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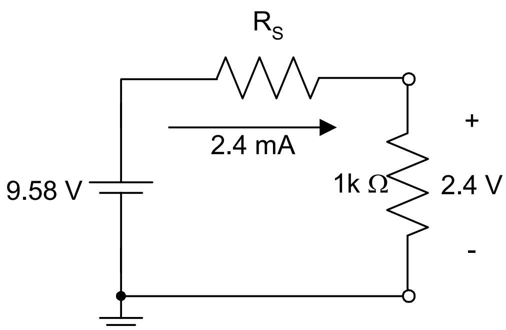
Battery Source Resistance

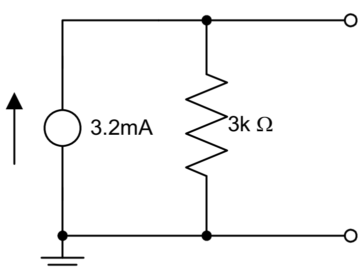
EVEREADY [Failed]

9.58 Volts Open Circuit
2.4 Volts with a 1kΩ load resistor
I = 2.4 mA



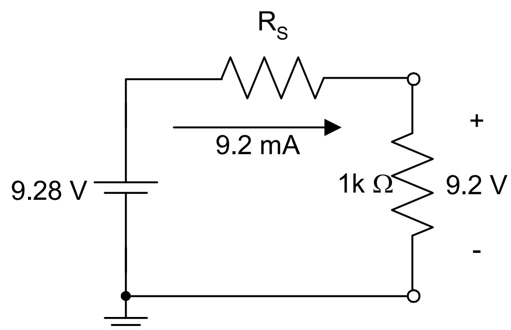
$$R_S = \frac{9.58V - 2.4V}{2.4\,mA} = 3k\Omega$$

$$I_{sc} = \frac{9.58V}{3k\Omega} = 3.2mA$$



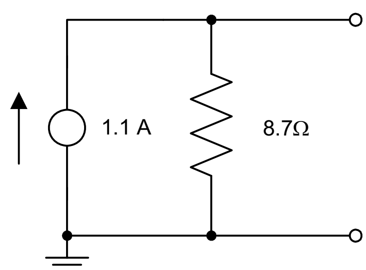
DURACELL [Fresh]

9.28 Volts Open Circuit
9.20 Volts with a 1kΩ load resistor
I = 9.2 mA



$$R_S = \frac{9.28V - 9.2V}{9.2\,mA} = 8.7\Omega$$

$$I_{sc} = \frac{9.28V}{8.7\Omega} = 1.07A$$



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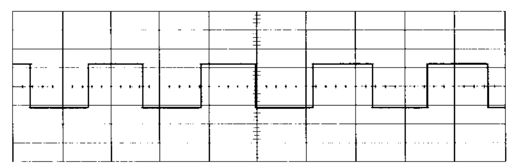
COMPENSATE YOUR 'SCOPE PROBES!

If you don't, you won't get accurate voltage measurements on the oscilloscope; they won't agree with the value displayed on your function generator!

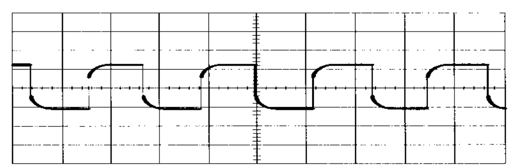
1. To compensate your probes, hook the probe tip on to the metal terminal labeled **"Probe Comp = 5V Π"**, [or similar] located at the bottom of the right half of most 'scopes. Adjust your horizontal sweep until you can see 2 or 3 cycles of the square wave displayed horizontally.

2. Your display will probably look like either the second or third diagram below; if it looks like the top diagram you need go no further.

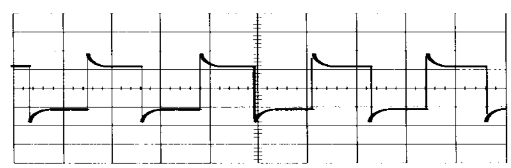
CORRECTLY COMPENSATED



PROBE UNDERCOMPENSATED



PROBE OVERCOMPENSATED



3. Obtain a non-metallic screwdriver, or at least a plastic one with just a metal tip, and inserting it into the screw slot on the probe, gently adjust the screw until the waveform looks "square" as in the top figure above.

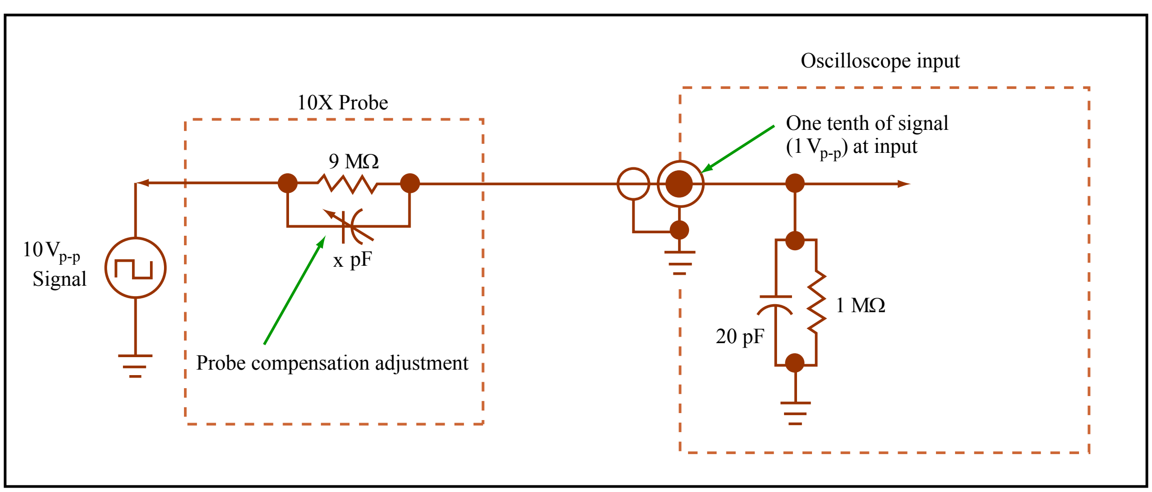


Figure by MIT OpenCourseWare.

