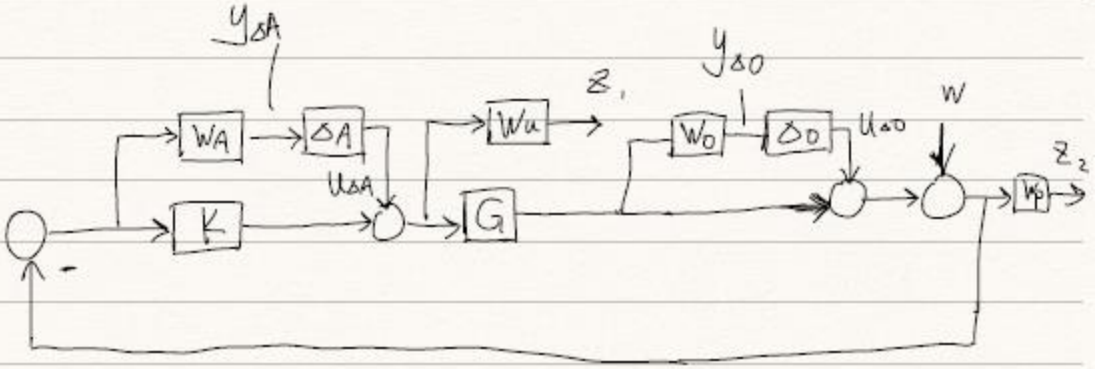


$$y_{\delta A} = W_A \left[0 - u_{\delta 0} - G\left(u_{\delta A} + \frac{y_{\delta A}}{W_A} K \right) \right]$$

$$y_{\delta A} = -W_A \left[u_{\delta 0} + G\left(u_{\delta A} + \frac{y_{\delta A}}{W_A} K \right) \right]$$

$$y_{\delta A} = -W_A u_{\delta 0} - W_A G \left(u_{\delta A} + \frac{y_{\delta A}}{W_A} K \right)$$

$$y_{\delta A} = -W_A u_{\delta 0} - W_A G u_{\delta A} - G y_{\delta A} K$$

$$y_{\delta A} + G y_{\delta A} K = -W_A u_{\delta 0} - W_A G u_{\delta A}$$

$$(1 + GK) y_{\delta A} = -W_A u_{\delta 0} - W_A G u_{\delta A}$$

$$y_{\delta A} = -W_A S \left(u_{\delta 0} + G u_{\delta A} \right)$$

$$y_{\Delta 0} = W_0 G \left[u_{\Delta A} + K\left(-u_{\Delta 0} - \frac{y_{\Delta 0}}{W_0} \right) \right]$$

$$y_{\Delta 0} = W_0 G \left(u_{\Delta A} - K u_{\Delta 0} - \frac{y_{\Delta 0}}{W_0} K \right)$$

$$y_{\Delta 0} = W_0 G u_{\Delta A} - W_0 G K u_{\Delta 0} - G y_{\Delta 0} K$$

$$(1 + GK) y_{\Delta 0} = W_0 G (u_{\Delta A} - K u_{\Delta 0})$$

$$y_{\Delta 0} = W_0 GS (u_{\Delta A} - K u_{\Delta 0})$$

$$\begin{bmatrix} y_{\Delta A} \\ y_{\Delta 0} \end{bmatrix} = \begin{bmatrix} -W_A SG & -W_A S \\ W_0 GS & -W_0 KGS \end{bmatrix} \begin{bmatrix} u_{\Delta A} \\ u_{\Delta 0} \end{bmatrix}$$

$$\downarrow$$

$$M$$

$$\Delta = \begin{bmatrix} \Delta_A & 0 \\ 0 & \Delta_0 \end{bmatrix}$$

$$\left| I - M\Delta \right| = \begin{vmatrix} 1 + W_A SG\Delta_A & W_A S\Delta_0 \\ -W_0 GS\Delta_A & 1 + W_0 KGS\Delta_0 \end{vmatrix}$$

$$= (1 + W_A SG\Delta_A)(1 + W_0 KGS\Delta_0) + (W_0 GS\Delta_A)(W_A S\Delta_0)$$

$= 1 + W_0 KGS\Delta_0 + W_A SG\Delta_A + W_A W_0 KS^2 G^2 \Delta_A \Delta_0 + W_0 W_A S^2 G \Delta_A \Delta_0 = 0$

$T = SKG$

$\therefore \quad 1 + W_0 T\Delta_0 + W_A SG\Delta_A + W_A W_0 TSG\Delta_A\Delta_0 + W_0 W_A SSG\Delta_A\Delta_0 = 0$

$1 + W_0 T\Delta_0 + W_A SG\Delta_A + W_A W_0 SG\Delta_A\Delta_0 (T+S) = 0$

$1 + W_0 T\Delta_0 + W_A SG\Delta_A + W_A W_0 SG\Delta_A\Delta_0 = 0$

$1 + W_0 T\Delta_0 + W_A \Delta_A SG(1 + W_0\Delta_0) = 0$

$|\Delta_A| = |\Delta_0| = |\Delta|$

$-|W_0 T| - |W_A SG| - |W_A W_0 SG| = \frac{1}{|\Delta|}$

$\mu = \left\| \frac{1}{|\Delta|} \right\|_\infty \leq 1$

$\therefore \left\| |W_0 T| - |W_A SG| - |W_A W_0 SG\Delta| \right\|_\infty \leq 1$

