Block Diagram Algebra in Control Systems - GATE Study Material in PDF

If you are preparing **Control Systems** for [GATE 2018](#) **examination**, you will need to learn the most common form for representing a control system - the Block Diagram. To start off, you need to understand **Block Diagram Algebra in Control Systems** to help you better navigate the topic of **Signal Flow Graphs and Block Diagrams** in Control Systems.

These block diagrams are used to graphically show the system components and flow of signals while containing the information about dynamic behavior of the system. It uses functional blocks to link the system variable.

In these **free GATE notes**, you can learn all about **Block Diagram Reduction Techniques.** You can even download this **GATE Study Material in PDF** so that you can revise at your convenience. This GATE Study Material is also useful for other exams like IES, BSNL, DRDO, BARC etc.

Recommended Reading before you begin with Block Diagram Algebra in Control Systems –

[Sensitivity & Its Effects on Parameters in Open & Closed Loop Systems](#)

Block Diagram Algebra in Control Systems

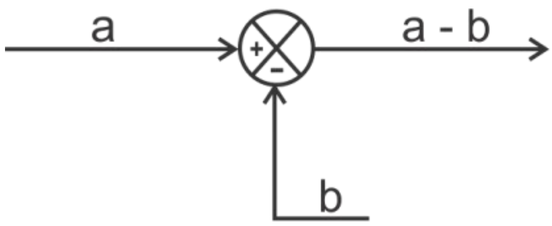
Block represents the mathematical operation on the incoming signal. Arrows are used to indicate the direction of signal flow. Also, a system can be represented by more than one type of a block diagram. Once represented, systems can be analyzed further for various parameters like stability, system gain, etc. It is the basic tool used for the mathematical modeling of the systems. The various points for analyzing and reduction of these units are explained below.

Basic Blocks in a Control System

The elements used for the connectivity in a block diagram are given as follows.

Summing point: It refers to the summing operation on the incoming signals.

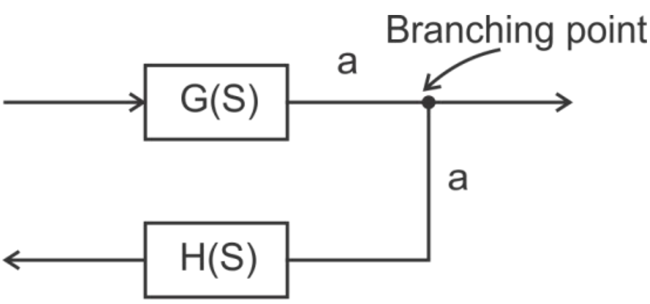
Summing Point Representation in a Block Diagram:



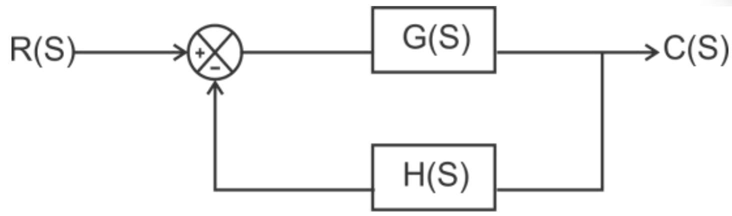
It should be noted that the dimensions of the incoming signals on which the summing operation is performed, must be same.

Branch point: It is the point from where the signal goes concurrently to the other place in block diagram.

Branch Point Representation in a Block Diagram:



Block Diagram of a Closed Loop Transfer Function:



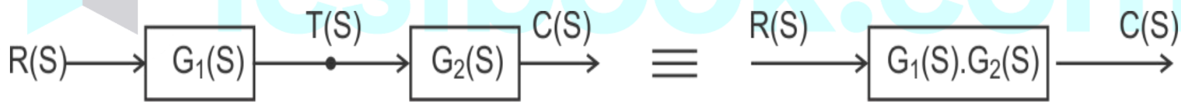
The output C(s) of the system is fed back to the input through H(s). Before comparing the output to the input, the form of output has to be changed and made alike input, for this purpose H(s) is used.