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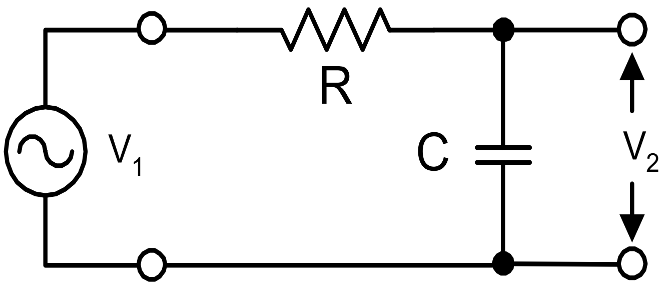
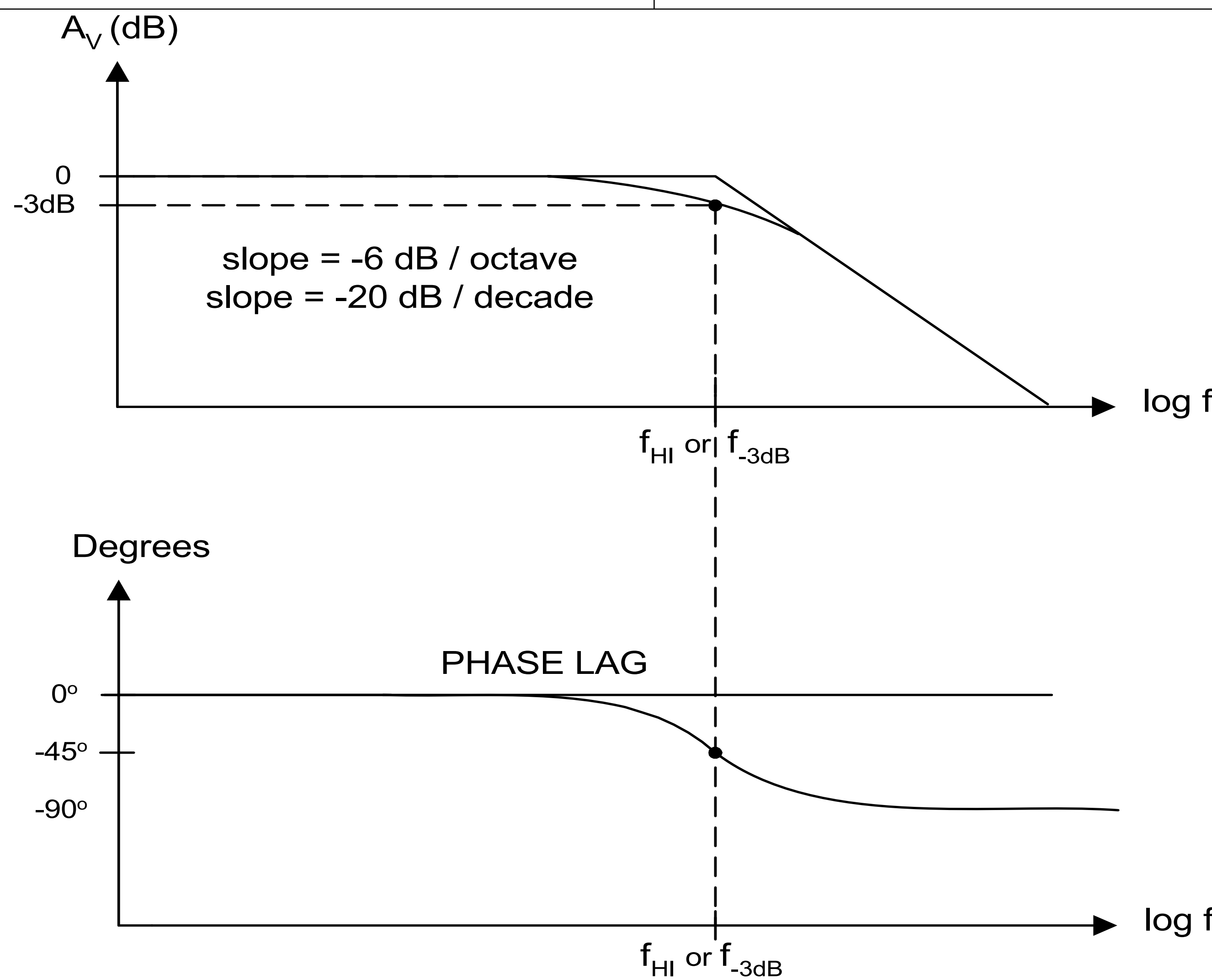
Low-Pass Filter Basics [Integrator]



$$A_v = \frac{V_2}{V_1} = \frac{-jX_C}{R + -jX_C} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{1}{j\omega CR + 1}$$

