Modelling and control summaries

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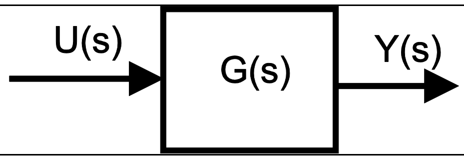
Block diagrams 4 – summing junctions

SUMMING JUNCTIONS ARE NEEDED FOR FEEDBACK AND WHERE WE NEED ADDITION OR SUBTRACTION OF SIGNALS: We assume readers are now comfortable with transfer function representations and series/parallel arrangements.

Y(s)=G(s)U(s) is equivalent to

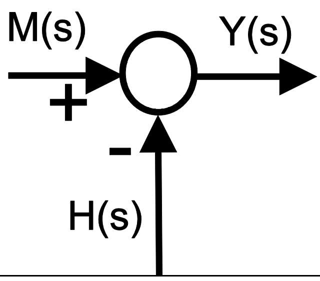


Example with a summing junction

Summing junctions are represented by circles with + or – next to the signal paths entering the circle. The summing junction represents simple addition or subtraction of signals using the signs provided. [**Summation here applies only to SIGNALS**]

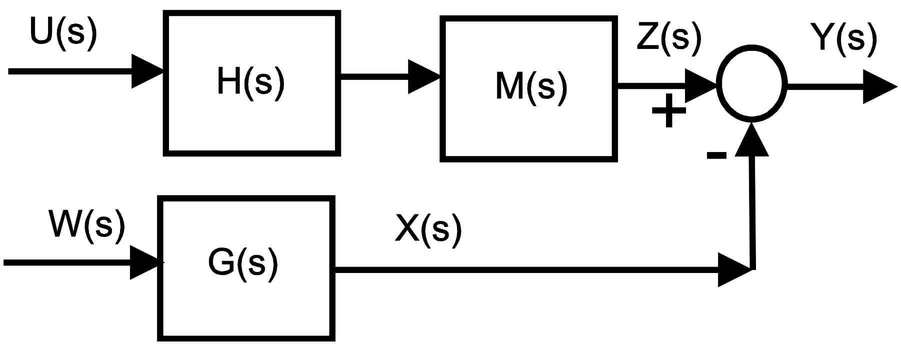
The example here shows two signals, M(s) and H(s), entering a summing junction.
According to the signs provided we have

Y(s)=M(s) – H(s)



COMBINING SUMMING JUNCTIONS WITH PARALLEL AND SERIES PATHS

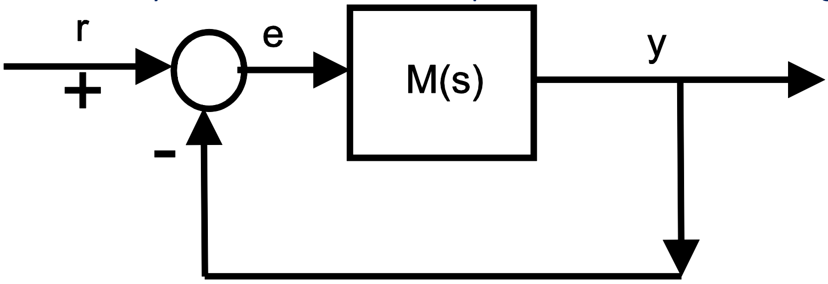
Applying the block diagram rules derived in the first handouts, the relationships for the following diagram can be written down by inspection.



$$\left.\begin{array}{r} Z(s) = M(s)H(s)U(s) \\ X(s) = G(s)W(s) \end{array}\right\} \Rightarrow \quad Y(s) = M(s)H(s)U(s) - G(s)W(s)$$

SUMMING JUNCTION TO PROVIDE FEEDBACK

More often, a summing junction is used as a comparator, that is to compare a target value with an actual value. Following this comparison, the resulting error is used to determine a control action and hence provide continuous feedback. This is represented in simple form using the diagram below. A core skill is the ability to solve for the interdependencies between the signals in this loop.

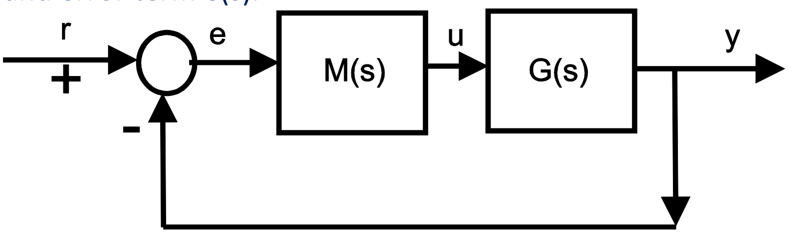


The basic technique is to write down equations at every point in the loop and then remove variables systematically. An example procedure s shown next.

1. Write the expression for the forward path. Eliminate internal variables if necessary.	**1. y(s)=M(s)e(s)**
2. Write expression for feedback path.	2. **Feedback term is just y(s).**
3. Write expression linked to summing junction.	3. **e(s)=r(s)-y(s)**
4. Eliminate *e(s)*	4. **Using (1) and (3)➔y(s)=M(s)[r(s)-y(s)]**
5. Rearrange into form linking target to output.	5. **[1+M(s)]y(s)=M(s)r(s) or y(s)=[M/(1+M)] r(s)**

Example 2 of closed-loop transfer functions

A more typical feedback diagram has a compensator M(s) and a process G(s), target signal r(s), process input u(s), process output y(s) and error term e(s).



The basic technique is the same, that is to write down equations at every point in the loop and then remove variables systematically. An example procedure s shown next.

1. Write the expression for the forward path. Eliminate internal variables if necessary.
   Y(s)=G(s)M(s) e(s)
2. Write expression for feedback path.
   This is just the signal y(s)
3. Write expression linked to summing junction.
   e(s)=r(s)-y(s)
4. Eliminate *e(s)*
   y(s)=G(s)M(s)[r(s)-y(s)]
5. Rearrange into form linking target to output.

$$[1+GM]y(s)=GMr(s) \quad \Rightarrow \quad y(s)=\frac{GM}{1+GM}r(s)$$