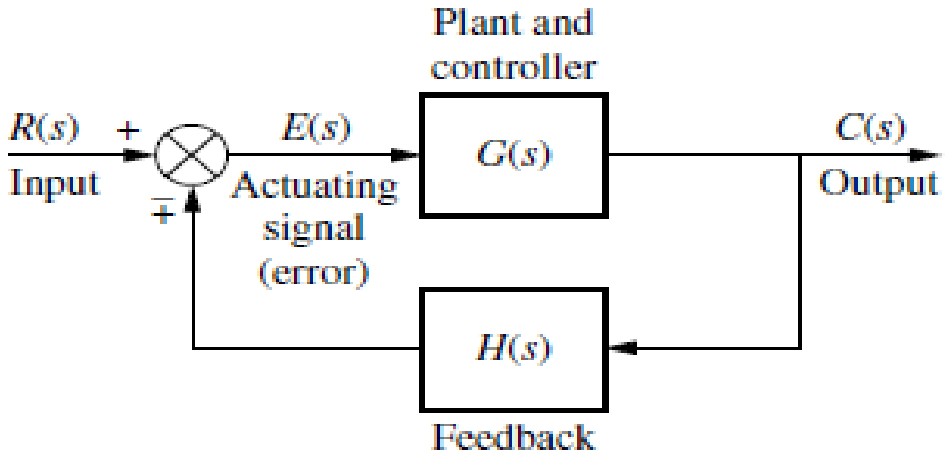
$E(s) = \frac{C(s)}{G(s)}$, put this in (1)

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

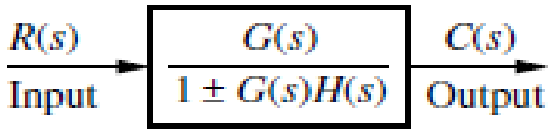
The product $G(s)H(s)$ is known as Open Loop T.F. or Loop Gain



(a)



(b)



(c)

Block Reduction Techniques:

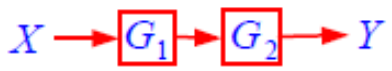
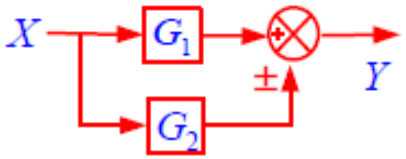
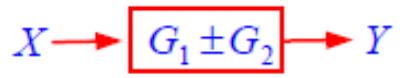
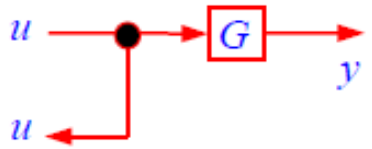
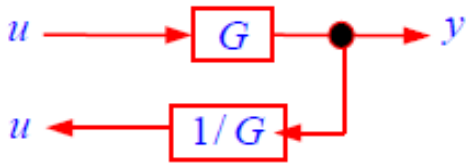
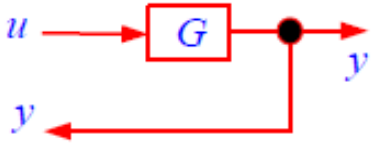
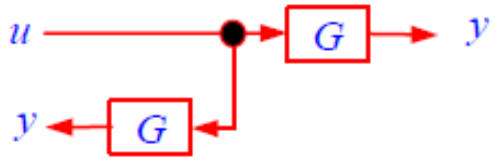
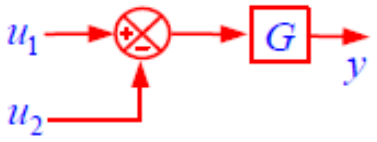
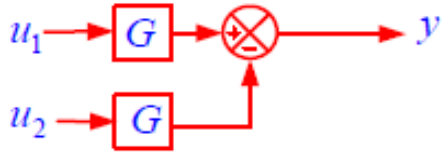
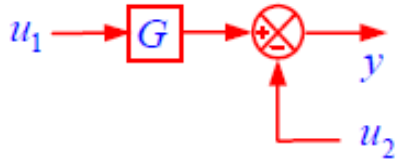
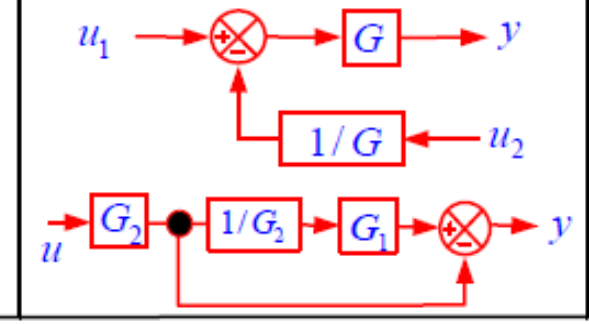
Rules to be applied:

There are some rules to be applied, when we are going to reduce a block as under:

1. Combine all cascade (series) blocks
2. Combine all parallel blocks
3. Eliminate all minor (interior) feedback loops
4. Shift summing points to left
5. Shift takeoff points to right
6. Repeat steps 1 to 5 until the canonical form is obtained.

