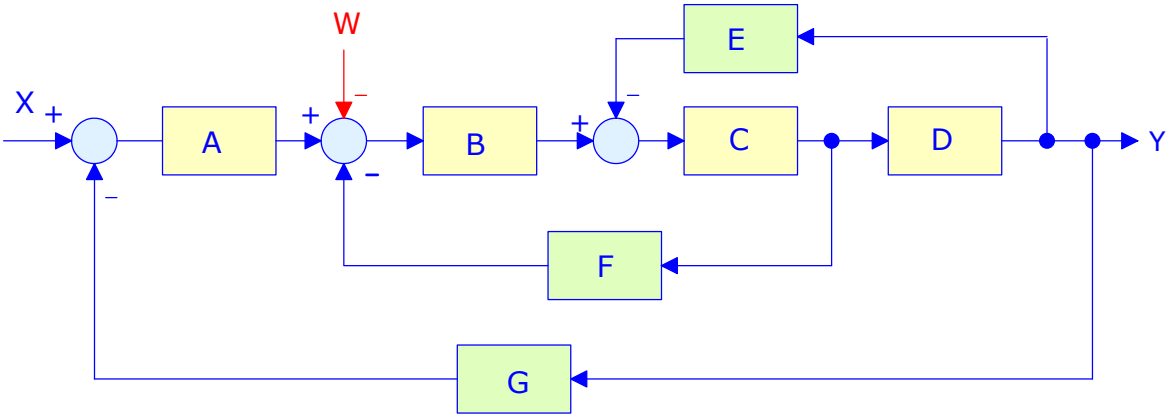
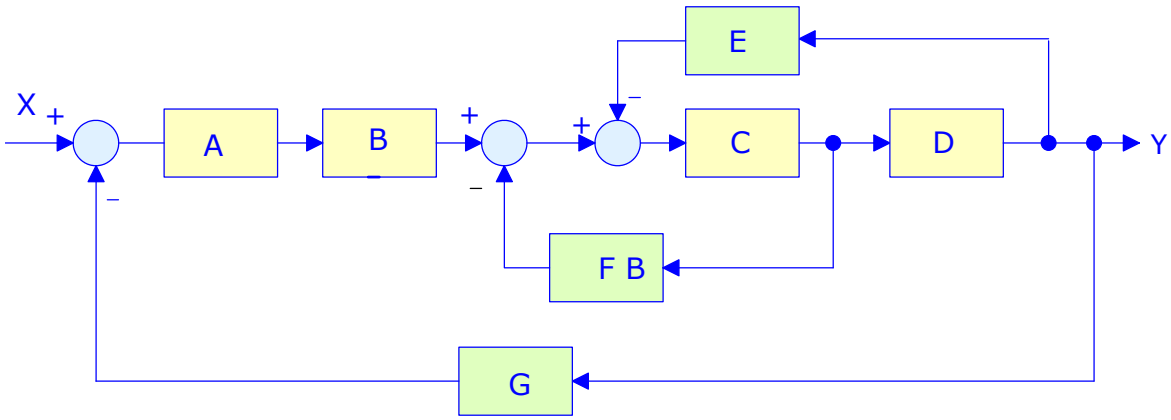
2. Mathematical Models of Systems (cont.)

