HW: 3
Due Date: 16.10.2003

1) Proof that $\phi_j^T [M] \phi_i = 0$ and $\phi_j^T [K] \phi_i = 0$ for $i \neq j$ where $\phi_i$ is the $i$th eigenvector (modeshape) corresponding to the $i$th eigenvalue (square of the natural frequency of vibration, $\omega$), and $K$ and $M$ are the stiffness and mass matrices, respectively.

2) You have written a simulation program in HW No:2. Now modify it to become a function as follows

```matlab
function [u,ud,udd] = resp(T,ksi ,p, t, u0, ud0)
//RESP Numerical integration procedure by use of the Newmark Beta method
//
//Usage [u,ud,udd] = resp(T,ksi ,p, t, u0, ud0)
//
// Outputs u, ud, udd are the relative displacement, velocity and acceleration responses, respectively.
//
// Input T is the system period, ksi is the system damping ratio, p is a row vector of applied forces, t is the corresponding time vector, and u0 and ud0 are the initial conditions for displacement and velocity, respectively.
//
//Author <Here comes your Name>
//Last Modified <Date>

m =1;  // mass equals to unity.

---
Add your program here and change your variable names to match the input and output variables

---
```

Now write a sci-file that makes calls to this function to evaluate the maximum responses for a given natural period of vibration, damping ratio, etc. as follows

```matlab
---
[u,ud,udd]=resp(T,ksi ,p, t, u0, ud0);
---
```

Repeat the call to the function for a range of $T$ values that would be enough to plot a response spectrum for the 1999 Gebze Earthquake. Use a damping ratio of 0.02 for all cases. (Check your computer code by running it for the 1940 El Centro Earthquake. The response spectrum for this Earthquake is available in all text books.)

3) Comment on stability and computational error that may arise due to numerical integration.