Shortcut Method for Implementation of BDRT

Prof. Vikram M. Kakade
[1] *Lecturer, EXTC Dept., PRMCEAM-Badnera, Amravati, Maharashtra, India*

ABSTRACT

In this paper my aim is analyze the behavior of physical system in terms of Block Diagram. Block Diagram widely used Due to their simplicity and versatility control engineers to model all types of dynamic systems. The complexity of a block diagram is in general caused by the existence of summing/pickoff points within a loop. A novel concept, the main/branch stream concept and the corresponding shifting rule for the relocation of summi ng/pickoff points are overviewed in this paper. It simplification of block diagrams and make teaching the simplification of block diagrams much easier. Paper mainly deals with shortcut implementation of existing block Diagram Reduction Technique which ultimately leads to the reduction of time to implement this method and also create scope of simulation of physical system in easier way. Formula generated in this paper are mainly working for both type of feedback system positive and negative.

Keyword: Block Diagram; Gain; summing point; System; Take off point; Transfer function.

---

1. INTRODUCTION

Most physical systems can be represented by block diagrams -a group of properly interconnected blocks, with each interconnected block representing and describing a portion of the system. In control engineering, the block diagram is a primary tool that together with transfer functions can be used to describe cause-and-effect relationships throughout a dynamic system. The manipulation of block diagrams adheres to a mathematical system of rules often known as block diagram algebra.

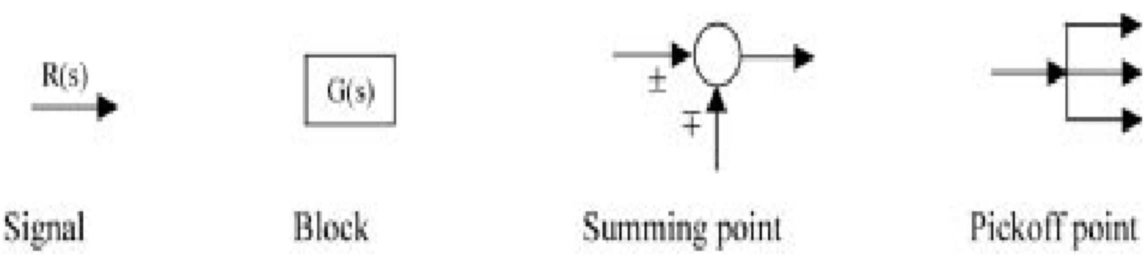


Fig 1: Basic Component of Block Diagram

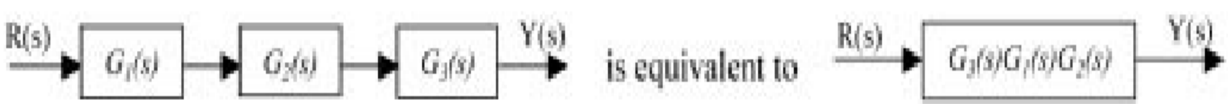


Fig 2: Basic Rule for Block Diagram Reduction Technique

Effects of a system are not straightforward and the simplification of block diagrams is required. The signal flow graph (SFG) developed by Mason, which is based on a representation of a system by line segments, is used to simplify block diagrams. When using the SFG method, the cause-and-effect relationships are normally obtained by applying `Mason's gain formula'. Applying the formula however involves a relatively complex process such as identifying the nodes, the various paths (forward/loop, touching/non-touching) and calculating the corresponding path gains. Block diagrams can also be simplified using the rules of `block diagram algebra'. This too is a relatively complex process where up to 33 rules were introduced [7] that may need to be applied. In this paper, a novel concept, the concept of main/branch stream and the corresponding shifting rule are introduced to simplify the complexity of the rules in the simplification of block diagrams using the block diagram algebra. A brief review of the block diagram basics is presented in part A of section II. The current practice in the simplification of block diagrams and the proposed alternative approach in the simplification of block diagrams using the novel main/branch stream concepts and the corresponding shifting rule are described in part B and C of section II respectively. Two illustrative examples are given in section III, which is followed by the conclusion.

