SKU JOURNAL OF ENGINEERING RESEARCH
Vol-2 Issue-1
(NATIONAL PEER REVIEWED E-RESEARCH JOURNAL)
(January – March 2025)
E-ISSN 3048-930X

Reduction Methods in Control System

Lawkesh Tripathi
Assistant Professor
(Electronics and Communication Engineering)
Shri Krishna University, Chhatarpur (M.P.)

ABSTRACT
The topic will commence with the methods of block diagram reduction rules, followed by a detailed examination of each rule pertaining to block diagram reduction and lastly use the block diagram reduction technique to solve a problem. A complicated control system is difficult to assess due to the numerous aspects involved, as we are all aware. Block diagram reduction rules are the only way to analyse a control system in an easy-to-understand manner, as this article will demonstrate. Summing points, and functional blocks are connected through branches in this system form, which facilitates easy, straightforward, and step-by-step, crystal-clear analysis.

KEY WORDS
Control System, Rules, Function, Connected, Points, Element, Block, Diagram.

INTRODUCTION
A control system is represented diagrammatically by a block diagram. Stated differently, a control system's block diagram serves as its practical representation. Each control system component is represented by a block, which serves as a symbolic representation of the element's transfer function (Nagrath et al., 2008). Deriving the complete transfer function of a complex control system in a single function is not always practical. The control element that is connected to the system independently has a simpler transfer function to determine (Friedland et al., 2012. Every block shows the transfer function of an element linked with the signal flow line. By using block diagrams, complex control systems can be simplified. Every element of the control system has a block that represents it is the function of transmission (Satyanarayana et al., 2017).

These blocks, when put together, make a comprehensive control system. Analyzing any system in a control system can be done in two ways, given below-
1. Transfer function method
2. State variable method

Transfer Function Method
The "Transfer Function" is the quotient of the transformation of Laplace, the input variable to that of the output variable under on the presumption that every initial condition is zero.

State Variable Method
The Transfer Function Approach has the advantage of providing a straight forward algebraic equation together with the system's poles and zeroes. This method allows for the immediate determination of the system's output and stability for any given input.

Figure.1- Structure of Block Diagram of Transfer Function (GeeksforGeeks (2024); https://www.geeksforgeeks.org/block-diagram-reduction-rules/)

Identifying the whole transfer function for complex control systems can be challenging. Consequently, each control system component's function is depicted using a block diagram. The symbol's shortened form illustrates the connection in between the control system's inputs and outputs. The full system can be constructed by combining each block in accordance with the specifications of the system. Examine some instances of this method's application and discuss its advantages and disadvantages. A solved example will be presented in order to better illustrate the value of block diagram reduction concepts in the simplification of complex systems. Guidelines for the reduction method of block diagram, is the method that creates the transfer function, and the blocks are put together as required to construct a control system (GeeksforGeeks.,2024). The guidelines listed below should be adhered to while determining the system's transfer function:

Rule 1: Explains that when numerous blocks are cascaded, the total transfer function is the product of all the transfer functions.
G1(s) = C1(s)/ R(s); G2(s) = C2(s) / C1(s); G3(s) = C(s) / C2(s)
C(s) / R(s) = G1(s). G2(s). G3(s)

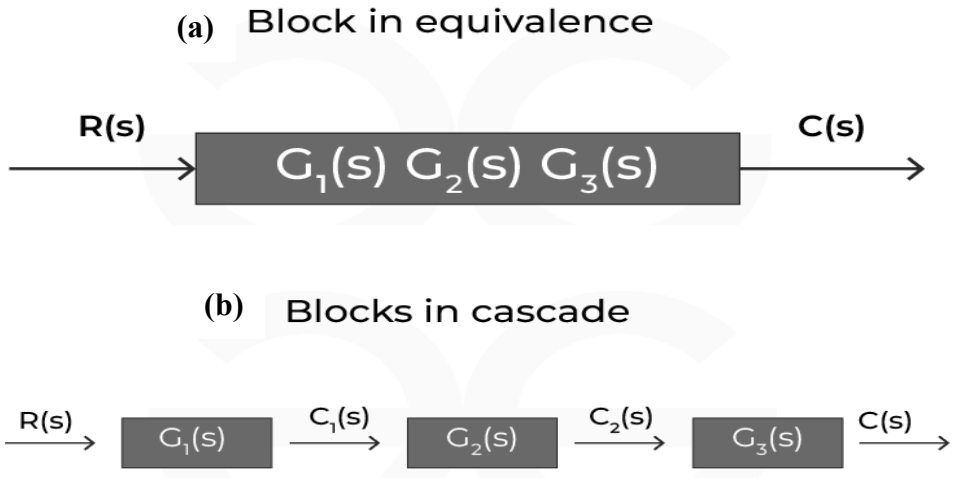

Figure.2- Structure of Blocks in cascade and Block in Equivalence (GeeksforGeeks (2024); https://www.geeksforgeeks.org/block-diagram-reduction-rules/**).**

Rule 2: A point is referred to as a summing point, when more than one input signal enters the system; the output from this point is equal to the total of each input that came through the summing point.

