Chapter 13: Control theory: analysis

chapter13_Intro_ second_order Analysis in the Frequency Domain for Introduction to second order

```
% Onwubolu, G. C.
% Mechatronics: Principles & Applications
% Elsevier
%
% Mechatronics: Principles & Applications Toolbox Version 1.0
% Copyright © 2005 by Elsevier
%
% Chapter 13: Analysis in the Frequency Domain
%
%Introduction to second order    MATLAB's calculating power is greatly
enhanced
%using the Symbolic Math Toolbox. In this example we demonstrate its power
by
%calculating the peak, settling, and rise times and
%overshoot for second-degree systems
%a=25;
%b=225;
a=input('Coefficient of middle term of denominator: a  '); %input from keyboard
b=input('Last term of denominator: b  '); %input from keyboard

%computation commences
Wn=sqrt(b) %speed
Zeta=a/(2*Wn) %Damping factor
%classification
if Zeta<1
   'System is underdamped'
end;

if Zeta==1
   'System is critically damped'
end;

if Zeta>1
   'System is overerdamped'
end;

%interpolation for value of Zeta from a Table
if (0.1<=Zeta & Zeta<0.2)
   Tn=1.104+((1.203-1.104)/0.1)*(Zeta-0.1)
end;

if (0.2<=Zeta & Zeta<0.3)
   Tn=1.203+((1.321-1.203)/0.1)*(Zeta-0.2)
end;
```

```
if (0.3<=Zeta & Zeta<0.4)
    Tn=1.321+((1.463-1.321)/0.1)*(Zeta-0.3)
end;

if (0.4<=Zeta & Zeta<0.5)
    Tn=1.463+((1.638-1.463)/0.1)*(Zeta-0.4)
end;

if (0.5<=Zeta & Zeta<0.6)
    Tn=1.638+((1.854-1.638)/0.1)*(Zeta-0.5)
end;

if (0.6<=Zeta & Zeta<0.7)
    Tn=1.854+((2.126-1.854)/0.1)*(Zeta-0.6)
end;

if (0.7<=Zeta & Zeta<0.8)
    Tn=2.126+((2.467-2.126)/0.1)*(Zeta-0.7)
end;

if (0.8<=Zeta & Zeta<0.9)
    Tn=2.467+((2.883-2.467)/0.1)*(Zeta-0.8)
end;

'peak time'
Tp=pi/(Wn*sqrt(1-Zeta^2)) %peak time
'settling time'
Ts=4/(Wn*Zeta) %settling time
'rise time'
Tnormal=Tn %from interpolation
Tr=Tnormal/Wn %rise time
'%OS'
OS=exp(-Zeta*pi/sqrt(1-Zeta^2))*100 %percentage overshoot
'Finished computation'
% This generates response for second order system
%clear
T = 0:20; %T=Wn*t
%y = 1-(exp(-Zeta*Wn*t)/sqrt(1-Zeta^2))*cos(Wn*sqrt(1-Zeta^2)*t-phi);
ang=sqrt(1-Zeta^2);
factor=cos(ang*T)+(Zeta/ang)*sin(ang*T)
y = 1-exp(-Zeta*T')*factor;
plot(T,y,'+')
```