2 .BLOCK DIAGRAMS

The combined block is interchangeable in sequence in both cases. The simplification of the general feedback loop described can be obtained by performing simple algebraic operation around the loop, which can be found in most textbooks on control engineering. Note that the understanding of the properties of summing junction in series is crucial in the simplification of some block diagrams: summing points in series can be interchanged, combined and separated algebraically. The equivalency of summing junction in series to mathematical summer is self explanatory. The current practice in the simplification of block diagrams using block diagram algebra the block diagram is in general complicated by the existence of the summing/pickoff point(s) within a loop. However the simplification of the block diagram can always be achieved through the relocation of such summing/pickoff point(s) appropriately. In the current practice of simplifying block diagrams using block diagram algebra, in addition to the three basic rules described in part A various numbers of other rules are introduced in various textbooks with regard to the relocation of the summing/pickoff point(s). Each rule involves a pair of equivalent block diagram [1]. The equivalency is not hard to verify by tracing the signals at the input through to the output and recognizing the output signal is identical in the corresponding cases. However, it is hard enough for the students to memorize such rules, not to mention to let them decide when to use which rule while facing a complex block diagram. The proposed alternative approach in the simplification of block diagrams by using the novel main/branch stream concepts and the corresponding shifting rule the main/branch stream is defined as following: At a summing point or pickoff point, there are signals flowing in and out. The signal flow that goes in the unique direction, either into or out of the summing/ pickoff point, is defined as the main stream and the rest of the signal flows are defined as branch streams. With the introduction of the main/branch stream concepts, summing/pickoff point(s) can be easily relocated for the purpose of simplification by simply following the shifting rule described by which I have presented one base formula for formulation of basic block diagram rather than following typical reduction approach formula is given as below

3 .SHORTCUT METHOD FOR BLOCK DIAGRAM REDUCTION TECHNIQUE

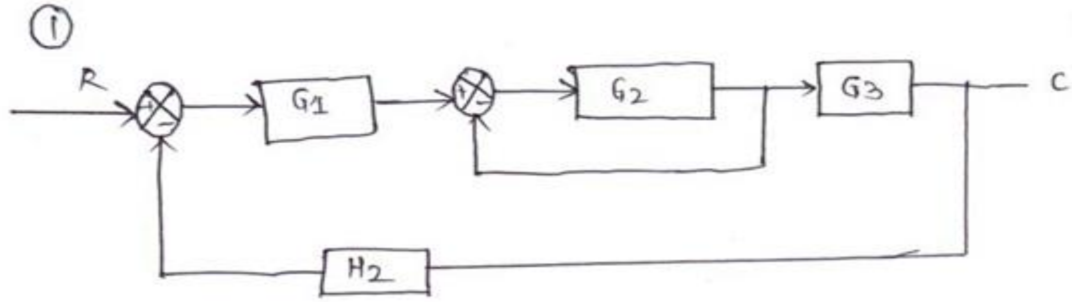
$$\text{T.F}=\frac{Multiplication\ of\ forword\ path\ gain\ of\ system}{1+loop\ gain\ Multiplication}$$

If it is negative feedback system

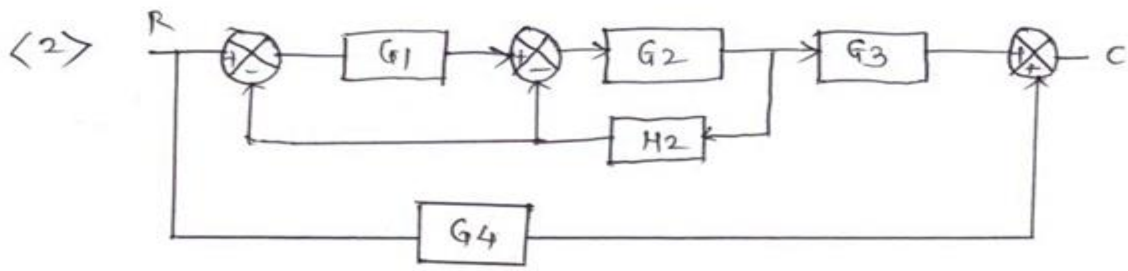
$$\text{T.F}=\frac{Multiplication\ of\ forword\ path\ gain\ of\ system}{1-loop\ gain\ Multiplication}$$

If it is positive feedback system

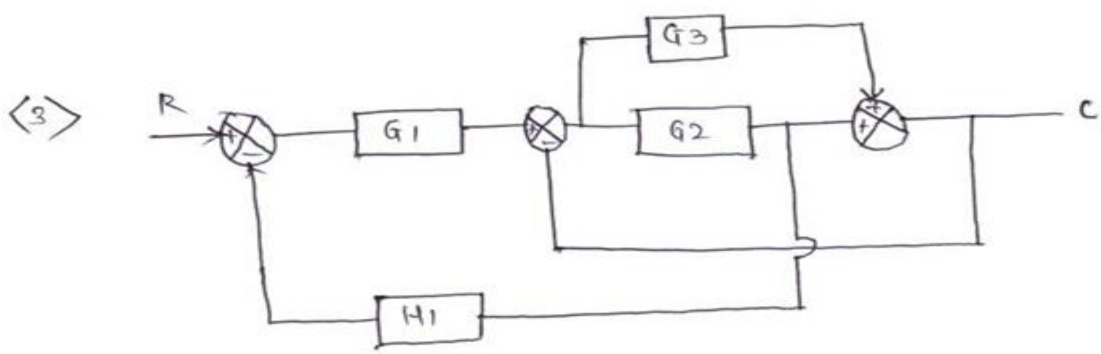
But if there exist more than one forword path add forword path gain by considering it s eperately.Also observe each path individually if ikt is having any non-touching loop to that perticular forword path then multiply forword path (1+loop gain multiplication) for negative feedback system and (1-loop gain multiplication) for positive feedback system. Some examples for this shortcut technique are shown below



$$TF=\frac{G1G2G3}{1+G2+G1G2G3H2}$$



$$TF=\frac{G1G2G3+G4+G2G4H2+G1G2G4H2}{1+G2H2+G1G2H2}$$



$$TF=\frac{G1G2+G1G3}{1+(G2+G3)+G1G2H1}$$

Fig3. Block Diagram and its solution by shortcut method

4. Mason's gain rule for SF6

It is rule derived by scientist Mason's hence called as mason's Gain Rule for the specific outcome of calculating Transfer Function. The two ways of depicting a system are equivalent, and you can use either diagram to apply Mason's rule (to be defined shortly). In a signal-flow graph the internal signals in the diagram, such as the common input to several blocks or the output of a summing junction, are called nodes. The system input point and the system output point are also nodes; the input node has outgoing branches only, and the output node has incoming branches only. Mason defined a path through a block diagram as a sequence of connected blocks, the route passing from one node to another in the direction of signal flow of the blocks without including any block more than once. A forward path is a path from the input to output such that no node is included more than once. If the nodes are numbered in a convenient order, then a forward path can be identified by the numbers that are included. Any closed path that returns to its starting node without passing through any node more than once is a loop, and a path that leads from a given variable back to the same variable is a loop path. The path gain is the product of component gains (transfer functions) making up the path. Similarly, the loop gain is the path gain associated with a loop - that is, the product of gains in a loop. If two paths have a common component, they are said to touch. Notice particularly in this connection that the input and the output of a summing junction are not the same and that the summing junction is a one-way device from its inputs to its output. Mason's rule relates the graph to the algebra of the simultaneous equations it represents.1 Consider Fig. W.1(c), where the signal at each node has been given a name and the gains are marked.

