

EENG307: Block Diagrams¹

Lecture 8

Elenya Grant, Kathryn Johnson, and Hisham Sager²

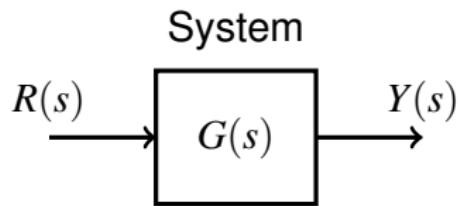
Department of Electrical Engineering
Colorado School of Mines

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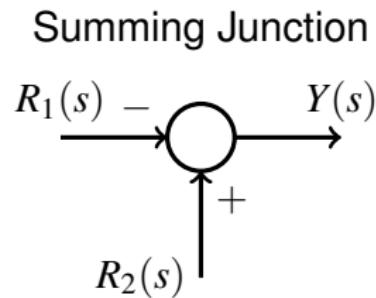
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²Developed and edited by Tyrone Vincent and Kathryn Johnson, Colorado School of Mines, with contributions from Salman Mohagheghi, Chris Coulston, Kevin Moore, CSM and Matt Kupilik, University of Alaska, Anchorage

Block Diagram Elements



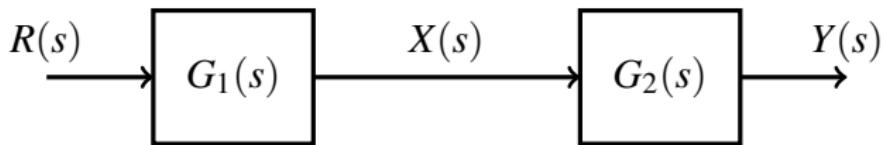
$$Y(s) = G(s)R(s)$$



$$Y(s) = -R_1(s) + R_2(s)$$

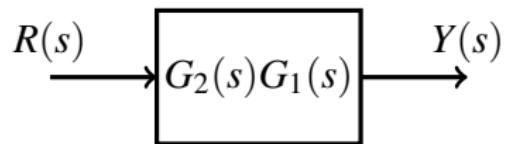
Block Diagram Simplifications:

Systems in Series



$$X(s) = G_1(s)R(s)$$

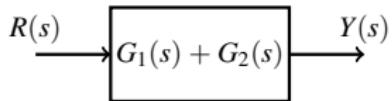
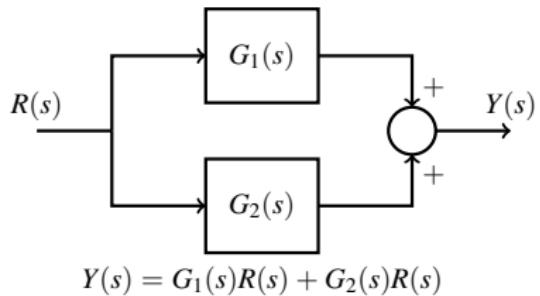
$$Y(s) = G_2(s)X(s)$$



$$Y(s) = G_2(s)G_1(s)R(s)$$

Block Diagram Simplifications:

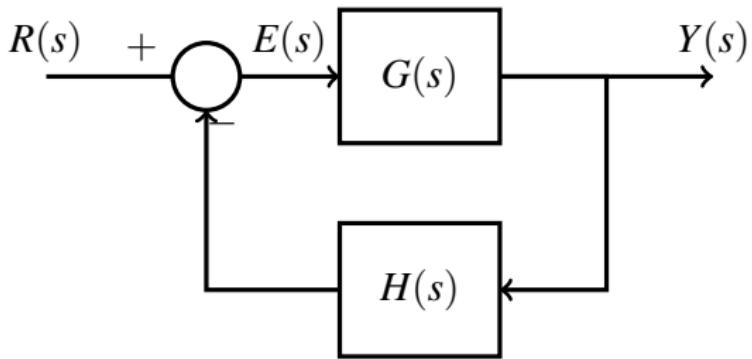
Systems in Parallel



$$Y(s) = (G_1(s) + G_2(s))R(s)$$

Block Diagram Simplifications:

Systems in Feedback



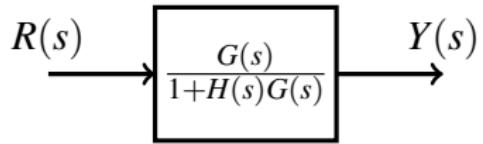
$$Y(s) = G(s)E(s)$$

$$E(s) = R(s) - H(s)Y(s)$$

Block Diagram Simplifications:

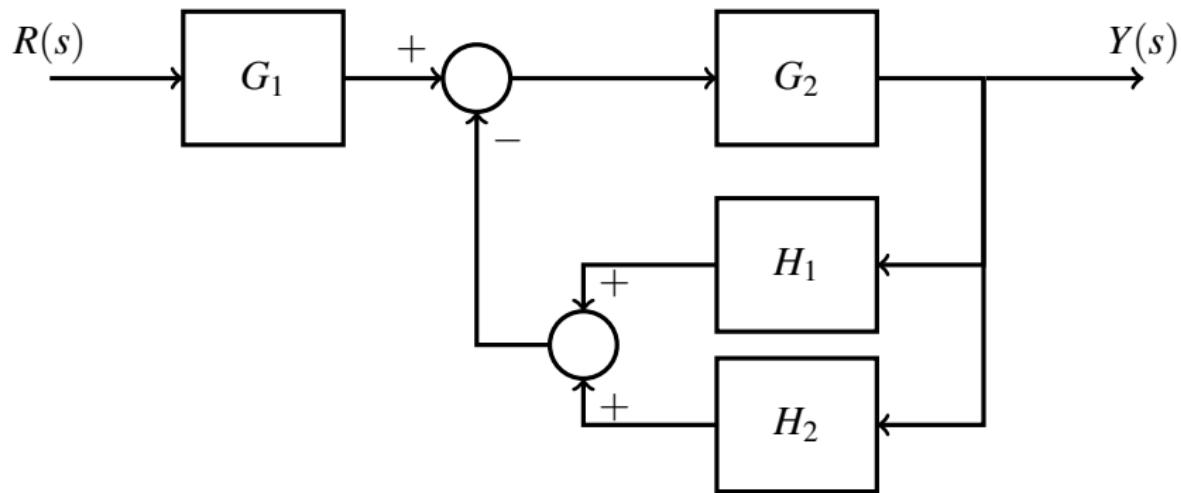
Feedback Simplification

$$Y(s) = \frac{G(s)}{1 + G(s)H(s)}R(s)$$



Example 1

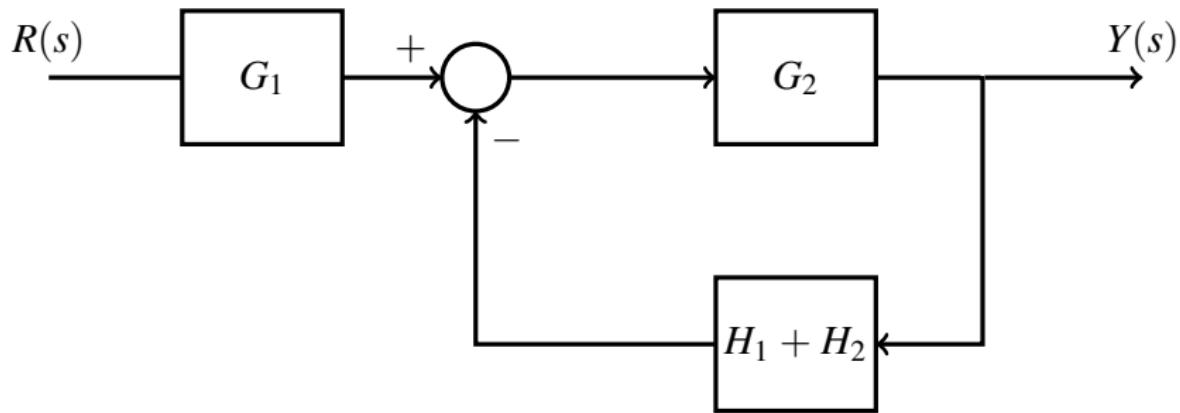
- Simplify the following block diagram. All variables are functions of s .