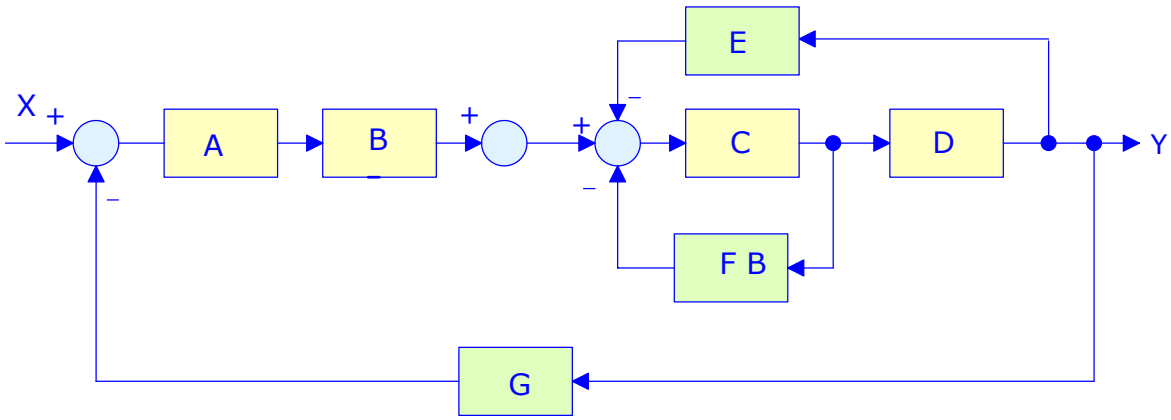
Example

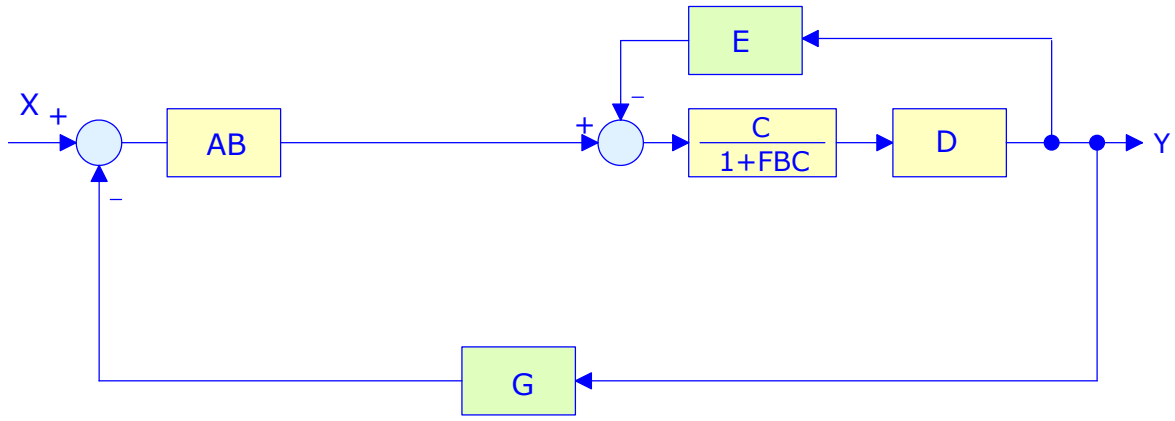
Find the transfer function $\frac{Y(s)}{X(s)}$

