

System Modeling & Control

Presented by

Prof. Amit Kumar Sahoo CUTM, BBSR



Block diagram Algebra

A graphical tool can help us to visualize the model of a system and evaluate the mathematical relationships between their elements, using their transfer functions.

In many control systems, the system of equations can be written so that their components do not interact **except by having the input of one part be the output of another part**.

In these cases, it is very easy to draw a block diagram that represents the mathematical relationships in similar manner to that used for the component block diagram.





Block Diagram

It represents the *mathematical relationships* between the elements of the system.



```
U_1(s)G_1(s) = Y_1(s)
```

The *transfer function* of each component is placed *in box*, and the *input-output relationships* between components are indicated by *lines and arrows*.



Block Diagram Algebra

- Using block diagram, we can **solve the equations by graphical simplification**, which is often easier and more informative than algebraic manipulation, even though the methods are in every way equivalent.
- It is convenient to think of each block as representing an electronic amplifier with the transfer function printed inside.
- The interconnections of blocks include summing points, where any number of signals may be added together.

st & 2nd Elementary Block Diagrams

Centurion UNIVERSITY

Blocks in parallel with their outputs added:



$$\frac{Y_2(s)}{U_1(s)} = G_1 G_2$$



 $\frac{Y_2(s)}{U_1(s)} = G_1 + G_2$





Feedback Rule



 $\frac{Y(s)}{R(s)} = \frac{G_1}{1 + G_1 G_2}$

The gain of a single-loop negative feedback system is given by the forward gain divided by the sum of 1 plus the loop gain



1st Elementary Principle of Block Diagram Algebra





2nd Elementary Principle of Block Diagram Algebra





3rd Elementary Principle of Block Diagram Algebra





Example 1: Transfer function from a Simple Block Diagram



































 $T(s) = \frac{G_1 G_2 G_5 + G_1 G_6}{1 - G_1 G_3 + G_1 G_2 G_4}$