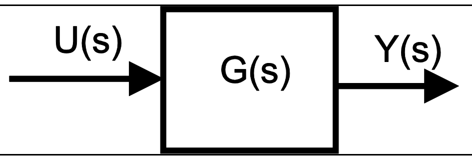
Modelling and control summaries

by Anthony Rossiter

Block diagrams 3 – systems in parallel

INTERPRETING BLOCK DIAGRAMS: Lines represent signals and blocks represent systems. An arrow (or line) into a block represents a system input. An arrow (or line) out of a block represents a system output. Laplace transform of the output is the transfer function multiplied by the Laplace transform of the input. HENCE

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



Systems in parallel

Consider the context where several systems share the same input. How might this be represented using a block diagram?

- System 1 has input w and output p.
- System 2 has input w and output x.

System 2

System 1

$$a\frac{dp}{dt}+bp=kw \quad and \quad \left\{g\frac{dx}{dt}+fx=ny,\, c\frac{dy}{dt}+ey=mw\right\}$$

The overall system has two separate outputs, P(s) and X(s).

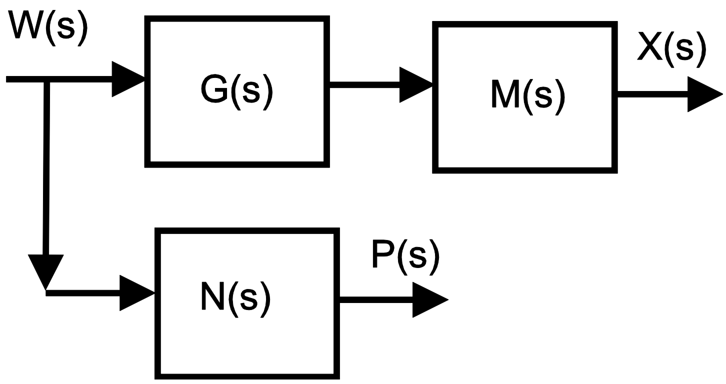
$$P(s)=\left(\frac{k}{as+b}\right)U(s)=N(s)W(s); \quad X(s)=\left(\frac{n}{gs+f}\cdot\frac{m}{cs+e}\right)W(s)=M(s)G(s)W(s)$$

The associated block diagram is straightforward if one remembers that

- Lines represent signals (inputs and outputs).
- Blocks represents systems (transfer functions).

Hence, a signal going into two separate systems can be represented in the same way as an electrical circuit using a split in the path.

Any connected path is assumed to carry the same signal. Arrows help to clarify directions of flow.



REMARK: One can combine the series and parallel observations to form relationships quickly and easily as the example on the next page will demonstrate.

EXAMPLE OF 3 SYSTEMS IN SERIES AND PARALLEL WITH THE ASSOCIATED BLOCK DIAGRAM REPRESENTATION

$$X(s) = G(s)U(s); \quad Y(s) = H(s)U(s); \quad W(s) = M(s)Y(s)$$
$$Z(s) = P(s)X(s); \quad T(s) = Q(s)Y(s)$$

First it is useful to clarify the flow of information, input to output and so forth. Hence, combining the above relationships it is clear that:

1. There are 3 separate outputs.
2. Two of the outputs (W and T) share a common internal signal, that is Y(s)=H(s)U(s) so this can be represented in the block diagram.

$$W(s) = \underbrace{M(s)H(s)}_{Path\ \ 1}U(s); \quad Z(s) = \underbrace{P(s)G(s)}_{Path\ \ 2}U(s); \quad T(s) = \underbrace{Q(s)H(s)}_{Path\ \ 3}U(s)$$