Exam Acoustics 2010

1 a) $\frac{\partial^2 \sigma}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 \sigma}{\partial t^2} = 0$, $c = \sqrt{\frac{E}{\rho}} = 5064$ m/s

b) $\sigma(x,t) = \hat{\sigma} e^{i(\omega t - kx)}$ insert in wave eqn.!

c) $t_1 = \frac{L}{c} = 0{,}20$ ms is no 1

d) no2: $t_2 = t_1 + \frac{2L}{c} = t_1 + 0{,}40$ ms is the first reflex

no3: $t_3 = t_2 + \frac{2L}{c} = t_2 + 0{,}40$ ms is the second reflex

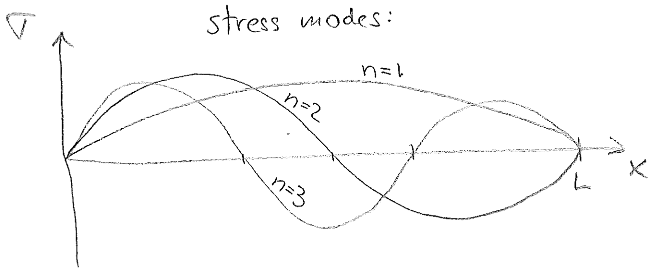
e) Knocking at the end ⇒ longitudinal wave ⇒ only sound emission at the ends

Knocking on the middle ⇒ bending wave ⇒ sound emission from the sides: loud!

2. a) Eigenfrequencies or resonance frequencies.

b) $f_n = \frac{c \cdot n}{2L} = 2470$ Hz, 4940 Hz and 7410 Hz $(n=1,2,3)$

c) $\lambda_n = \frac{c}{f_n} = \frac{2L}{n} = 2{,}05$ m, 1,025 m and 0,68 m

d) 

e) We will have maximum displacement at the ends, zero displ. in the middle of the rod.

3. a) Nyquist criteria: you need to sample with twice the frequency in the signal ⇒ $f_s = 2 \cdot 7410 = 14820$ Hz

b) Plot 2 is the frequency spectrum of plot 1, from the (fast) Fourier transform

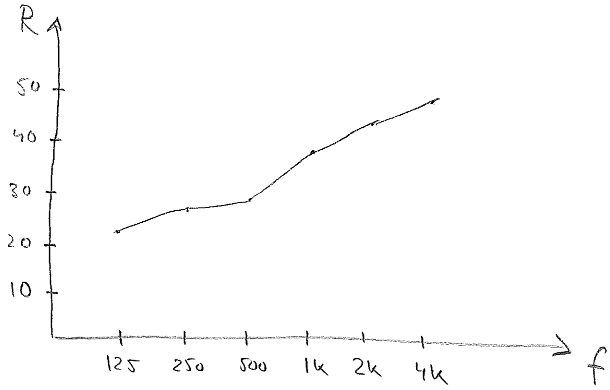
4. $L_{p2} = 10\log\left(10^{L_m/10} + 10^{\frac{L_{p0}}{10}}\right)$

$\Rightarrow L_m = 10\log\left(10^{\frac{L_{p2}}{10}} - 10^{\frac{L_{p0}}{10}}\right)$

$A = 0{,}16\,\frac{V}{T_{60}}$

$R = L_{p1} - L_m + 10\log\left(\frac{S}{A}\right)$

f	125	250	500	1k	2k	4k
L_{p1}	90	90	90	90	90	90
L_{p2}	70	65	60	52	46	40
L_{p0}	65	60	50	47	40	32
L_m	68,3	63,3	59,5	50,3	44,7	39,3
T_{60}	0,9	0,8	0,7	0,6	0,5	0,5
A	7,1	8	9,1	10,7	12,8	12,8
R	23,1	27,6	30,8	39,4	44,2	49,7



5. $f_0 = \frac{1}{2L_0}\sqrt{\frac{E'}{\mu_0}} \Rightarrow$

a) $f = \frac{1}{2} f_0$

b) $f = f_0$ (f does not depend on E)

c) $f = \frac{1}{\sqrt{2}} f_0$

d) $f = f_0$ (f does not depend on force of stroke)

e) $f = \sqrt{2}\cdot f_0$

6. a) $t = \frac{2Z_y}{Z_y + Z_{air}} \approx 2$

b) $\tau = \frac{4 Z_y Z_{air}}{(Z_y + Z_{air})^2} \approx 0$

c) $r = \frac{Z_2 - Z_1}{Z_2 + Z_1} \approx 1$

d) $\rho = \frac{|Z_2 - Z_1|^2}{(Z_2 + Z_1)^2} \approx 1$

e) There is no transmission of energy since $\tau \approx 0$, there is however a transmisson of a pressure wave, but with very low particle velocity due to the high impedance Z_y.