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%                               Hand-out
%                               Advanced Vibrations
% Free response of a 3 DOF system
m1=2;m2=1;m3=1.5;                %define masses
k1=150;k2=100;k3=80;k4=25;      %define stiffnesses

m=[m1 0 0; 0 m2 0; 0 0 m3];
k=[k1+k2+k4 -k2 -k4; -k2 k2+k3 -k3; -k4 -k3 k3+k4];

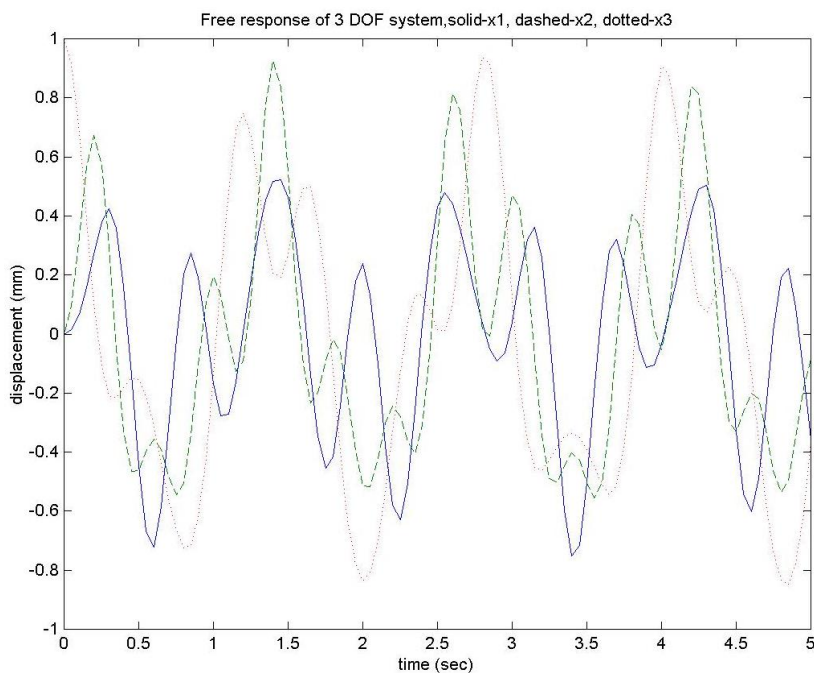
invmk=inv(m)*k;                  % inverse of m times k
[p d]=eig(invmk);                % d stores eigenvalues, p stores eigenvectors

for i=1:3                          % find natural frequencies
    wn(i)=sqrt(d(i,i))
end
p(:,1)=p(:,1)/p(1,1);             % normalize the eigenvectors
p(:,2)=p(:,2)/p(1,2);
p(:,3)=p(:,3)/p(1,3);

p
p'*m*p;                           % check orthogonality
p'*k*p;
x0=[0 0 1]';dx0=[0 0 0]';        % initial conditions
y0=inv(p)*x0                       % transform xo, dx0 to y0, dy0
dy0=inv(p)*dx0
%compute the responses
t0=0;tf=5.;dt=.05;nn=round((tf-t0)/dt)+1;
temp=t0;
for i=1:nn
    for j=1:3
        y(j)=y0(j)*cos(wn(j)*temp)+dy0(j)*sin(wn(j)*temp)/wn(j);
    end
    t(i)=temp;
    temp=temp+dt;
    x(:,i)=p*y';
end

plot(t,x(1,:),t,x(2,:),t,x(3,:), '--',t,x(3,:), ':')
title('Free response of 3 DOF system,solid-x1, dashed-x2, dotted-x3');
xlabel('time (sec)');
ylabel('displacement (mm)');

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wn =
    15.6421    11.0391     4.5783

p =
    1.0000    1.0000    1.0000
   -2.2948    0.5291    1.7657
    0.6053   -0.8655    2.2602

y0 =
    0.1162
   -0.3814
    0.2653

dy0 =
    0
    0
    0

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