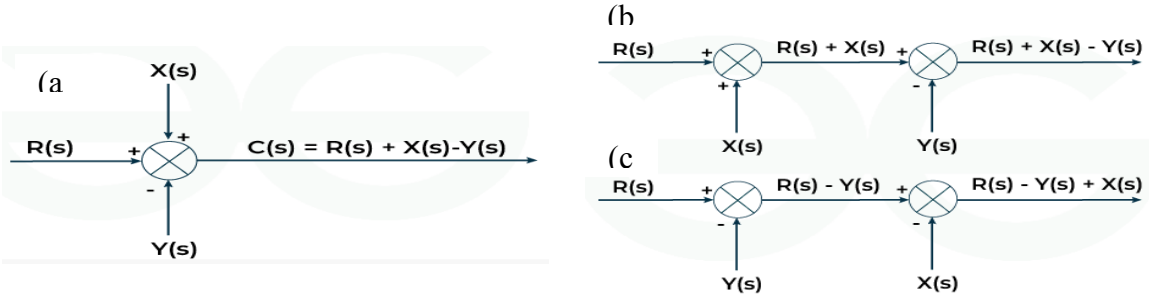

Figure.2- Structure of Summing Point in block (GeeksforGeeks (2024); https://www.geeksforgeeks.org/block-diagram-reduction-rules/).

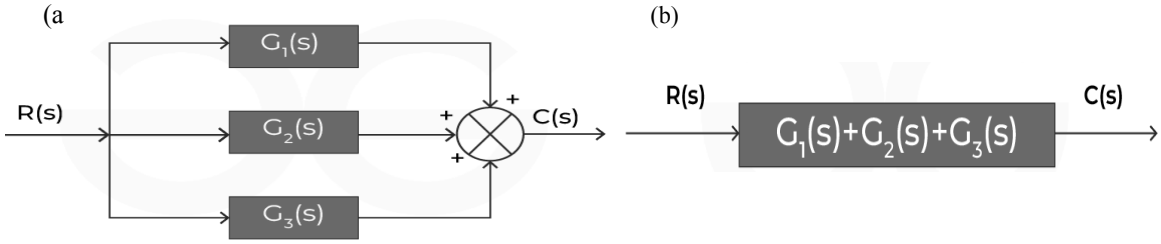

Figure.3-Structure of Parallel and Equivalence Blocks (GeeksforGeeks (2024); https://www.geeksforgeeks.org/block-diagram-reduction-rules/**).**

Rule 3: As shown in the image below, it can be altered the summing points in relation to each other when two or more of them are present.
Rule 4: When one or more blocks are connected to other blocks in parallel, the final equivalent transfer function can be determined as follows:
C(s) /R(s) = G1(s) + G2(s) + G3(s)
C(s) = R(s) G1(s) + R(s) G2(s) + R(s) G3(s)
C(s) = R(s) [G1(s) + G2(s) + G3(s)]

Block Diagram Reduction Rule's benefits

1. It makes creating block diagrams of intricate control systems easier.
2. The performance of every block can be examined separately.
3. It is easy to obtain the specified control system's transfer function.
4. The type of feedback in the system makes it simple to determine the stability of the control system.
5. Through it, we can see how the block diagram functions.

Block Diagram Reduction Rule's drawbacks

1. It takes a long time for a complex control system.
2. No details on the system's actual construction are available.
3. It provides no information regarding the system's energy source.

Block Diagram Reduction's Applications

1. Applied to the design of hardware.

2. Applied to the design of electric systems.
3. Applied to software design.
4. Applied to process flow diagrams.
5. Applied to ascertain the system's transfer function and stability.

CONCLUSION

One highly useful technique for figuring out a complex system's transfer function is the rule of block diagram reduction. It facilitates the analysis of the system's stability and other performance by breaking down the complex control system into a simpler one. By joining basic building parts to create a whole system, engineers may easily troubleshoot and observe complicated systems.

REFERENCES

1. Geeks for Geeks. (2024, February 21). Block Diagram reduction rules. Geeks for Geeks. https://www.geeksforgeeks.org/block-diagram-reduction-rules/.
2. Nagrath, I. J., & Gopal, M. (2008). Textbook of control systems engineering (Vtu). New Age International.
3. Friedland, B. (2012). Control system: an introduction to state-space methods. Courier Corporation.
4. Satyanarayana P.S. (2017). Control Systems Engineering. Engineering & Technology, Medtech (Second Edition).
5. Ghosh, S. (2013). Theory and Applications Of Control System. *Pearson* (Second Edition) Education India.
6. Choudhury, D. R. (2005). Modern control engineering. 4th Edition, *PHI* Learning Pvt. Ltd.
7. Golnaraghi, F., & Kuo, B. C. (2010). Automatic control systems. Complex Variables, 2, 1-1.