$$A_v = \frac{1}{sCR + 1}$$



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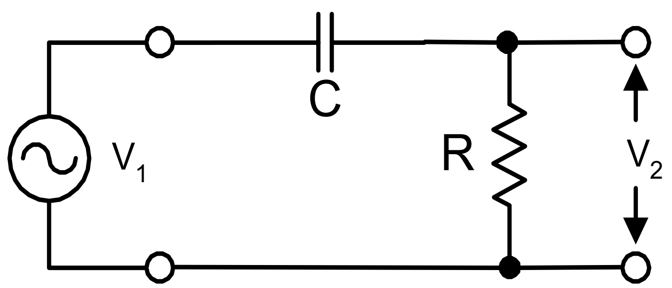
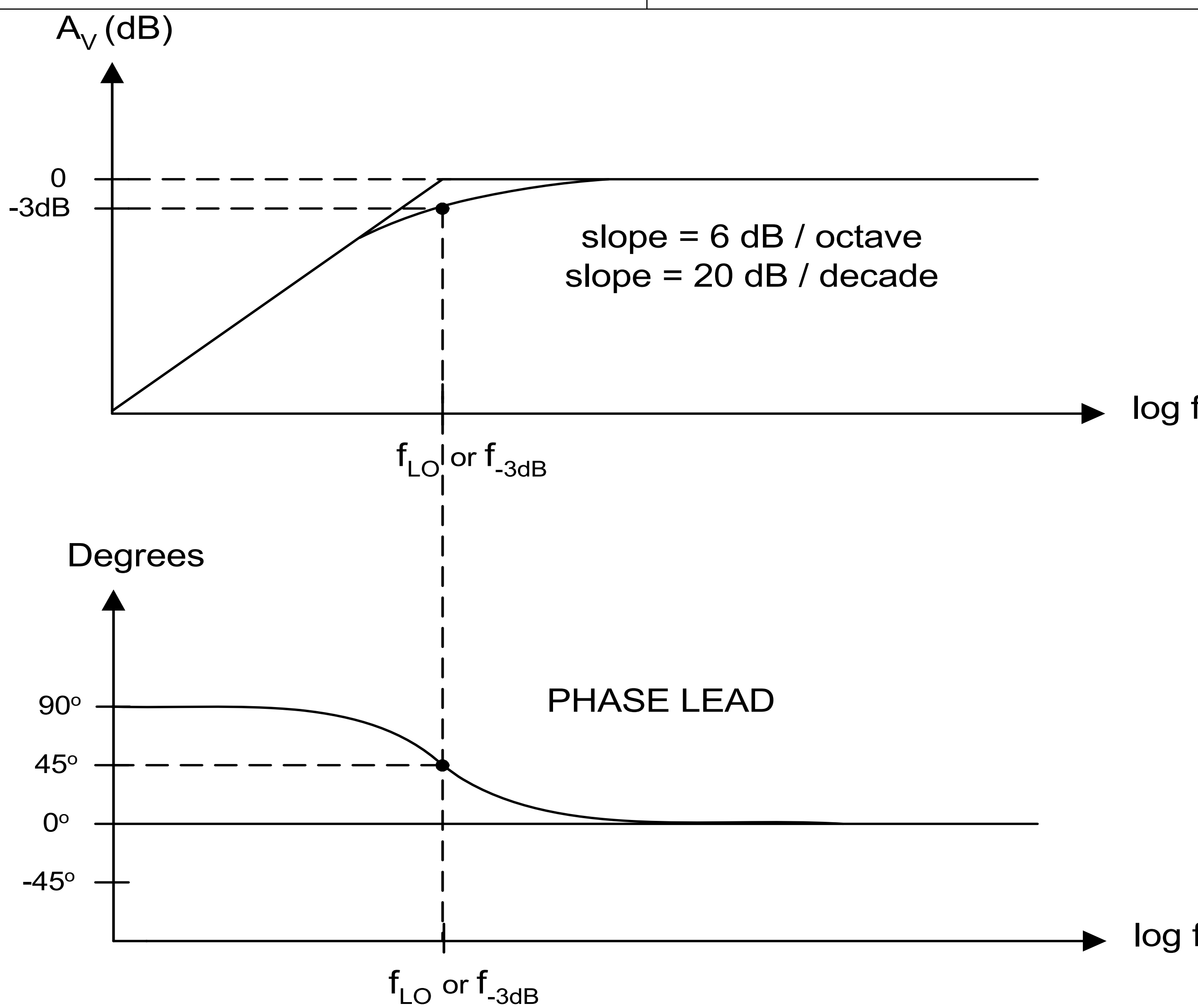
High-Pass Filter Basics [Differentiator]



$$A_v = \frac{V_2}{V_1} = \frac{R}{R + \frac{1}{j\omega C}} = \frac{j\omega CR}{j\omega CR + 1} = \frac{s\,CR}{s\,CR + 1}$$



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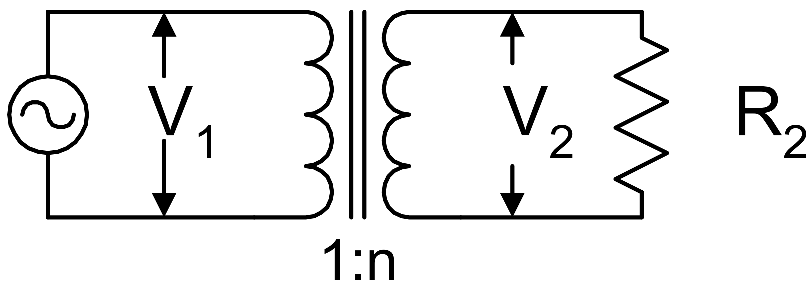
Transformer Derivation [for voltage step-UP transformer]



For a perfect [lossless] transformer, the power in the primary will equal the power in the secondary. Therefore:

$$V_1 I_1 = V_2 I_2$$

substituting for the current, where R_1 = the secondary resistance as reflected to the primary:

$$V_1 \frac{V_1}{R_1} = V_2 \frac{V_2}{R_2}$$

$$\frac{V_1^{\ 2}}{R_1} = \frac{V_2^{\ 2}}{R_2}$$

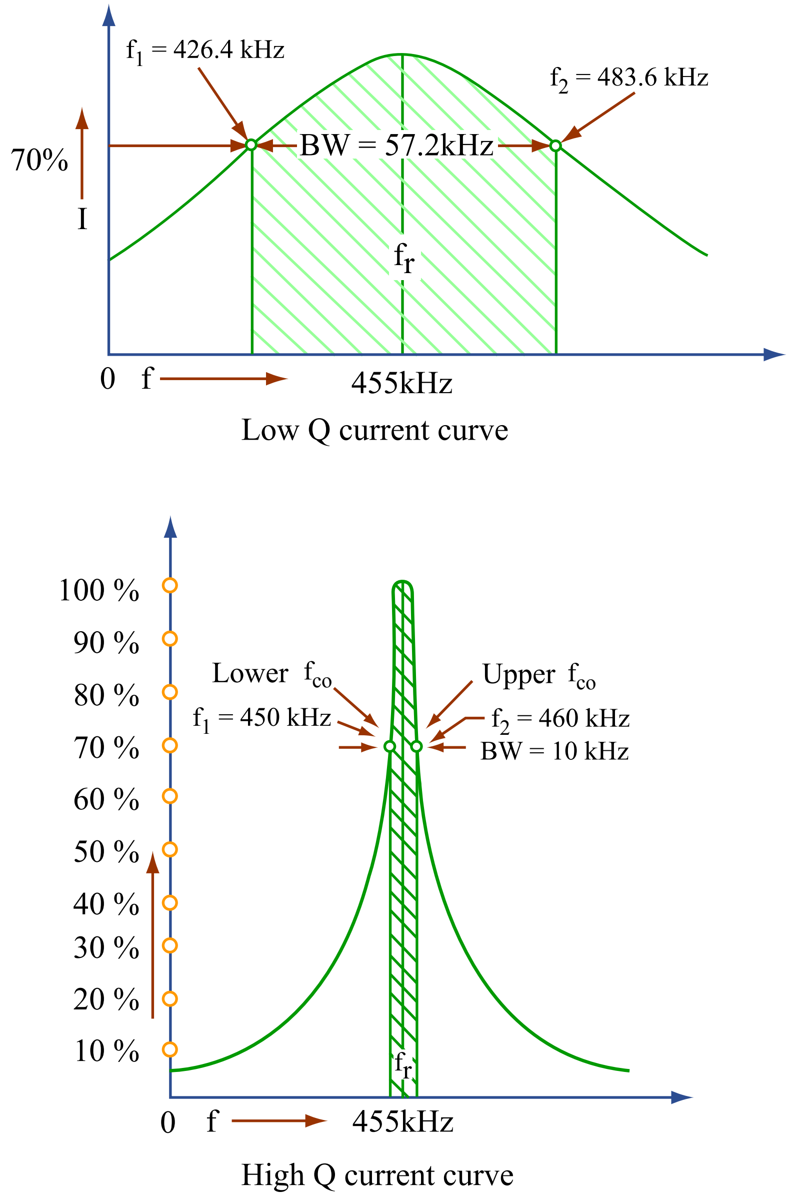
$$R_1 = \frac{V_1^2 \ R_2}{V_2^2}$$

$$but \quad V_2 = nV_1$$

$$R_1 = \frac{V_1^2 \ R_2}{(nV_1)^2} = \frac{V_1^2 \ R_2}{n^2 V_1^2}$$

$$so$$

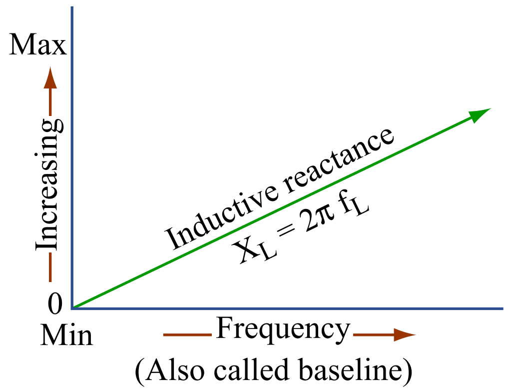
$$R_1 = \frac{R_2}{n^2}$$



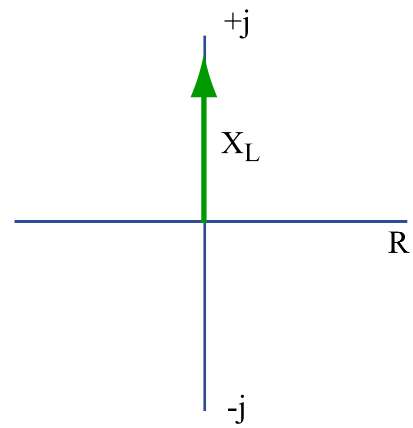
Bandwidth for high- and low- Q series circuit.

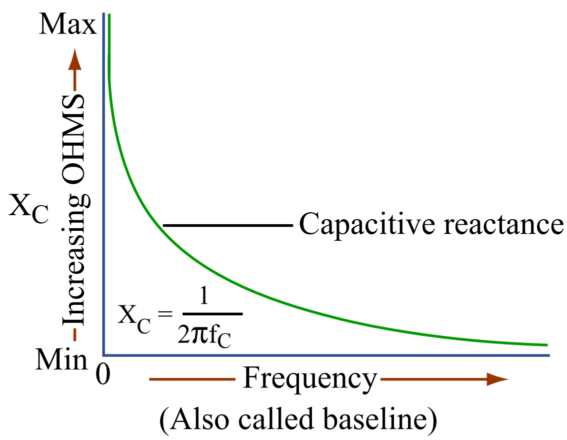
Figure by MIT OpenCourseWare.