Example 1:

Step 1

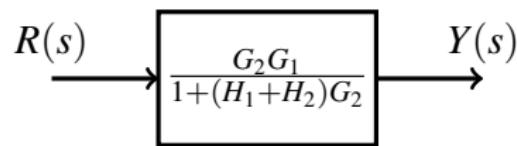
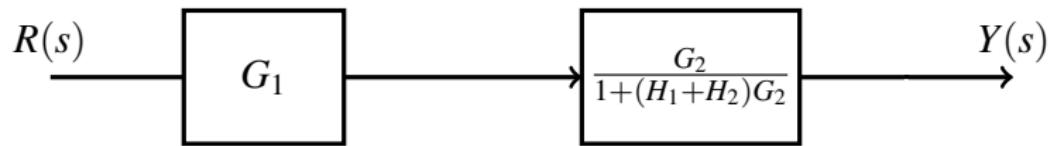
- Combine systems in parallel



Example 1:

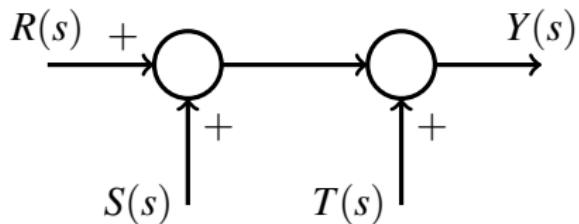
Steps 2 and 3

- Combine feedback systems
- Combine systems in series

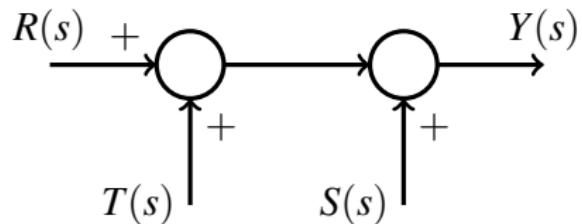


Moving Summers

- Since addition is commutative, summing can be done in any order



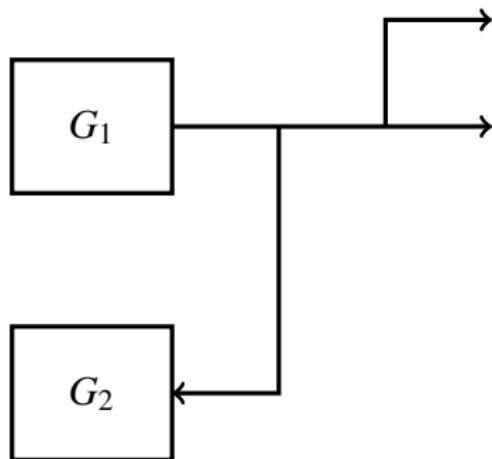
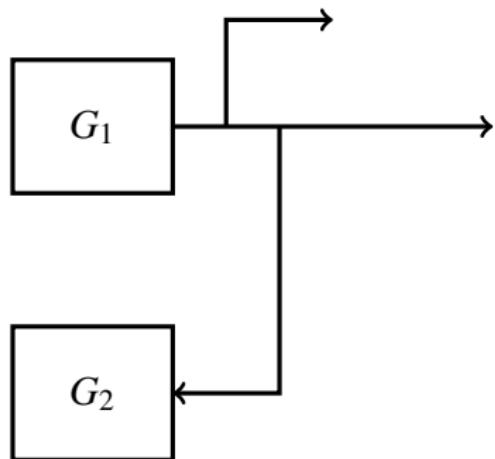
$$Y(s) = (R(s) + S(s)) + T(s)$$



