1. $p(x,t) = \hat{p}_i e^{i(\omega t - kx)} + \hat{p}_r e^{i(\omega t + kx)} = 2\hat{p}_i \cos kx\, e^{i\omega t}$ $L_i = 10 \log \frac{\tilde{p}_i^2}{p_{ref}^2}$

$$\tilde{p}^2(x) = 4\cos^2 kx \frac{1}{T}\int_0^T (\hat{p}_i^2 e^{i\omega t})\, dt = 4\left(\frac{1}{2} + \frac{1}{2}\cos 2kx\right)\tilde{p}_i^2 = 2\tilde{p}_i^2(1 + \cos 2kx)$$

a) $x = 0 \Rightarrow \tilde{p}^2 = 2\tilde{p}_i^2 \cdot 2 \Rightarrow L = L_i + 6\,dB = 56\,dB$

b) $x = \frac{\lambda}{2} \Rightarrow \tilde{p}^2 = 2\tilde{p}_i^2(1 + \cos 2\frac{k\lambda}{2}) = 2\tilde{p}_i^2(1 + \cos 2\pi) = 4\tilde{p}_i^2 \Rightarrow L = 56\,dB$

c) $x = \frac{\lambda}{4} \Rightarrow \tilde{p}^2 = 2\tilde{p}_i^2(1 + \cos \pi) = 0 \Rightarrow L = -\infty$

d) $x = \lambda \Rightarrow \tilde{p}^2 = 2\tilde{p}_i^2(1 + \cos 2\pi) = 0 \Rightarrow L = 56\,dB$

e) $x = \frac{\lambda}{6} \Rightarrow \tilde{p}^2 = 2\tilde{p}_i^2(1 + \cos 2\frac{k\lambda}{6}) = 2\tilde{p}_i^2(1 - 0{,}5) = \tilde{p}_i^2 \Rightarrow L = 50\,dB$

2. $x = 0{,}25$

motfas om $x = \frac{\lambda}{4} + \frac{n\lambda}{2} = \lambda\left(\frac{1}{4} + \frac{n}{2}\right)$ $f = \frac{c}{\lambda} = \frac{c}{x}\left(\frac{1}{4} + \frac{n}{2}\right) =$

$340 + 680 \cdot n$ Hz

3. $f_{n_x n_y} = \frac{c}{2}\sqrt{\left(\frac{n_x}{L}\right)^2 + \left(\frac{n_y}{B}\right)^2}$

$f_{10} = \frac{340}{2} \cdot \frac{1}{2{,}8} = 60{,}7$ Hz

$f_{01} = \frac{340}{2} \cdot \frac{1}{1{,}65} = 103$ Hz

$f_{11} = \frac{340}{2}\sqrt{\left(\frac{1}{2{,}8}\right)^2 + \left(\frac{1}{1{,}65}\right)^2} = 120$ Hz

$f_{2,0} = \frac{340}{2}\sqrt{\left(\frac{2}{2{,}8}\right)^2 + \frac{0}{1{,}65^2}} = 121$ Hz

$f_{2,1} = \frac{340}{2}\sqrt{\left(\frac{2}{2{,}8}\right)^2 + \left(\frac{1}{1{,}65}\right)^2} = 159$ Hz

4 a) $t = \dfrac{2}{1+\frac{Z_1}{Z_2}} \approx 2$ $\qquad r = \dfrac{1-\frac{Z_1}{Z_2}}{1+\frac{Z_1}{Z_2}} \approx 1$

b) $t = \dfrac{2}{1+1} = 1$ $\qquad r = \dfrac{1-1}{1+1} = 0$

c) $t = \dfrac{2}{1+0{,}5} = 1{,}33$ $\qquad r = \dfrac{1-0{,}5}{1+0{,}5} = 0{,}33$

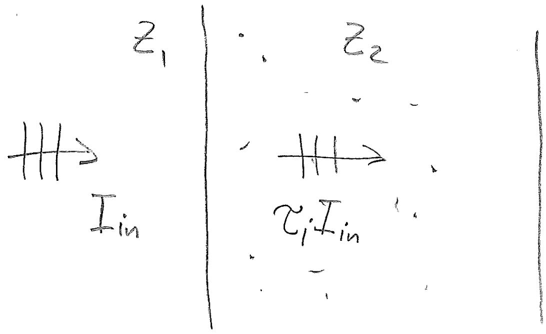
5 a) $\tau = \dfrac{4\frac{Z_2}{Z_1}}{\left(1+\frac{Z_2}{Z_1}\right)^2} = 1{,}12 \cdot 10^{-3}$ $\qquad \Delta L = L_t - L_i = 10\log\dfrac{I_t}{I_{ref}} - 10\log\dfrac{I_i}{I_{ref}} =$

$$= 10\log\frac{I_i \cdot \tau}{I_i} = 10\log\tau = -30\,\mathrm{dB}$$

b) $\rho = 1 - \tau - \underbrace{\alpha}_{=0} = 1 - 1{,}12\cdot 10^{-3} \approx 1$ $\qquad L_{refl} \approx L_{in}$

6. $Z_2 = \rho c = \rho\sqrt{\dfrac{E'}{\rho}} = \sqrt{E\rho'} = 7{,}7\cdot 10^{6}\ \dfrac{\mathrm{Pa}\cdot\mathrm{s}}{\mathrm{m}}$

a) $\tau_1 = \dfrac{4\frac{Z_2}{Z_1}}{\left(1+\frac{Z_2}{Z_1}\right)^2} = 2{,}15\cdot 10^{-4}$ $\qquad \tau_2 = \dfrac{4\frac{Z_1}{Z_2}}{\left(1+\frac{Z_1}{Z_2}\right)^2} = 2{,}15\cdot 10^{-4}$



$\tau_2 \cdot (\tau_1 I_{in}) = \tau_{tot} I_{in}$

$\tau_{tot} = \tau_1 \tau_2 = 6{,}4\cdot 10^{-8}$

b) $\rho = 1 - \tau \approx 1$