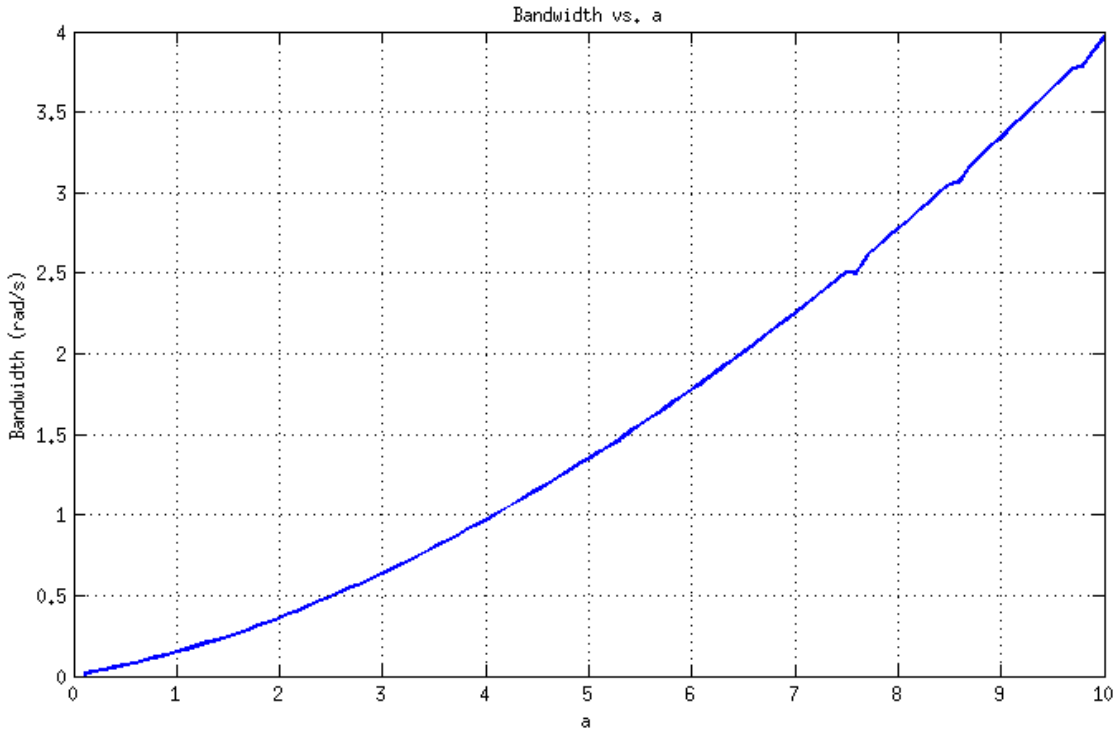
Problem 8.4



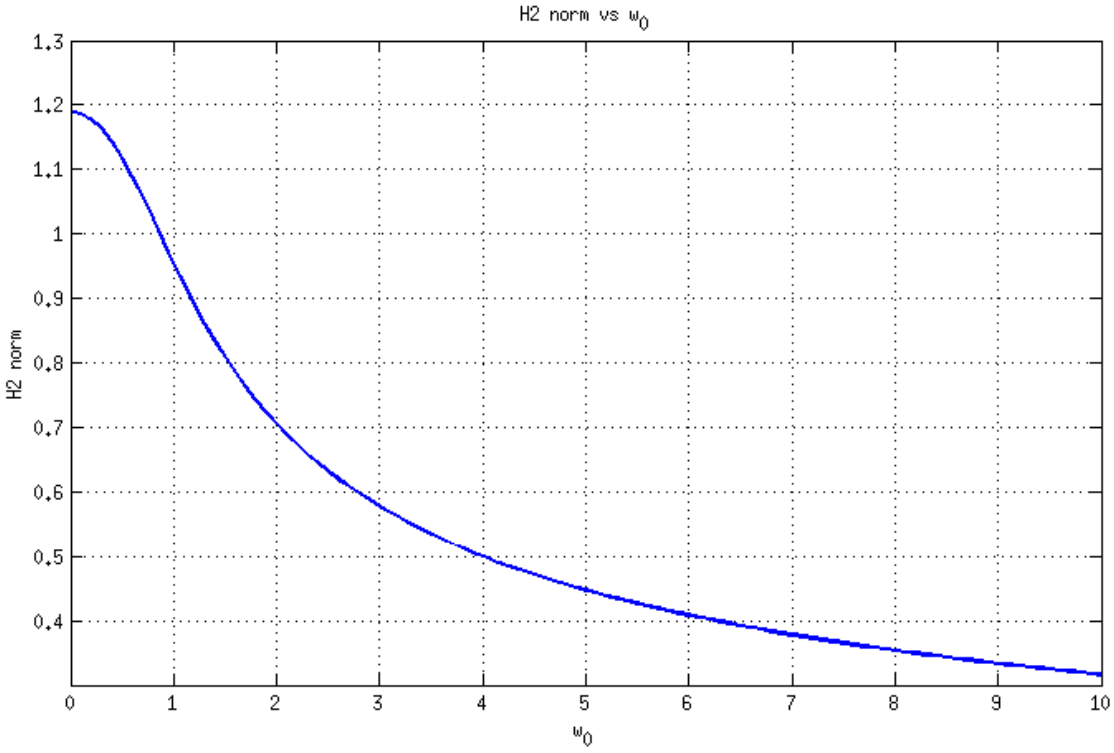
'PS_8_4_bsearch.m'

```
targ = 20;
tol = 1e-3;
avals = [];
wcvals = [];
mindiff = 1e-5;

% loop through range of a's
for a = 0.1:0.3:10
   disp(num2str(a));
   prev_wcval = 0;
   wcval = 10;
   % perform binary search for optimal cutoff frequency
   while(1)
      maxval = PS_8_4(wcval,a);
      if ((abs(wcval-prev_wcval)) < tol)
         wcvals = [wcvals, wcval];
         avals = [avals, a];
         break
      end
      temp = prev_wcval;
      diff = abs(wcval - temp)/2;
      prev_wcval = wcval;
      if (maxval < targ)
         if (diff < mindiff)
            wcval = wcval + mindiff;
         else
            wcval = wcval + diff;
         end
      else
         if (diff < mindiff)
            wcval = wcval - mindiff;
         else
            wcval = wcval - diff;
         end
      end
      %disp(num2str(diff));
      %disp(num2str(wcval));
      disp(num2str(maxval));
   end
end

plot(avals,wcvals)
```

