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DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING

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Introduction to Acoustics and Noise

Homework 3

I. Spectral Density in White and Pink Noise

For sound in a frequency band Δf, the spectral density is defined as

$$I_f(f) = \lim_{(\Delta f)\to 0} \frac{I_b}{(\Delta f)}, \qquad (1)$$

where I_b is the average sound intensity in a frequency band Δf centered at f. This definition allows us to define the average sound intensity in a finite frequency band $\{f_1, f_2\}$ by

$$I_b = \int_{f_1}^{f_2} I_f df. \qquad (2)$$

1. For a one-octave band centered at $1000Hz$, find the lower and upper limits f_1 and f_2, respectively.
2. A white noise is an idealized model for sound with constant spectral density. The intensity of a one-octave band of sound centered at $1000Hz$ is equal to $85dB$. How does this intensity vary with the band center frequency f_c? What is the sound level of a one-octave band centered at $f_c = 250$.
3. A pink noise is an idealized model for sound with a spectral density $\propto 1/f$. If again the intensity of a one-octave band of sound centered at $1000Hz$ is equal to $85dB$, how does this intensity vary with the band center frequency f_c? What is the sound level of a one-octave band centered at $f_c = 250$.

II. Sound Transmission Through a Wall

The intensity transmission coefficient for sound at a frequency ω through a wall of thickness $L = o.1m$ separating air and water is given by

$$T_I = \frac{4}{2 + (r_3/r_1 + r_1/r_3)cos^2 k_2 L + (r_2^2/r_1 r_3 + r_1 r_3/r_2^2)sin^2 k_2 L}, \tag{3}$$

ere $k_2 = \omega/c_2$.

1. Plot T_I versus the frequency f in Hz and particularly show what happened when $k_2 L \approx n\pi$ and $k_2 L \approx (n - \frac{1}{2})\pi$.
2. Estimate the narrow band of frequencies when $k_2 L \approx n\pi$ and $k_2 L \approx (n - \frac{1}{2})\pi$.