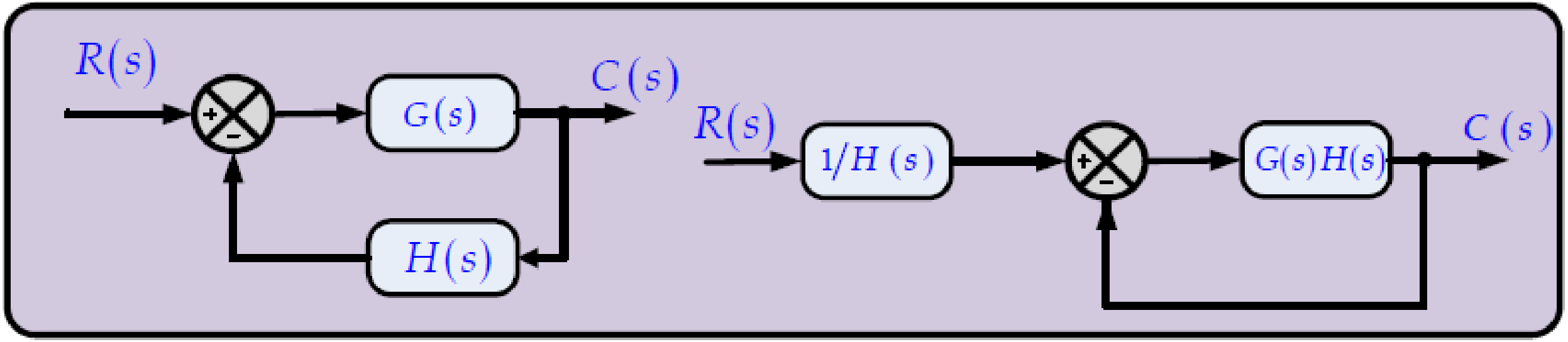
Block Reduction Tech

Basic Transformation:

	Manipulation	Original Block Diagram	Equivalent Block Diagram	Equation
1	Combining Blocks in Cascade			$Y=(G_1G_2)X$
2	Combining Blocks in Parallel; or Eliminating a Forward Loop			$Y=(G_1\pm G_2)X$
3	Moving a pickoff point behind a block			$y = G\,u$ $u = \frac{1}{G}\,y$
4	Moving a pickoff point ahead of a block			$y=Gu$
5	Moving a summing point behind a block			$e_2=G(u_1-u_2)$
6	Moving a summing point ahead of a block			$y=Gu_1-u_2$ $y=(G_1-G_2)u$

Block Reduction Techniques:

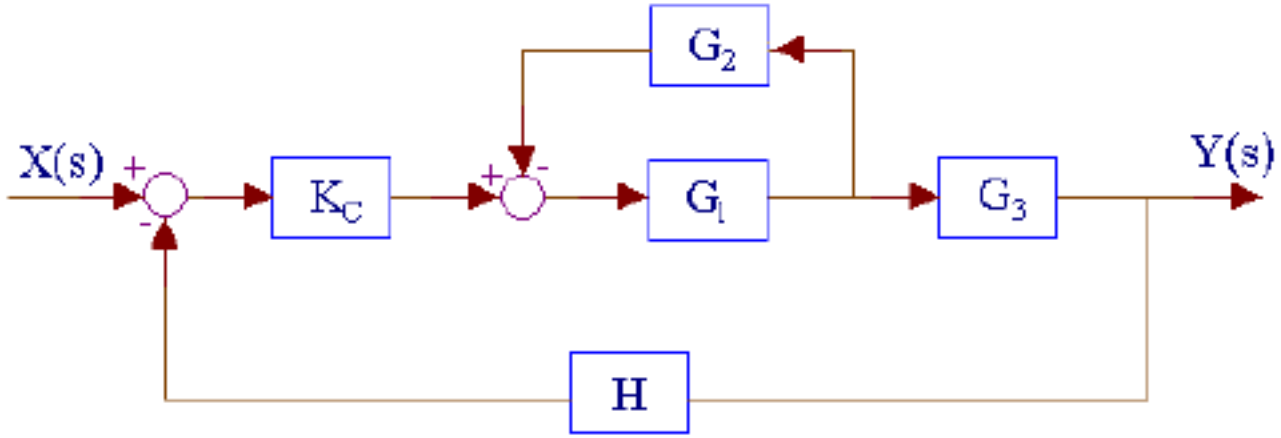
Example: 01

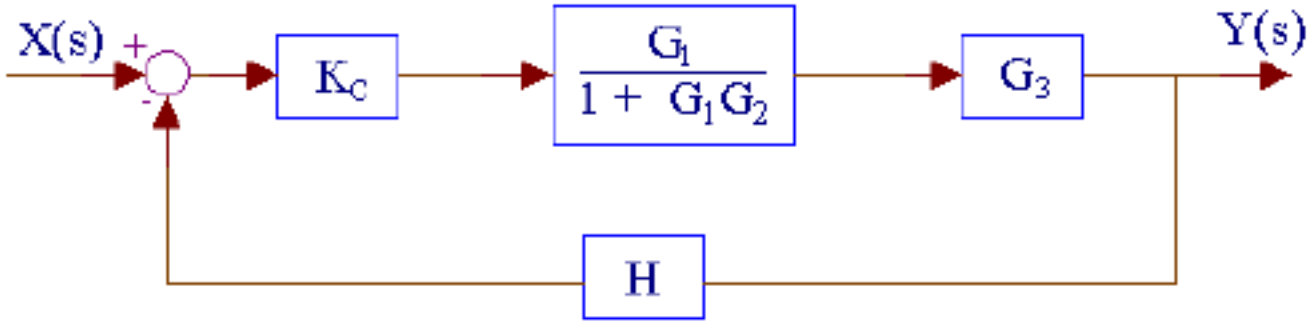


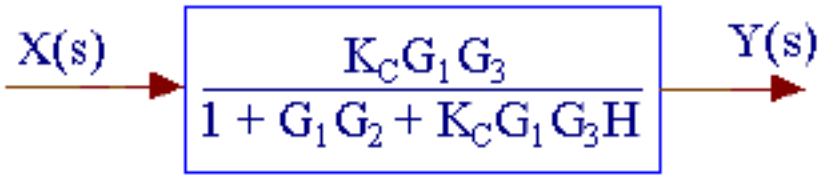
Transfer Function: $\frac{C(s)}{R(s)} = \frac{G(s)}{1 \pm G(s)H(s)} = \frac{1}{H(s)} \cdot \frac{G(s)H(s)}{1 \pm G(s)H(s)}$

Block Reduction Techniques:

Example: 02





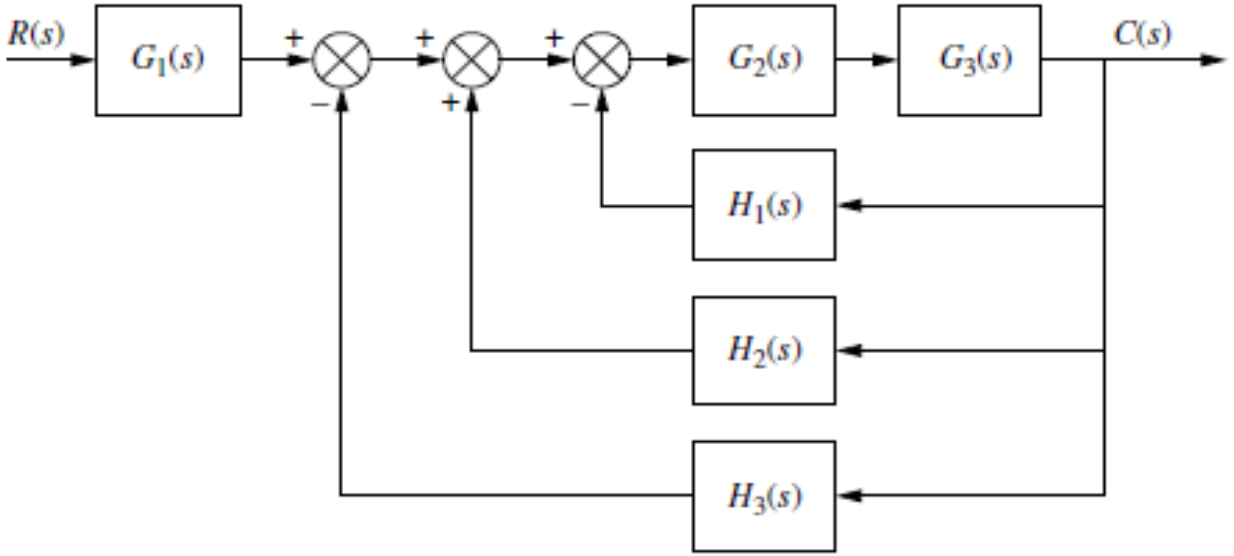


Transfer Function:

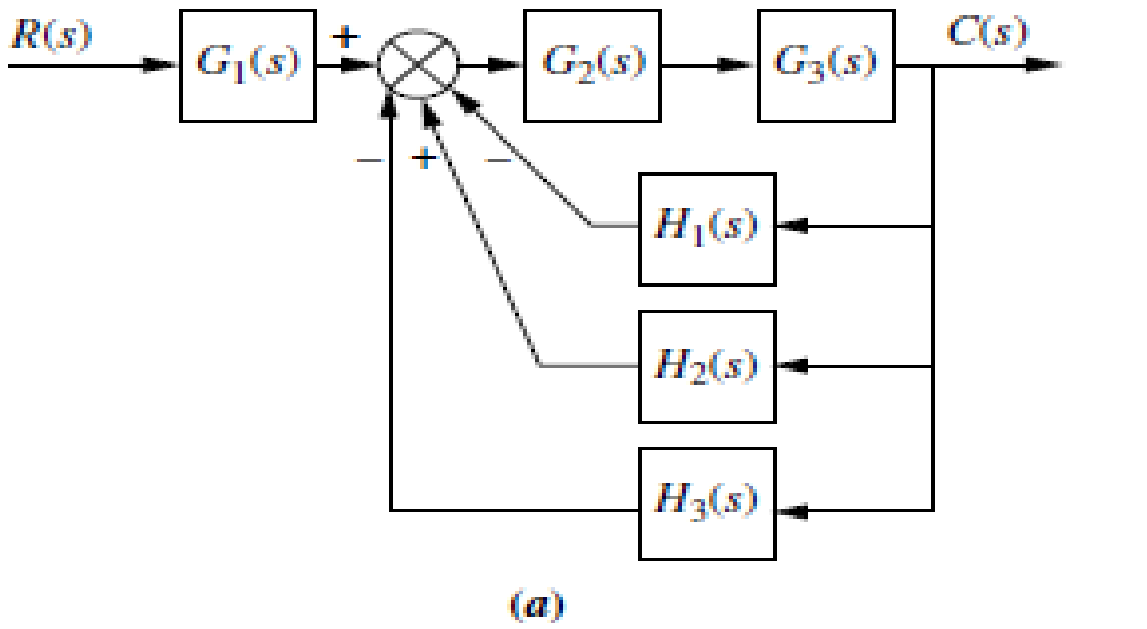
$$\frac{Y(s)}{X(s)} = \frac{K_c G_1 G_3}{1 + G_1 G_2 + K_c G_1 G_3 H}$$

Block Reduction Techniques:

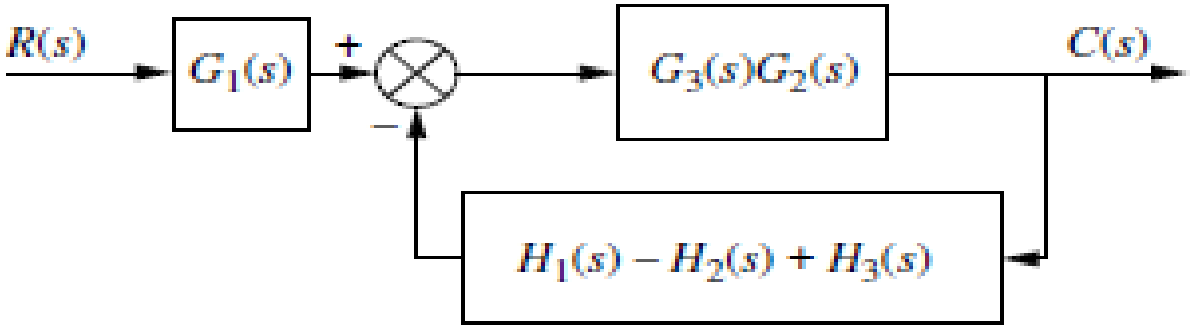
Example: 03



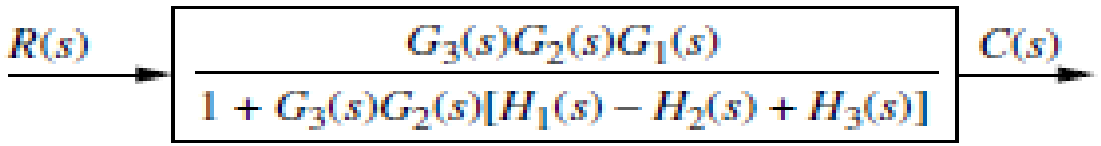
Ans:>>



(a)



(b)



(c)

Thank You !