Block Diagram Algebra

When a number of blocks are connected in block diagram then overall transfer function can be obtained by block diagram reduction technique.

Rules for Block Diagram Reduction

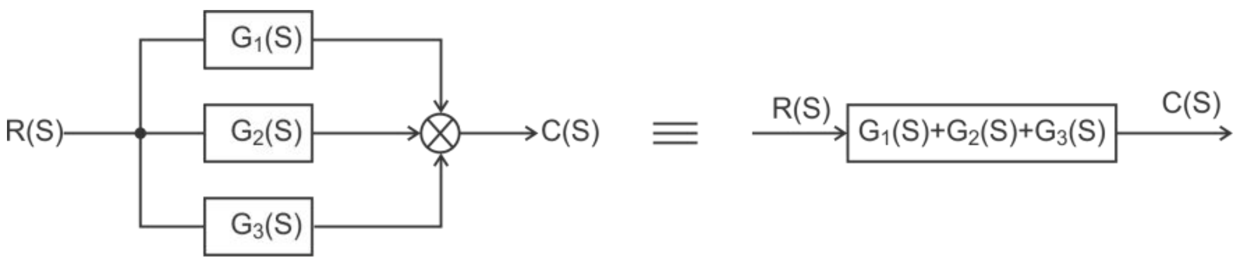
(1) Blocks in Cascade Reduction:



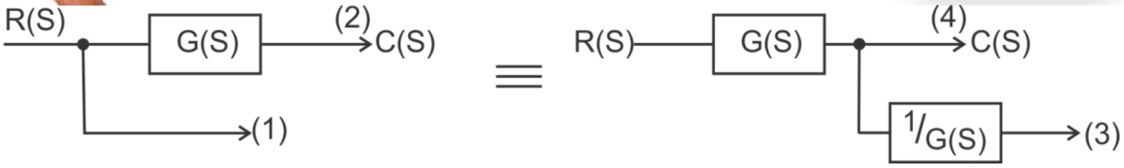
We can calculate:

$$\frac{C(s)}{R(s)} = \frac{C(s)}{T(s)} \cdot \frac{T(s)}{R(s)} = G_1(s).G_2(s)$$

(2) Blocks in Parallel Reduction:



(3) Moving a Take-off Point After the Block:

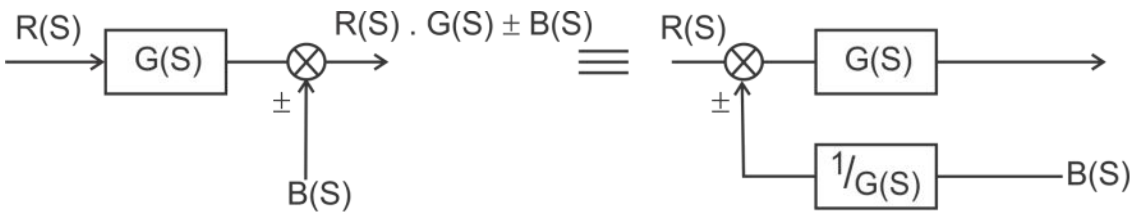


While transforming the block diagram we have to keep in mind that the signals at points must not change. As we can see that signal at (1) is R(s) and signal at (3) is again

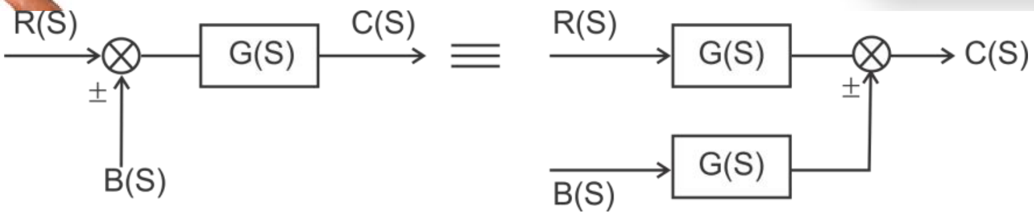
$$R(s)\,.\,G(s)\,.\,\frac{1}{G(s)} = R(s).$$