$$Y(s) = (R(s) + T(s)) + S(s)$$

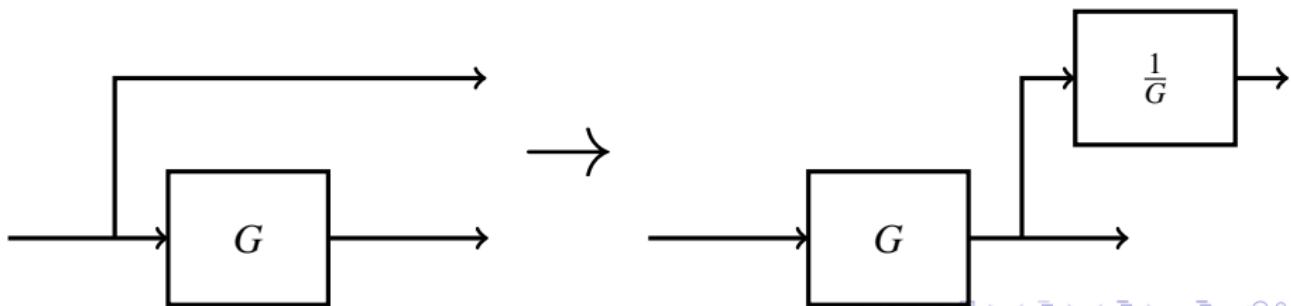
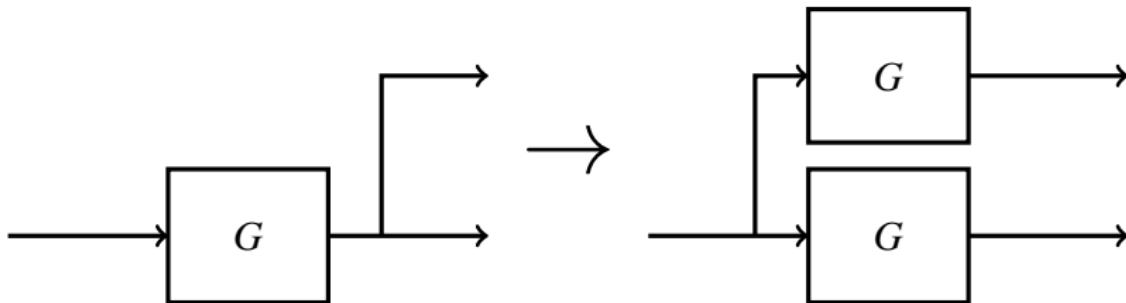
Moving Pick-off points

- Pick-off points can be taken anywhere on a line



Moving Pick-off points around blocks

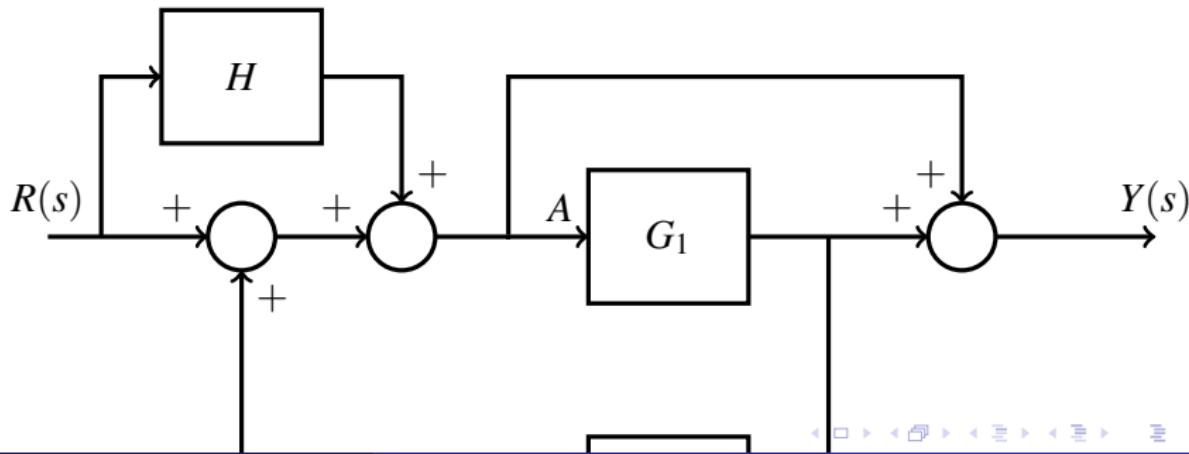
- Pick-off points can be moved around a block by adding blocks



Backup Plan

If you ever get stuck - just convert back to algebra relationships and solve these by hand

- ① First, add signal names at inputs to blocks (pick any unused letter)
- ② Then, write equations for all variables
- ③ Finally, eliminate the intermediate variables (signals you labeled, not the primary input and output signals) and solve for transfer function



Untangling Loops

- Sometimes, loops interfere with each other

