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4/25/07

MATH 5 WORKSHEET : Decay & Q factor

The wood stick from class has $f_0 = 2900$ Hz
and decay time of 0.02 s

a) Compute the Q factor of this oscillator :

Is Q more or less for { a tuning fork? / lump of jello? }

b) If the initial amplitude is 1, what is the amplitude 0.1 s later? (write formula if no calculator).

c) How long does the signal take to drop by 120 dB in intensity? [Hint : first find the ratio of amplitudes needed]

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~SOLUTIONS~

The wood stick from class has $f_0 = 2000$ Hz and decay time of 0.02 s (τ)

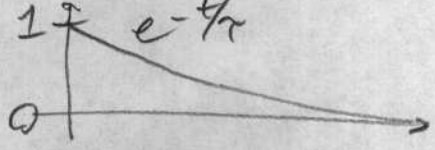
so period $T = \frac{1}{f_0} = \frac{1}{2000}$ s

a) Compute the Q factor of this oscillator:

$$Q = \pi \frac{\tau}{T} = \pi \frac{1/50}{1/2000} = 40\pi \approx 126$$

Is Q more or less for { a tuning fork? more (~10^4 typ.) / lump of jello? less (~1 typ.)

b) If the initial amplitude is 1, what is the amplitude 0.1 s later? (write formula if no calculator)



$$e^{-\frac{0.1}{0.02}} = e^{-5} = 0.0067$$

(less than 1% of original amplitude)

c) How long does the signal take to drop by 120 dB in intensity? [Hint: first find the ratio of amplitudes needed]

$$-120\,\text{dB} = 10 \log_{10} \frac{I_2}{I_1} \quad \text{so} \quad \frac{I_2}{I_1} = 10^{-12}$$

$$\frac{A_2}{A_1} = \sqrt{\frac{I_2}{I_1}} = \sqrt{10^{-12}} = 10^{-6}$$

Finally $10^{-6} = e^{-\frac{t}{0.02}}$ → take ln both sides, $\ln(e^x) = x$

$$\ln(10^{-6}) = \frac{-t}{0.02}$$

$$t = 0.02\left(-\ln(10^{-6})\right) = 0.276\,\text{s}$$

pretty short decay!