EEE1023, Electronics 3, lecture 15: Solutions to worked examples

Slide ref. [0.14]

1.(a) $I = \frac{W_0}{4\pi r^2}$ $\qquad I = \frac{p_{rms}^2}{\rho_0 c}$ [N.7] [N.6]

$$p_{rms,1} = \sqrt{\frac{W_1 \rho_0 c}{4\pi r_1^2}} = \sqrt{\frac{1 \times 1.22 \times 340}{4\pi \times 1^2}} \approx 5.75 \text{ Pa}$$

$$SPL_1 = 10 \log_{10}\left(\frac{5.75^2}{(2\times10^{-5})^2}\right) \approx 109.2 \text{ dB} \quad [N.8]$$

$$\bar{p}_{rms} = p_{rms,1} + p_{rms,2} = 2 \times 5.75 = 11.5 \text{ Pa} \quad [0.7]$$

$$\bar{p}_{rms}^2 = (11.5)^2 = 132.0 \text{ Pa}^2 \Leftrightarrow \overline{SPL} = 115.2 \text{ dB} \quad [N.8]$$

(b) $\bar{p}_{rms}^2 = p_{rms,1}^2 + p_{rms,2}^2 = 66.0 \text{ Pa}^2$ [0.7]

$\overline{SPL} = 112.2 \text{ dB}$ [N.8]

2. $f \leq f_{crit} = \frac{c}{\lambda_{crit}} = \frac{c}{2D} = \frac{340}{1.7} = 200 \text{ Hz}$ [0.9]

3. $\delta r = 0.68 \text{m}$ [0.11]

$\delta\phi = \omega\, \delta t = 2\pi f \frac{\delta r}{c}$

(a) $\delta\phi = 2\pi \times 500 \times \frac{0.68}{340} = 2\pi$ or one period (in phase)

(b) $\delta\phi = 2\pi \times 750 \times \frac{0.68}{340} = 3\pi$ or $1\frac{1}{2}$ periods (anti phase)

4. Re-arranging Snell's Law

$$\theta_2 = \sin^{-1}\left(\frac{c_2}{c_1}\sin\theta_1\right) = \sin^{-1}\left(\frac{1500}{1450}\sin 60^\circ\right) = 63.6^\circ \quad [0.12]$$

The sound bends away from the normal at the interface.

PJ, 2012