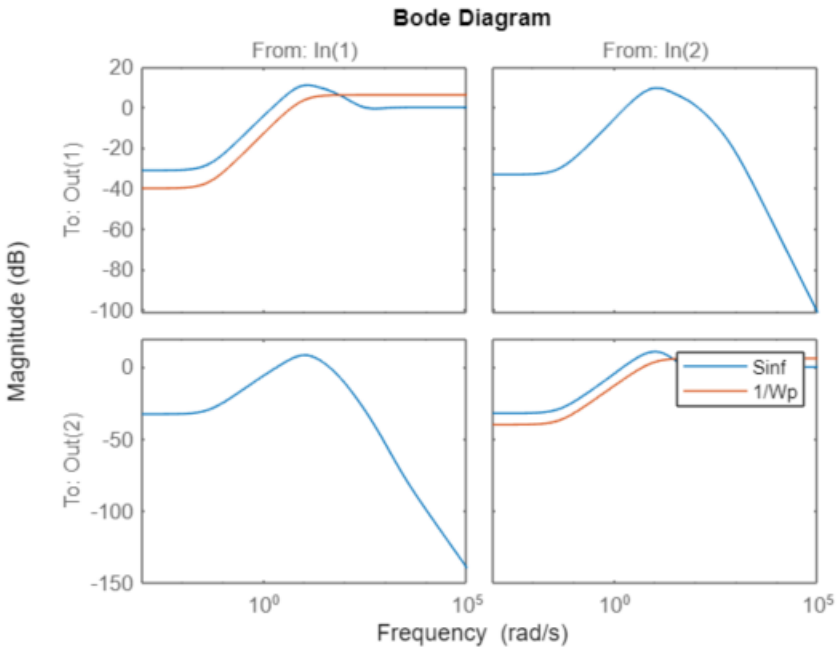
We compute these to get μ

b

```
s = tf("s");
a = ureal('a', 1, 'Percentage', 20);
G = [1/(s+a) 2/(s+3);1/(s+a) 1/(s+a)];
WA = 0.2*((s+100)/10/(s+10))*eye(2);
Wu = (1/50)*eye(2);
Wp = makeweight(100, 5, 1/2)*eye(2);

%fit uncertainty weight
Gunc = usample(G,100);
Gnom = G.NominalValue;
[P,info] = ucover(Gunc,Gnom,2);
Wo = info.W1*eye(2);

systemnames = 'Gnom WA Wp Wu Wo'; %Block name only
inputvar = '[duA{2};duO{2};w{2};u{2}]';
outputvar = '[WA;Wo;Wu;Wp;-w-duO-Gnom]'; %Strangely, the system outputs are just the name
input_to_Gnom = '[u+duA]';
input_to_Wo = '[Gnom]';
input_to_WA = '[-w-duO-Gnom]';
input_to_Wp = '[w+Gnom+duO]';
input_to_Wu = '[u+duA]';
cleanupsysic = 'yes';  %This drops all the useless variables from workspace
P = sysic;
[Kinf,CL,GAM] = hinfsyn(P,2,2);
Sinf = inv(eye(2)+Gnom*Kinf);
bodemag(Sinf, inv(Wp))
legend("Sinf","1/Wp")
```



C

```
delta1 = ultidyn('delta1',[1,1]);
delta2 = ultidyn('delta2',[1,1]);
delta_diag = [delta1 0; 0 delta2];
delta_full = ultidyn('delta_full',[2,2]);
G_struct = (eye(2)+delta_diag*Wo)*Gnom;
G_unstruct = (eye(2)+delta_full*Wo)*Gnom;

%structured uncertainty
systemnames = 'G_struct Wp Wu'; %Block name only
inputvar = '[w{2};u{2}]';
outputvar = '[Wu;Wp;-w-G_struct]'; %Strangely, the system outputs are just the name
input_to_G_struct = '[u]';
input_to_Wp = '[w+G_struct]';
input_to_Wu = '[u]';
cleanupsysic = 'yes';  %This drops all the useless variables from workspace
P_struct = sysic;

N_struct = lft(P_struct, Kinf);
perfmarg_struct = robuststab(N_struct);
mu_struct = 1/perfmarg_struct.LowerBound
```

```
mu_struct = 0.9061
```

```
perfmarg_struct = robustperf(N_struct);
mu_struct = 1/perfmarg_struct.LowerBound
```

```
mu_struct = 5.7586
```

```
%unstructured uncertainty
systemnames = 'G_unstruct Wp Wu'; %Block name only
inputvar = '[w{2};u{2}]';
outputvar = '[Wu;Wp;-w-G_unstruct]'; %Strangely, the system outputs are just the name
input_to_G_unstruct = '[u]';
input_to_Wp = '[w+G_unstruct]';
input_to_Wu = '[u]';
cleanupsysic = 'yes';  %This drops all the useless variables from workspace
P_unstruct = sysic;

N_unstruct = lft(P_unstruct, Kinf);
perfmarg_unstruct = robuststab(N_unstruct);
mu_unstruct = 1/perfmarg_unstruct.LowerBound
```

```
mu_unstruct = 0.9061
```

```
perfmarg_unstruct = robustperf(N_unstruct);
mu_unstruct = 1/perfmarg_unstruct.LowerBound
```

```
mu_unstruct = 5.7593
```