Frequency Effect	Phase

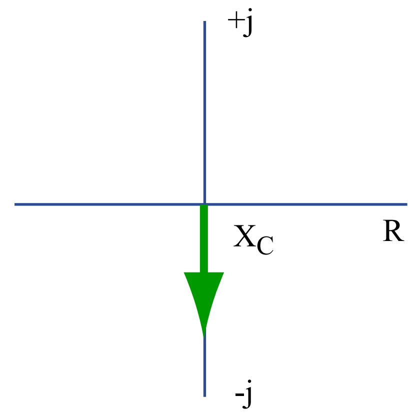


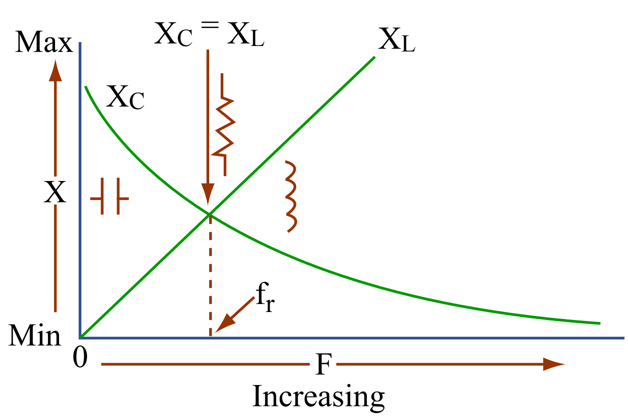
Effect of frequency on inductive reactance.





Effect of frequency on capacitive reactance.





Relationship between X_L and X_C as frequency increases.

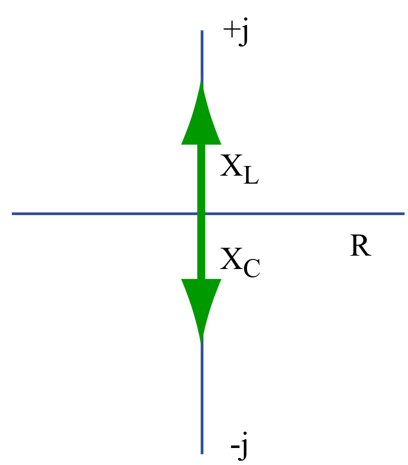
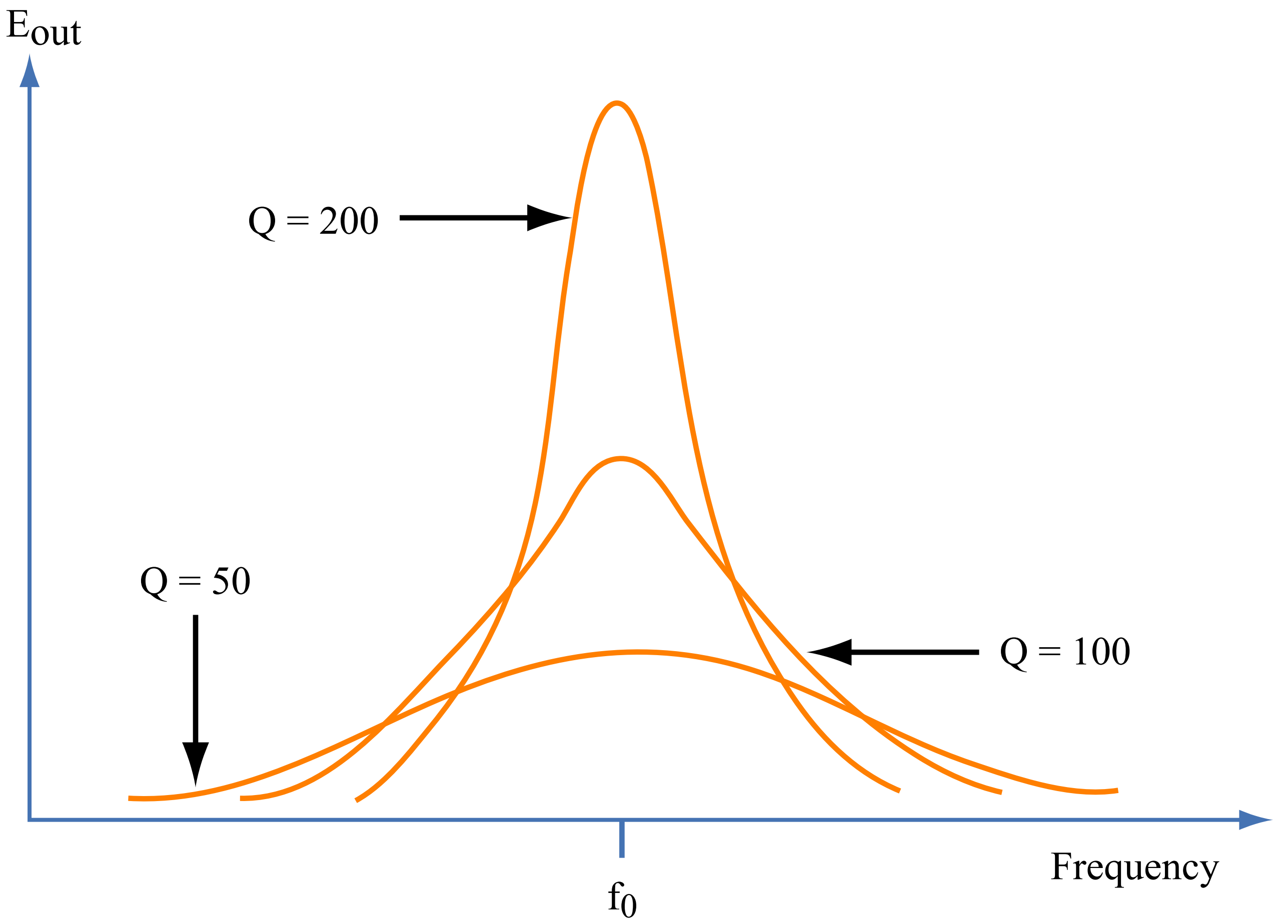
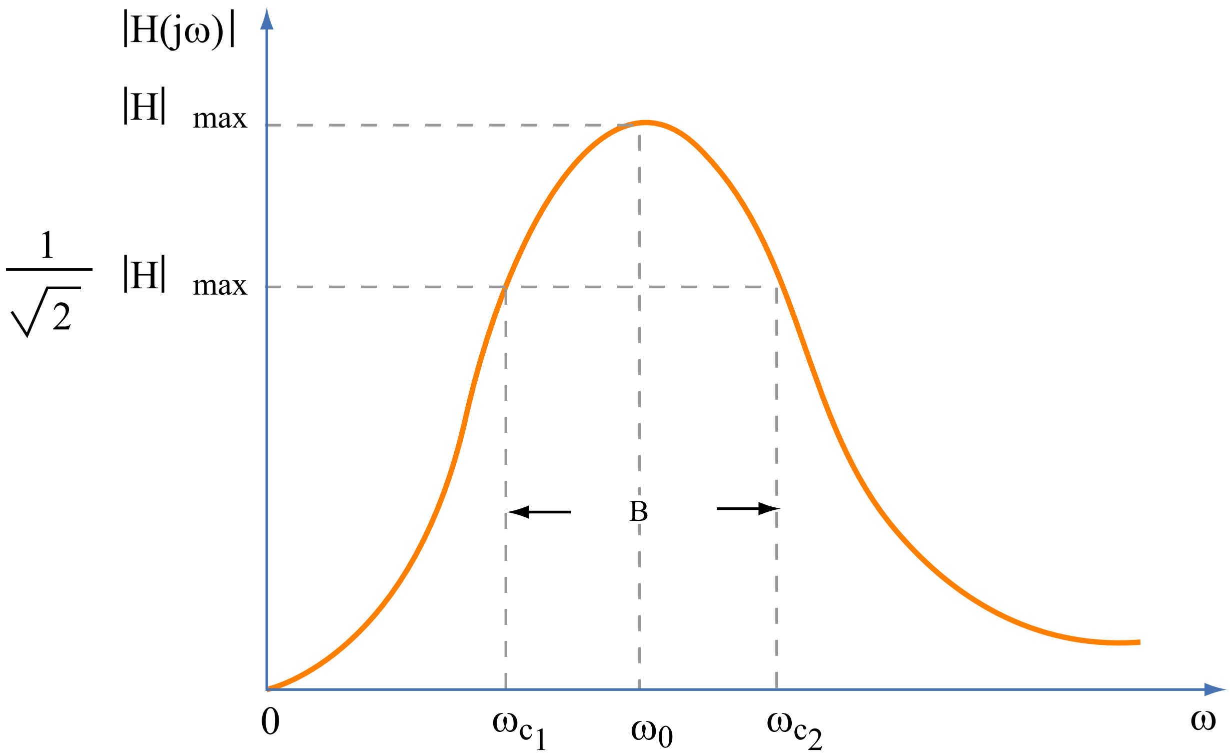


