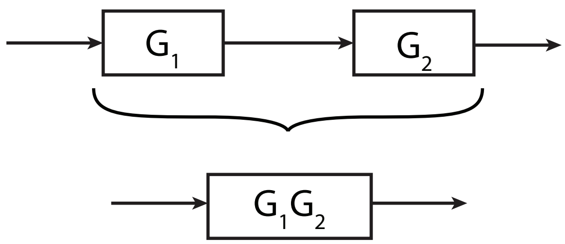
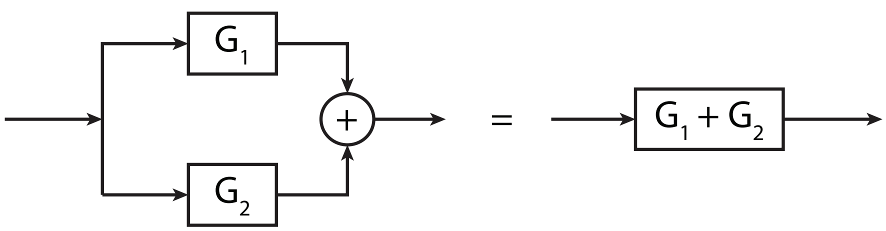
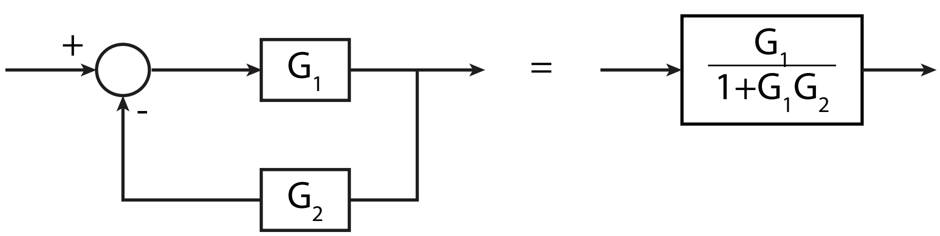
16.06 Principles of Automatic Control
Lecture 4

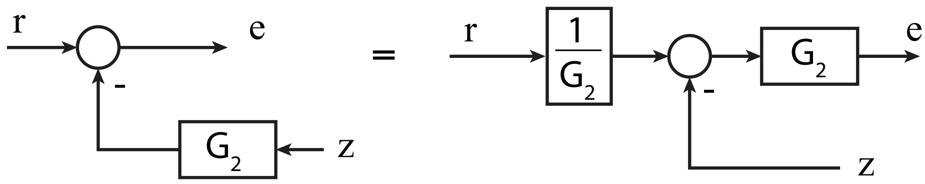
Block Diagram Manipulations:



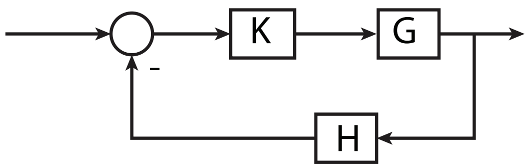




The gain of a single loop feedback system (with sign "-1" in the loop) is the forward gain divided by the sum of 1 plus the loop gain.



So,



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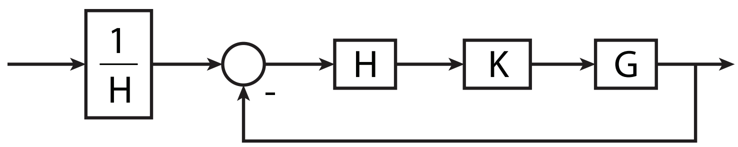
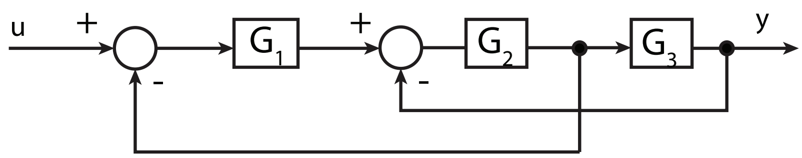


Mason's Rule:

$$
\begin{aligned}
H(s) =& \frac{1}{\Delta}\sum_i H_i \Delta_i \\
H(s) =& \text{closed-loop transfer function} \\
\Delta =& \text{system determinant} \\
=& 1 - \sum \text{all loop gains} \\
=& \ + \sum (\text{products of 2 loops that don't touch}) \\
=& \ - \sum (\text{products of 3 loops that don't touch}) \\
=& \ ... \\
H_i =& i^{th} \text{ forward path} \\
\Delta_i =& \text{determinant of } i^{th} \text{path} \\
=& \text{value of D for that part of diagram that does not touch path i}
\end{aligned}
$$

Example



$$H(s) = \frac{G_1 G_2 G_3}{1 + G_1 G_2 + G_2 G_3}$$