

Answers to homework 6

(1) Only 13 harmonics are used, not an infinite number as needed to make a perfect square wave.

(2)

Triangle Wave

n	a_n	b_n
0	0	0
1	1.000	0
2	0	0
3	0.111	0
4	0	0
5	0.040	0
6	0	0
7	0.020	0
8	0	0
9	0.012	0
10	0	0
11	0.008	0
12	0	0
13	0.006	0
14	0	0
15	0.004	0

$$\frac{d \sin(n\omega_0 t)}{dt} = n\omega_0 \cos(n\omega_0 t)$$

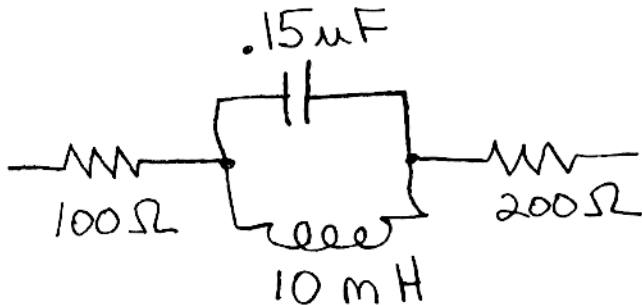
(3)

Harmonics above $n=1$ are present, square > triangle > sine, adding harshness to the sound.

④ How many dB does a system change a signal at 5 KHz if the amplitude of a 5 KHz sinusoid changes from 20V to 1mV? -86 dB

⑤ A sinusoidal pressure wave represents 5 W of power. How would this be expressed in dB relative to a 1mW sinusoidal pressure wave at the same frequency? +37 dB

⑥ Compute an expression for the total impedance Z of the following circuit.



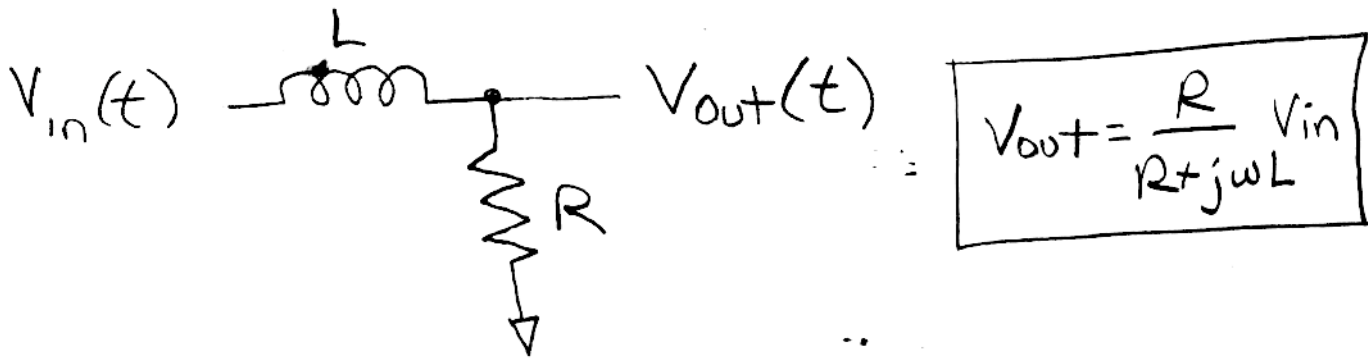
$$300 + \frac{1}{j\omega(1.5 \times 10^{-7}) + \frac{1}{j\omega 10^{-5}}}$$

What are the maximum and minimum values for $|Z|$ and at what frequencies do they occur? (Hint: there may be more than one maximum or minimum.)

$$|Z|_{\min} = 300\Omega \text{ at } \omega = 0 \text{ and } \omega = \infty$$

$$|Z|_{\max} = \infty \text{ at } \omega = \frac{1}{LC} = 8.2 \times 10^5 \frac{\text{radians}}{\text{sec}}$$

⑦ Consider the following circuit



write an equation for $H(\omega)$, the transfer function. (This is just a divider with impedances instead of resistances)

- ⑧ At what frequency (radians/sec) does $|Z_L| = R$ if $L = 10\text{mH}$, $R = 100\Omega$
 $\omega = 10^4$
- ⑨ Is this a high pass or low pass filter?
 Low Pass

⑩ Given the values in ⑧, sketch a plot of $|H(\omega)|$ in dB and $\angle H(\omega)$ in radians vs $\log \omega$. (Bode plot)