Figure by MIT OpenCourseWare.



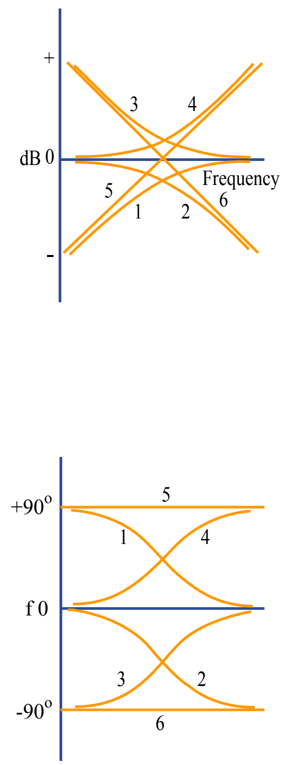
Frequency curve of single LC tuned circuit.

Figure by MIT OpenCourseWare.



General bandpass and amplitude response.

Figure by MIT OpenCourseWare.



	Constant voltage input		Constant current input	
Curve no.	Voltage output into open circuit	Current output into short circuit	Voltage output into open circuit	Current output into short circuit
1	$\frac{j\omega T}{1+j\omega T}$	$\frac{1}{R}+\frac{j\omega T}{1+j\omega T}$	$R\,\frac{j\omega T}{1+j\omega T}$	$\frac{j\omega T}{1+j\omega T}$
2	$\frac{1}{1+j\omega T}$	$\frac{1}{R}\,\frac{1}{1+j\omega T}$	$R\,\frac{1}{1+j\omega T}$	$\frac{1}{1+j\omega T}$
3		$\frac{1}{R}\,\frac{1+j\omega T}{j\omega T}$	$R\,\frac{1+j\omega T}{j\omega T}$	
4		$\frac{1}{R}(1+j\omega T)$	$R\,(1+j\omega T)$	
5		$j\omega C$	$j\omega L$	
6		$\frac{1}{j\omega L}$	$\frac{1}{j\omega C}$	

Diagrams, transfer function, and frequency responses for basic circuits consisting of a resistor, capacitor, and/or inductor.

Figure by MIT OpenCourseWare.

