

**QE Topics List: *Structural Dynamics***  
**October 2003**

**General**

**Formulation of equations of motion**  
**Idealization of a structure to a system (model) with finite number of degrees of freedom**  
**Time-domain methods**  
**Types of dynamic loading**

**Single Degree-of-Freedom Systems**

**Free vibration of SDOF systems:**

- undamped systems; viscous-damped systems
- experimental determination of fundamental frequency and damping ratio
- critical damping
- gravity effects; support excitation

**Response of SDOF systems to harmonic excitation:**

- response of undamped systems; response of viscous-damped systems
- basic theory of accelerometers
- vibration isolation
- use of frequency response data (transfer functions) to determine fundamental frequency and damping ratio for underdamped systems
- equivalent viscous damping for inelastic systems

**Response of SDOF systems to general excitations:**

- response of viscous-damped SDOF systems to step and impulsive inputs
- approximate analysis for short duration load
- solution of equations of motion by Duhamel's integral

**Direct numerical integration of equations of motion:**

- explicit and implicit methods – central difference; Newmark's methods
- accuracy and stability analysis of time-integration algorithms

**Response spectrum concepts w/ emphasis on shock, earthquake, and blast loading:**

- elastic response spectra and peak response
- shock spectra

**Multi-Degree-of-Freedom System**

**Mathematical models of MDOF systems:**

- generalized coordinates
  - assumed modes method
  - stiffness, lumped mass, and consistent mass formulations

**Free vibration of MDOF systems:**

- natural frequencies and mode shapes – the eigenvalue problem
- orthogonality of mode shapes
- mode-superposition method