(4) Moving a Take-off Point Before the Block:

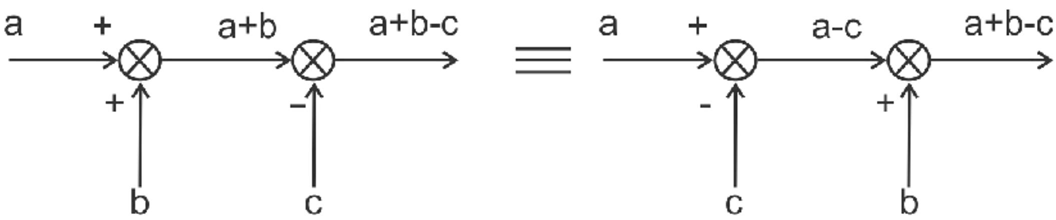
(5) Moving a Summing Point Before the Block:



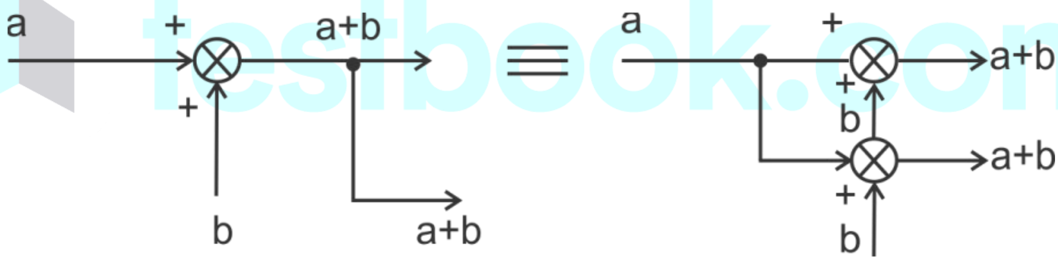
(6) Moving a Summing Point After the Block:



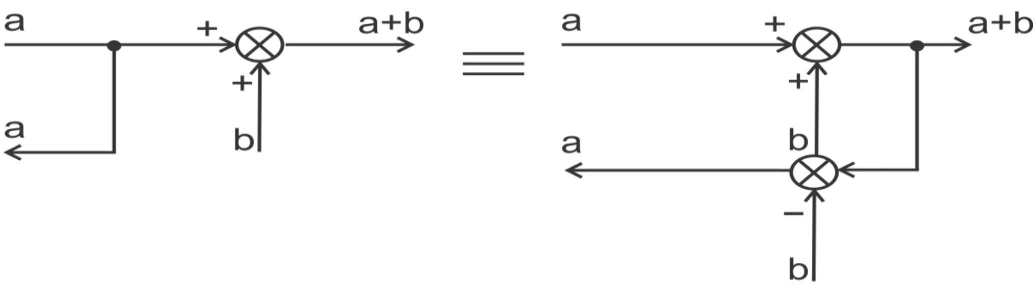
(7) Interchanging Two Summing Points:



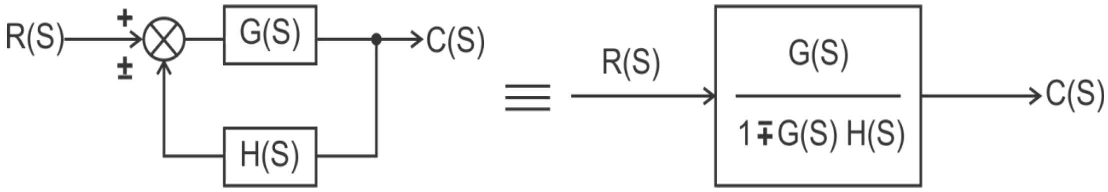
(8) Moving a Take-Off Point Before a Summing Point:



(9) Moving a Take-Off Point After a Summing Point:



(10) Eliminating Feedback Loop:



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