'PS_8_4.m'

```
function maxval = PS_8_4(bw, a)

P0 = tf([1 -a], [1 2 0]);
[Ah, Bh] = butter(3, bw, 'low', 's');
H = tf(Ah, Bh);
W1 = H;
W2 = 0.0001;
r = 0.0001;
P = [W1 -r*W1*P0 -W1*P0;
    0 r*W2*P0 W2*P0;
    0 r*0 r;
    1 -r*P0 -P0];
P_ = minreal(ss(P),[],false);
[K, G] = hinfsyn(P_,1,1);

[K_num, K_den]=ss2tf(K.a,K.b,K.c,K.d);

S_ = P0*tf(K_num,K_den);
S = minreal(S_/(1+S_),[],false);

w = logspace(-2,4,1000);
Sw = squeeze(freqresp(S,j*w));
Sens = (abs(1-Sw));
maxval = max(Sens);
```

Problem 8.5



'PS_8_4.m'

```
w0_vals = [];
H2_vals = [];

for w0 = 0:0.1:10
  A = [0 -w0^2;
      1 0];
  B1 = [1 0;
      0 0];
  B2 = [0;
      0];
  B = [B1 B2];

  C1 = [0 1];
  C2 = [0 1];
  C = [C1;
      C2];

  D11 = [0 0];
  D12 = -1;
  D21 = [0 1];
  D22 = 0;
  D = [D11 D12; D21 D22];

  L = [-1; -1];

  Af = A + L * C2;
  Bf = -L;
  Cf = C2;
  Df = 0;
  [num_H0, den_H0] = ss2tf(Af, Bf, Cf, Df);
  H0 = tf(num_H0, den_H0);

  As = A + L*C2;

  Bs1 = B1 + L*D21;
  Bs2 = B2;
  Bs = [Bs1 Bs2];

  Cs1 = C1;
  Cs2 = C2;
  Cs = [Cs1; Cs2];

  Ds11 = D11;
```

```
  Ds12 = D12;
  Ds21 = D21;
  Ds22 = D22;
  Ds = [Ds11 Ds12; Ds21 Ds22];

  P = ss(As, Bs, Cs, Ds);

  K = h2syn(P,1,1);
  [num_K, den_K] = ss2tf(K.a,K.b,K.c,K.d);
  Hs = minreal(tf(num_K, den_K));

  P0 = minreal(tf(1, [1 0 w0^2]));
  H = minreal(H0+Hs*(1-H0));
  G = minreal([P0-P0*tf(minreal(H)) -tf(minreal(H))]);
  G = tf(minreal(ss(G)));
  H2 = norm(G,2);

  w0_vals = [w0_vals, w0];
  H2_vals = [H2_vals, H2];
end

figure()
plot(w0_vals, H2_vals);
```