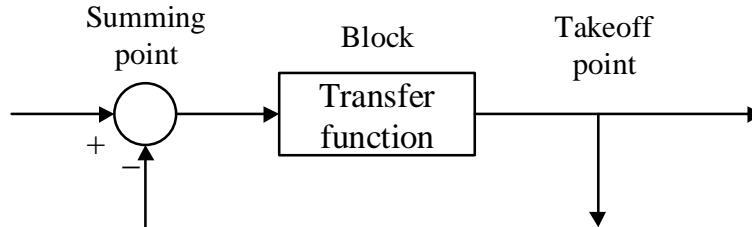


### 3. Block Diagrams

A block diagram of a system is a pictorial representation of the functions performed by each component and of the flow of signals. The block diagram gives an overview of the system.

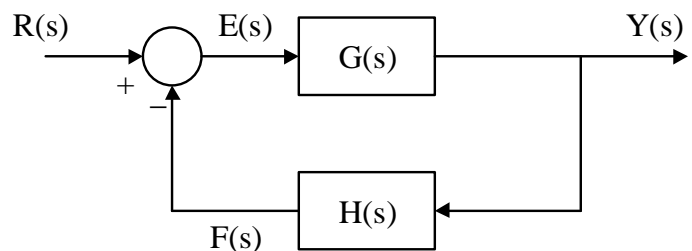
Block diagram items:



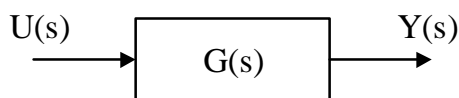
The above figure shows the way the various items in block diagrams are represented. Arrows are used to represent the directions of signal flow. A summing point is where signals are algebraically added together. The takeoff point is similar to the electrical circuit takeoff point. The block is usually drawn with its transfer function written inside it.

We will use the following terminology for block diagrams throughout this course:

- R(s) = reference input (command)
- Y(s) = output (controlled variable)
- U(s) = input (actuating signal)
- E(s) = error signal
- F(s) = feedback signal
- G(s) = forward path transfer function
- H(s) = feedback transfer function



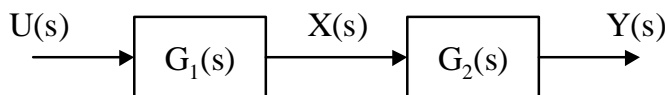
Single block:



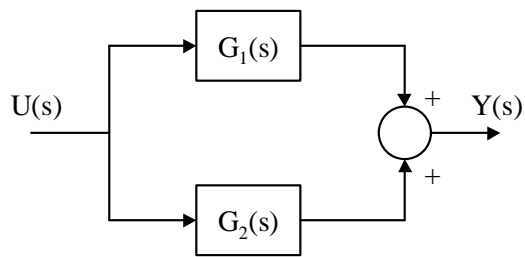
$$Y(s) = G(s)U(s)$$

U(s) is the input to the block, Y(s) is the output of the block and G(s) is the transfer function of the block.

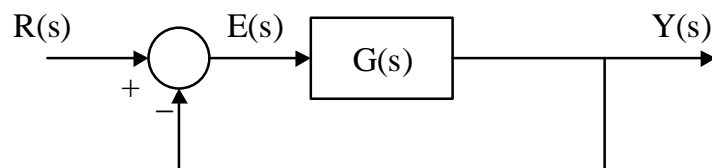
Series connection:



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

Parallel connection (feed forward):

$$Y(s) = [G_1(s) + G_2(s)]U(s)$$

Negative feedback system (closed-loop system):

The closed loop transfer function:  $\frac{Y(s)}{R(s)} = \frac{G(s)}{1 + G(s)}$

**Exercise:** Find the closed-loop transfer function for the following block diagram:

