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% Problem 2 part (a)
% Char. eqn. is  $s^2+(K-1)s+K=0$   $\implies K > 1$  for stability when  $h=0$ ;

% part (b)
% for  $h=0$  and each fixed  $K > 1$ ,  $DM(K) = (2\text{atan}(k)-\pi/2) / K$ 
K=linspace(1,20,1000);
for n=1:length(K)
    DM(n)=(2*atan(K(n))-pi/2)/K(n);
end
figure(1)
plot(K,DM)
[h_max,nn]=max(DM)
Kopt=K(nn)

% part (c)
% we need to find the feasible K values so that  $DM > h\_max/2$ 
% Figure 2 shows these values as the crossing points of the
%  $DM(K)$  versus  $K$ , and  $DM=h\_max/2$  lines

figure(2)
plot(K,DM)
axis([1, 20, h_max/2 , h_max])
% zooming on this plot we see that minimum K allowable is 1.22
% and the maximum allowable K is 8.12 for any fixed K in this interval
%  $\text{inv}(GM\_low) = K/1.22$ , and  $GM\_upper = 8.12/K$ , minimum of the two is
% maximized when they are equal, i.e.  $K/1.22 = 8.12/K \implies$ 
K_part_c= sqrt(8.12*1.22)
% the answer is  $K=3.1474$ 

% part (d)
% for  $K= 3.1474$  the  $DM(K)$  is equal to 0.3036 (zooming on Figure 2)
% thus the actual delay margin is  $0.3036 - h\_max/2 = 0.1404$ 

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