Notation for Structural Dynamics:

ω = undamped natural frequency (circular) = $2\pi f$
ω_d = damped natural frequency
ω_o = frequency of forcing function (steady-state)

	Displacement	Velocity	Acceleration
Absolute	x	$\dot{x}$	$\ddot{x}$
Relative	x^*	$\dot{x}^*$	$\ddot{x}^*$
Ground	x_g	$\dot{x}_g$	$\ddot{x}_g$

	Absolute	Relative
Displacement Response Spectrum	S_D	S_D^*
Velocity Response Spectrum	S_V	S_V^*
Acceleration Response Spectrum	S_A	S_A^*
Pseudo Displacement Response Spectrum	S_{PD}	S_{PD}^*
Pseudo Velocity Response Spectrum	S_{PV}	S_{PV}^*
Pseudo Acceleration Response Spectrum	S_{PA}	S_{PA}^*

Piecewise Constant Recurrence Formulas - Ground Acceleration:

$$x_i^* = e^{-\xi\omega\Delta t_i}\left[x_{i-1}^* \cos\omega_d\Delta t_i + \frac{\dot{x}_{i-1}^* + \xi\omega x_{i-1}^*}{\omega_d}\sin\omega_d\Delta t_i\right] + \frac{\ddot{x}_{g_i}}{\omega^2}\left[1 - e^{-\xi\omega\Delta t_i}(\cos\omega_d\Delta t_i + \frac{\xi\omega}{\omega_d}\sin\omega_d\Delta t_i)\right]$$

$$\frac{\dot{x}_i^*}{\omega_d} = e^{-\xi\omega\Delta t_i}\left[\begin{array}{l} -x_{i-1}^* \sin\omega_d\Delta t_i + \frac{\dot{x}_{i-1}^* + \xi\omega x_{i-1}^*}{\omega_d}\cos\omega_d\Delta t_i - \\ \frac{\xi\omega}{\omega_d}\left(x_{i-1}^*\cos\omega_d\Delta t_i + \frac{\dot{x}_{i-1}^* + \xi\omega x_{i-1}^*}{\omega_d}\sin\omega_d\Delta t_i\right)\end{array}\right] + \frac{\ddot{x}_{g_i}}{\omega^2}e^{-\xi\omega\Delta t_i}\left[1 + \left(\frac{\xi\omega}{\omega_d}\right)^2\sin\omega_d\Delta t_i\right]$$

$$\ddot{x}_i = -2\xi\omega\dot{x}_i^* - \omega^2 x_i^*$$