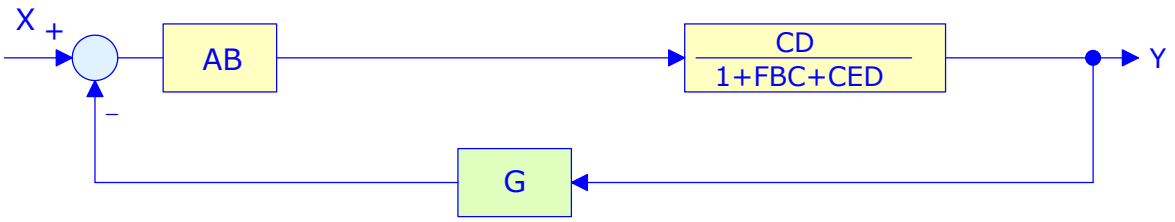


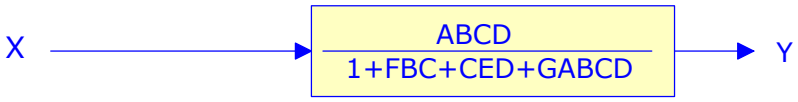
Solution











DRILL PROBLEM **[due on October 5]**

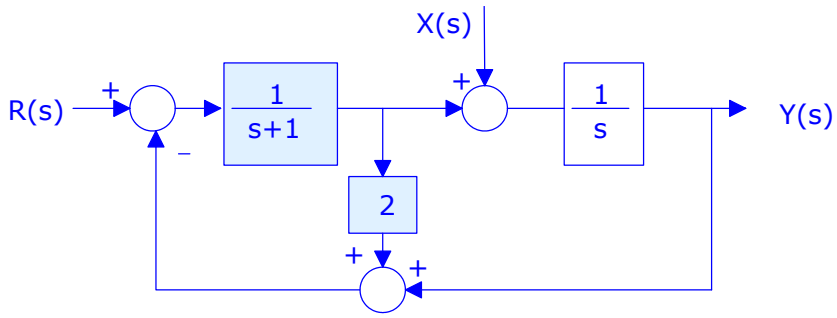
Find the transfer function $\frac{Y(s)}{W(s)}$.

COMPUTATION OF CLOSED-LOOP TRANSFER FUNCTIONS USING MATLAB

It is possible to use MATLAB to compute block diagram reductions and closed-loop transfer functions. An example will be given next:

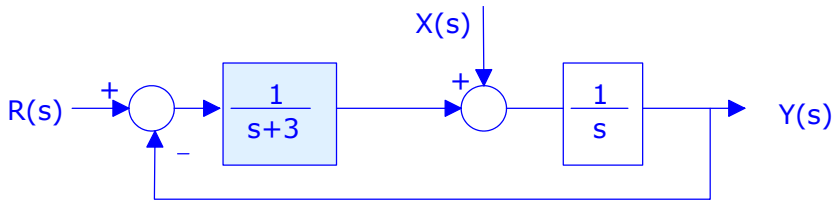
Example

For the system shown, determine the closed-loop transfer functions $\frac{Y(s)}{R(s)}$ and $\frac{Y(s)}{X(s)}$ using (i) Block diagram reduction, and (ii) MATLAB .



Solution

Block diagram reduction



$$\frac{Y(s)}{R(s)} = \frac{\frac{1}{s}\frac{1}{s+3}}{1+\frac{1}{s}\frac{1}{s+3}} = \frac{1}{s^2+3s+1} \quad ; \quad \frac{Y(s)}{X(s)} = \frac{\frac{1}{s}}{1+\frac{1}{s}\frac{1}{s+3}} = \frac{s+3}{s^2+3s+1}$$

MATLAB

Method 1

```
n1=[1];d1=[1 1 ];
n2=[1];d2=[1  0];
n3=[2];d3=[1];
nblocks=3;
blkbuild;
Q=[ 1 -2 -3;2 1 0;3 1 0];
inputs=[1 2 ];
outputs=[2]
[Ac,Bc,Cc,Dc]=connect(a,b,c,d,Q,inputs,outputs);
   [NN1,DD1] = SS2TF(Ac,Bc,Cc,Dc,1);
   [NN2,DD2] = SS2TF(Ac,Bc,Cc,Dc,2);
   G11=tf(NN1(1,:),DD1); G12=tf(NN2(1,:),DD2);
   G=[G11 G12]
```

```
          1
#1:  -------------
     s^2 + 3 s + 1

       s + 3
#2:  -------------
     s^2 + 3 s + 1
```

Method 2

```
n1=[1];d1=[1 1 ];G1=tf(n1,d1)
n2=[2];d2=[1];G2=tf(n2,d2)
n3=[1];d3=[1  0];G3=tf(n3,d3)
G=feedback(G1,G2)
GYR=feedback(series(G,G3),1)
GYX=feedback(G3, G)
```

```
      1
-------------
s^2 + 3 s + 1
```

```
    s + 3
-------------
s^2 + 3 s + 1
```