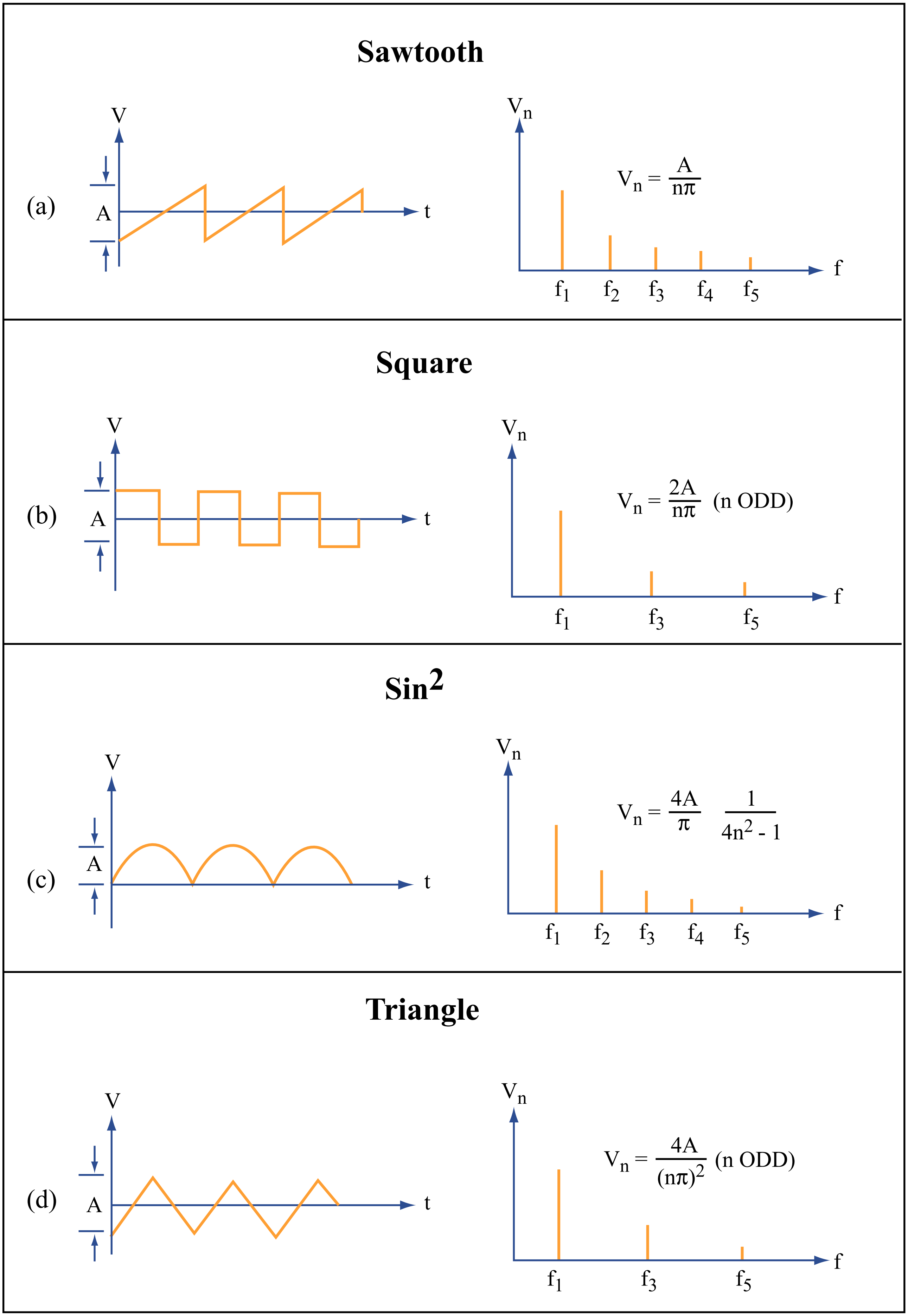
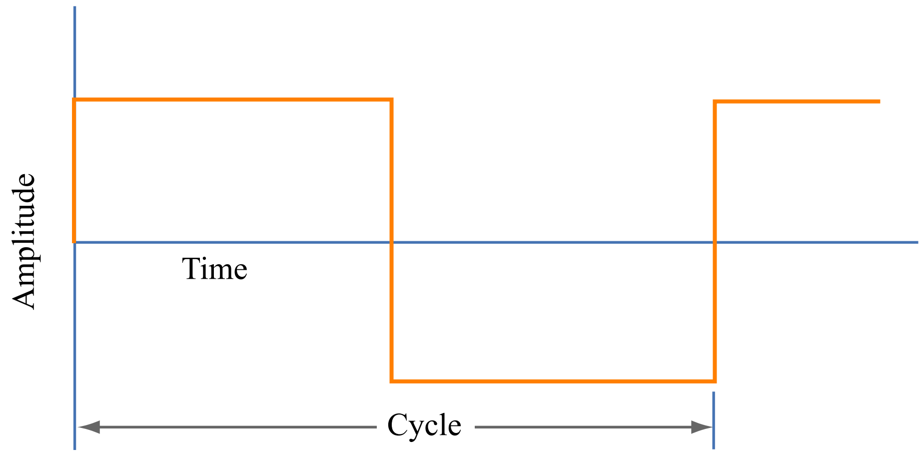
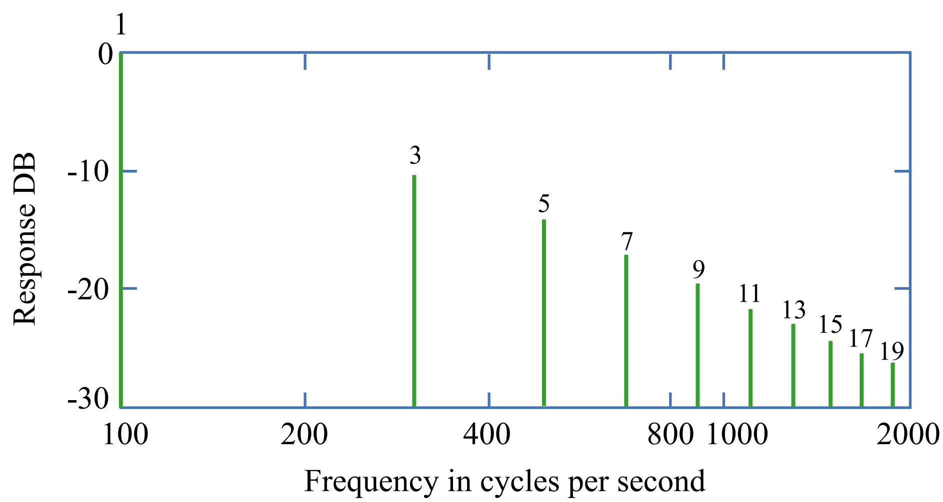


Figure by MIT OpenCourseWare.

