```
%                   Advanced Vibrations
% Free response of a unrestricted 3 DOF system
clc;
m1=100;m2=100;m3=100;            %define masses
k1=0;k2=1;k3=1;k4=0;   %define stiffnesses
x0=[0 0 0]';dx0=[1 0 0]';    % initial conditions
m=[m1 0 0; 0 m2 0; 0 0 m3];
k=[k1+k2+k4 -k2 -k4; -k2 k2+k3 -k3; -k4 -k3 k3+k4];

invvmk=inv(m)*k;              % inverse of m times k
[p d]=eig(invvmk);            % 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);
y0=inv(p)*x0                  % transform xo, dx0 to y0, dy0
d1=diag(wn);d1(1,1)=1;v1=p*d1;
dy0=inv(v1)*dx0
%compute the responses
t0=0;tf=80.;dt=.05;nn=round((tf-t0)/dt)+1;
temp=t0;
for i=1:nn
    y=[0 0 0]';
    y(1)=y0(1)+dy0(1)*temp;
  for j=2:3
     y(j)=y0(j)*cos(wn(j)*temp)+dy0(j)*sin(wn(j)*temp);
  end
  t(i)=temp;
  temp=temp+dt;
% p(:,1)=0
  x(:,i)=p*y;
end
plot(t,x(1,:),'k',t,x(2,:),'--',t,x(3,:),':k')
title('Free response of 3 DOF system,solid-x1, dashed-x2, dotted-x3');
xlabel('time (sec)');
ylabel('displacement (mm)');
```