CE-227 Midterm 1

3 Linear Response

General

- **Pseudo acceleration**: absolute acceleration of a SDF system with $\zeta = 0$.
- **Spetral displacement**: *relative* displacement.
- **Viscous Damping**:
- **DBE** $= \frac{2}{3} MCE_R$
- MCE_R: roughly 2% exceedance in 50 yrs (ASCE 7).

ASCE 7 Design Spectrum

Damping Effects

~~Use in Design~~

4 Nonlinear Response

General

$$R = \frac{f_{el}}{f_y} \qquad \gamma = \frac{\Delta_{max}}{\Delta_{el}} \qquad \mu = \frac{\Delta_{max}}{\Delta_y}$$

Generation

Trends

Code

~~Effects on response~~

5 - Nonlinear SDOF Analysis

5.1 Nonlinear RSA

ASCE 7

5.2 Equivalent Linearization

Iterative process where Δ_{max} is used to find $[K, \zeta]_{eff}$.

Used for base-isolated structures.

1. Apply P, obtain V_{base} (Pushover analysis)
2. Use T_0 and ζ find $\Delta_i = Sa(T_0, \zeta)T_0$

5.3 Capacity Spectrum

1. Guess ζ, find

5.4 Coefficient Method (ASCE 41)

$\delta_t = C_0 C_1 C_2 S_a \frac{T_e^2}{4\pi^2} g$

- C_o: converts SDOF spectral displacement to MDOF roof displacement
- C_1: amplification for nonlinear response of bilinear system
- C_2: amplification for pinched hysteresis, stiffness degradation, and strength deterioration
- $T_\text{e} = T_\text{initial} \sqrt{\text{k}_\text{i}/\text{ke}}$

$\mu_\text{strength} = \frac{S_a^e}{V_y/w} C_m$

$R_\text{max} = \mu_\text{max} = \frac{\Delta_d}{\Delta_y} + \frac{|\alpha_e|^{-h}}{4}$

$h = 1 + 0.15 \ln T_e$

$\alpha_e = \alpha_{P-\Delta} + \lambda\left(\alpha_2 - \alpha_{P-\Delta}\right)$

$\lambda = \begin{matrix} 0.8 \text{ if } S_{X1} \geq 0.6 \\ 0.2 \text{ if } S_{X1} \leq 0.6 \end{matrix}$

6 - MDOF Analysis

1. Linear Static

ELF (ASCE 7)

2. Linear Dynamic

Modal RSA

3. Nonlinear Static

1. Nonlinear RSA
2. Equivalent Linearization
3. Capacity Spectrum
4. Coefficient Method (ASCE 41)