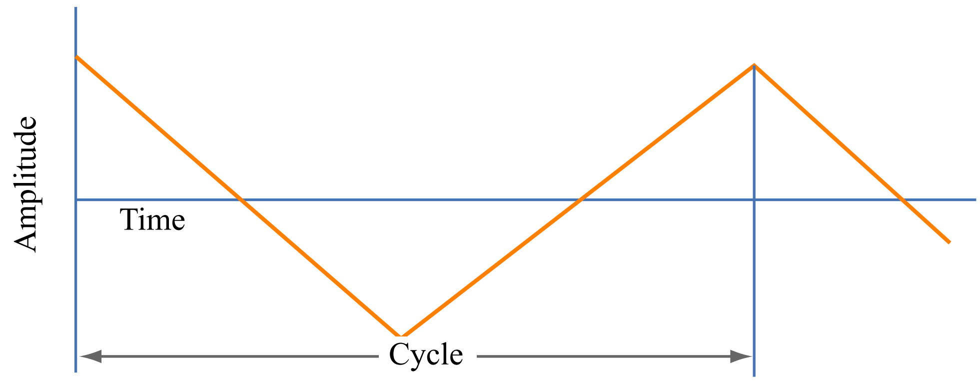


$$P_R = \frac{4}{\pi}\left[\sin \omega t + \frac{1}{3}\sin 3\,\omega t + \frac{1}{5}\sin 5\,\omega t \;\text{-----}\right]$$

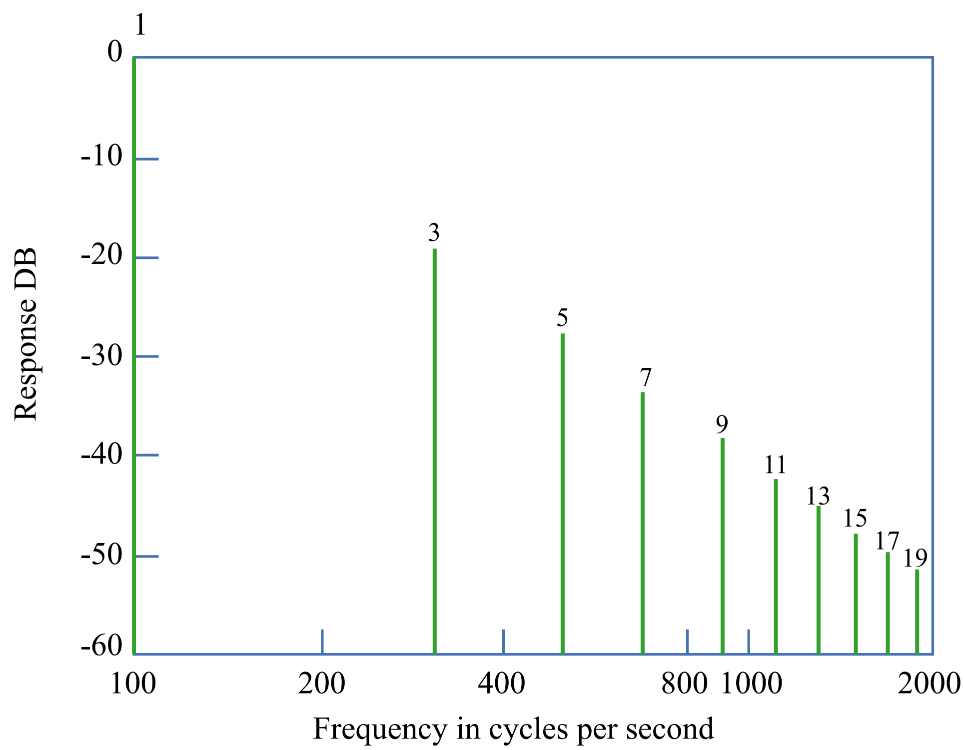


A rectangular wave, the equation of the wave, and the spectrum for a fundamental frequency of 100 cycles, that is, t = 1/100 second for a complete cycle.

Figure by MIT OpenCourseWare.



$$P_R = \frac{8}{\pi^2}\left[\cos \omega t + \frac{1}{9}\cos 3\,\omega t + \frac{1}{25}\cos 5\,\omega t \text{ -----}\right]$$



A triangular wave, the equation of the wave, and the spectrum for a fundamental frequency of 100 cycles, that is, t = 1/100 second for a complete cycle.

Figure by MIT OpenCourseWare.

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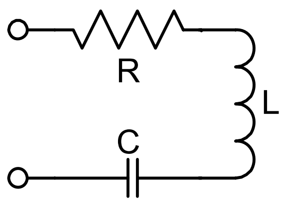
Impedance/Admittance Notation



$$X_L = j\omega L$$

$$X_C = \frac{1}{j\omega C}$$

$$Z = R + j\omega L + \frac{1}{j\omega C}$$

$$Z = R + j\left[\omega L - \frac{1}{\omega C}\right]$$

$$Z = R + j\left[X_L - X_C\right]$$

OHM's LAW:

$$V = I\,R\,; \quad V = I\,Z\,;$$

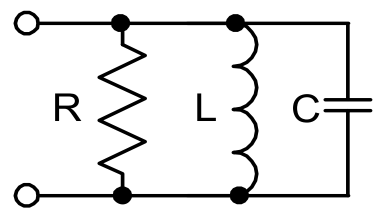
$$V = I\left[\frac{1}{Y}\right]; \quad V\,Y = I$$

$$Z = \frac{1}{\frac{1}{R} + \frac{1}{j\omega L} + j\omega C}$$

$$Y = \frac{1}{Z}; \quad B_L = \frac{1}{X_L}; \quad B_C = \frac{1}{X_C}; \quad G = \frac{1}{R}$$

$$Y = G + \frac{1}{j\omega L} + j\omega C = G + j\left[\omega C - \frac{1}{\omega L}\right]$$

$$Y = G + j\left[B_C - B_L\right]$$



Where does the $\sqrt{2}$ or $\frac{1}{\sqrt{2}}$ come from in –3dB point calculations?