The response of a single degree-of-freedom (SDOF) oscillator to ground shaking can be calculated by numerically integrating the Duhamel Integral (see link below for further explanation).

http://richardson.eng.ua.edu/Former_Courses/EQ_Eng_fa05/Notes/Response_Spectra.pdf

The process of calculating a response spectrum is illustrated below. Let’s say we have an earthquake ground acceleration record with a maximum ground acceleration of 0.3 g. Let’s also say that we assume the damping of our SDOF oscillator is 5%. We first set the period of the oscillator to 0.2 seconds and calculate its response to the ground shaking, shown in Figure 1(a). It’s maximum is observed to be 0.8g. We repeat the process for an oscillator period of 0.5 seconds, and for an oscillator period of 1.0 seconds, and observe the maximum responses indicated in Figure 1(b) and 1(c).

Figure 1. Maximum responses of SDOF oscillator to earthquake ground motion
A plot of the maximum oscillator responses versus oscillator periods is shown in Figure 2. Note that the oscillator response is equal to the ground acceleration for the shortest period, and drops below the ground acceleration toward zero for very large periods. If this process is repeated for different earthquakes, an average spectra can be developed similar to Figure 3.

![Figure 2. Maximum Responses of Oscillator in Figure 1](image1.png)

The design spectra shown below is from ASCE 7. It is defined by two spectral accelerations: $S_{DS}$ and $S_{DL}$, which in turn are calculated using expected maximum spectral acceleration maps and the soil conditions at the site.

![Figure 3. ASCE 7 Design Response Spectra](image2.png)