SHOCK AND VIBRATION RESPONSE SPECTRA COURSE
Unit 7E. dB/octave Slopes

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Introduction

NAVMAT P-9492 gives the power spectral density specification shown in Figure 1.

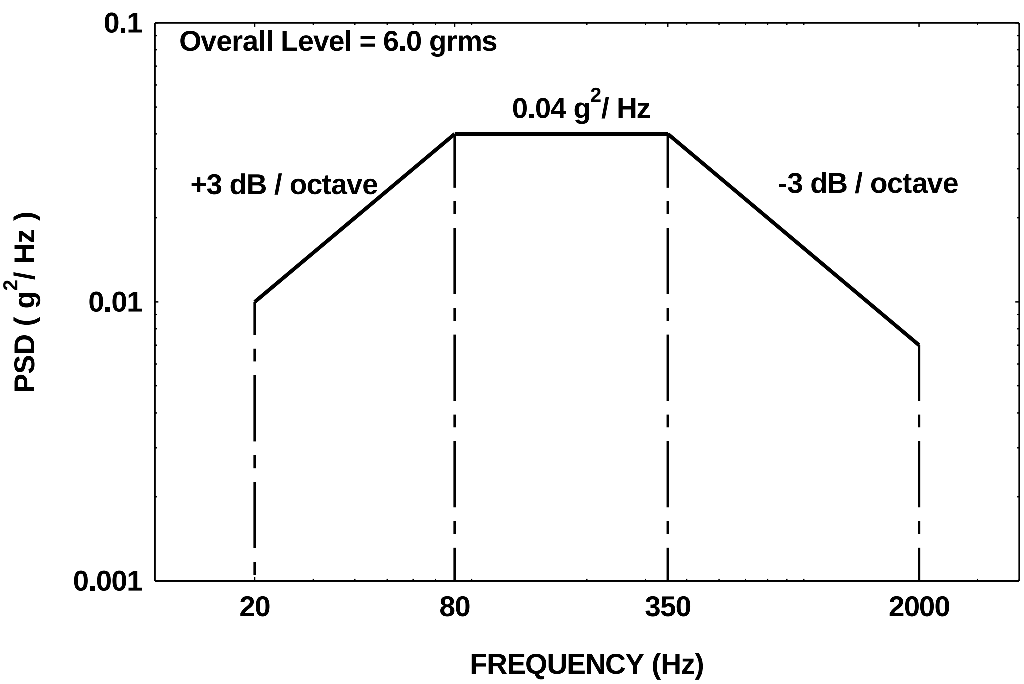

Figure 1.

The task is to determine the coordinates of the endpoints.

Derivation

Assume that a_1 and a_2 each has an amplitude in G^2/Hz. The difference in dB between a_1 and a_2 is

$$\Delta dB = 10 \log \left[\frac{a_2}{a_1} \right] \quad (1)$$

Furthermore,

$$a_2 = a_1 \left[10^{\Delta dB/10} \right] \tag{2}$$

Additional equations are needed.

The slope N between two coordinates (f_1, a_1) and (f_2, a_2) in a log-log plot is

$$N = \frac{\log\left[\frac{a_2}{a_1}\right]}{\log\left[\frac{f_2}{f_1}\right]} \tag{3}$$

Solve for a_2 .

$$N \log\left[\frac{f_2}{f_1}\right] = \log\left[\frac{a_2}{a_1}\right] \tag{4}$$

$$\log\left\{\left[\frac{f_2}{f_1}\right]^N\right\} = \log\left[\frac{a_2}{a_1}\right] \tag{5}$$

Take the anti-log.

$$\left[\frac{f_2}{f_1}\right]^N = \left[\frac{a_2}{a_1}\right] \tag{6}$$

$$\left[\frac{a_2}{a_1}\right] = \left[\frac{f_2}{f_1}\right]^N \tag{7}$$

Thus,

$$a_2 = a_1\left[\frac{f_2}{f_1}\right]^N \tag{8}$$

Now consider a one-octave frequency separation.

$$f_2 = 2 f_1 \tag{9}$$

Substitute equation (9) into (3).

$$N = \frac{\log\left[\frac{a_2}{a_1}\right]}{\log[2]} \tag{10}$$

Substitute equation (1) into (10).

$$N = \frac{\Delta dB / 10}{\log[2]} \tag{11}$$

Note that ΔdB represents the dB/octave slope in equation (11). Again, equations (10) and (11) assume a one-octave frequency separation.

Now substitute equation (11) into (8).

$$a_2 = a_1 \left[\frac{f_2}{f_1}\right]^{\left\{\frac{\Delta dB / 10}{\log[2]}\right\}} \tag{12}$$

<u>Example</u>

Calculate the amplitude at 2000 Hz for the power spectral density in Figure 1.

Note

$f_1 =$ 350 Hz

$f_2 =$ 2000 Hz

$a_1 =$ 0.04 G^2 / Hz

$$a_2 = 0.04\ G^2 / Hz \left[\frac{2000\ Hz}{350\ Hz}\right]^{\left\{\frac{-3\ dB / 10}{\log[2]}\right\}} \tag{13}$$

$$a_2 = 0.007 \ G^2 / Hz \quad (14)$$

Homework

1. Calculate the amplitude at 20 Hz for the power spectral density curve in Figure 1.

2. Calculate the overall GRMS value for the power spectral density curve in Figure 1. Use program psdint.exe. Give the answer to two decimal places.