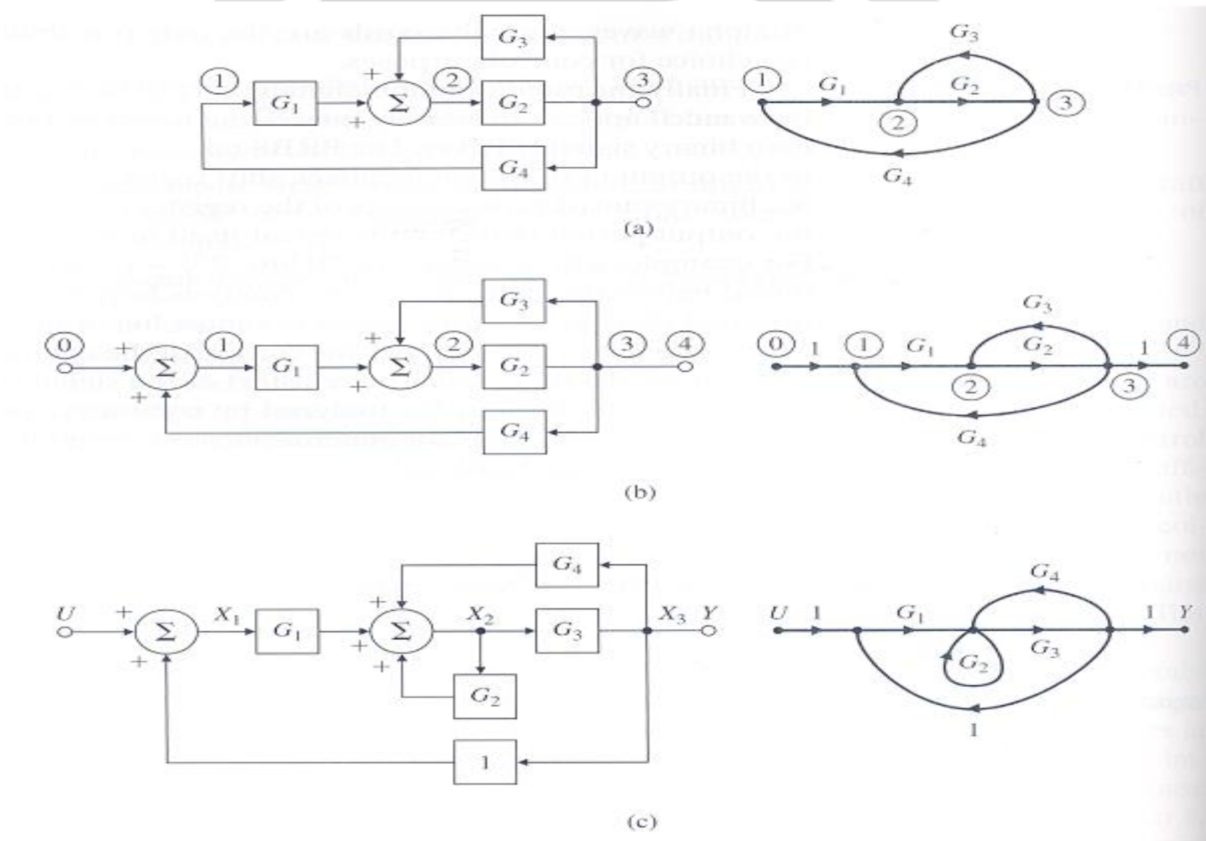


Figure 4: Block diagrams and its respective signal flow graphs.

5. CONCLUSION AND FUTURE WORK

The above method is used for calculation of typical complex diagram which required minimum time in the range of nanosecond .as we know that that block diagram is physical systembefore calculation of transfer function understanding the above physical systemis mandatory .From this method we can conclude that simulation time required for systemanalysis is less and which ultimately leads to the easiest way of stability analysis. The future scope for this method we can modify this formula in such way that directly by Transfer Function we can judge the nature and stability of system

REFERENCES

1. K. Ogata, Modern Control Engineering, 3rd Edition, Prentice Hall, Upper Saddle River, New Jersey, (1997).
2. G. F. Franklin, J. D. Powell and A. Emami-Naeini, Feedback Control Dynamic Systems, 3rd Edition, Addison-Wesley Publishing, (1994).
3. R. C. Dorf, Modern Control Systems, 5th Edition, Addison-Wesley Publishing, (1989).
4. B. C. Kuo, Automatic Control Systems, 7th Edition, Prentice-Hall, Inc., Upper Saddle River, New Jersey, (1995).
5. S. J. Mason, Feedback theory Ðsome properties of signal flow graphs, Proc. IRE, 41(9) pp. 1144±1156 (1953).
6. S. J. Mason, Feedback theory Ðfurther properties of signal flow graphs, Proc. IRE, 44(7), pp. 920±926 (1956).
7. N. M. Karayanakis, Advanced System Modeling and Simulation with Block Diagram Languages, CRC Press, Inc. (1995).Networks', Procedia Technology 4,pp. 703- 707, 2012.

BIOGRAPHIES

	Prof. Vikram Kakade is lecturer in Electronics and Telecommunication Department from Year 2012. He is having Experience of 4 Years during which he had contributed on topic like Basic Electronics, Control System Engineering, Embedded System and Communication System Design. He is perusing his master's degree from PRMITR, Badnera, and Amravati-Maharashtra- India.