Fourier Series

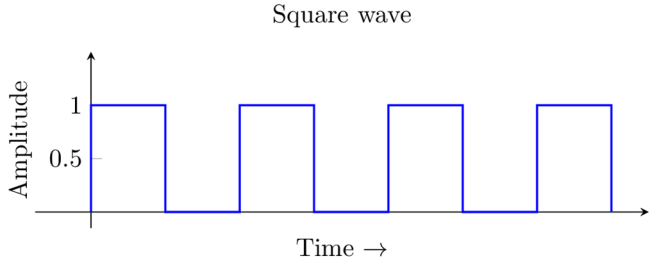
Assume we have some function $f(t)$ which is periodic with period $T_0 = \frac{2\pi}{\omega_0}$

$$f(t) = a_0 + \sum_{k=1}^{\infty} a_k \cos(k\omega_0 t) + b_k \sin(k\omega_0 t)$$

$f(t)$ can be expressed this way if

1. $f(t)$ is single-valued
2. $\int_{t_0}^{t_0+T_0} |f(t)|\, dt$ exists
3. $f(t)$ had finite discontinuities and max/min per period

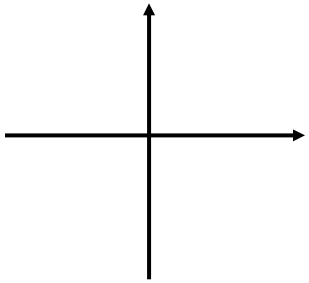
Example Calculation



Symmetry in Fourier Series

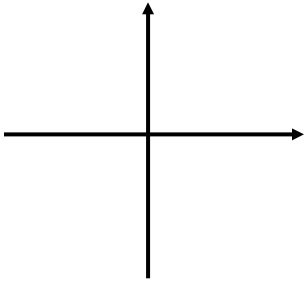
Even functions

$b_k = 0$



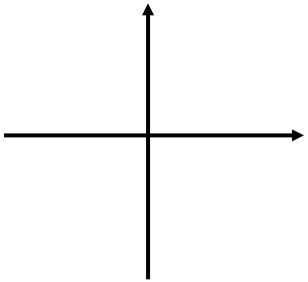
Odd functions

$a_k = 0$

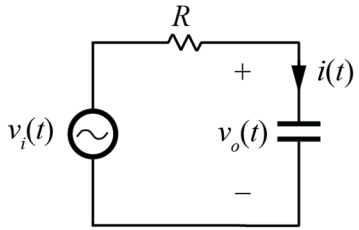


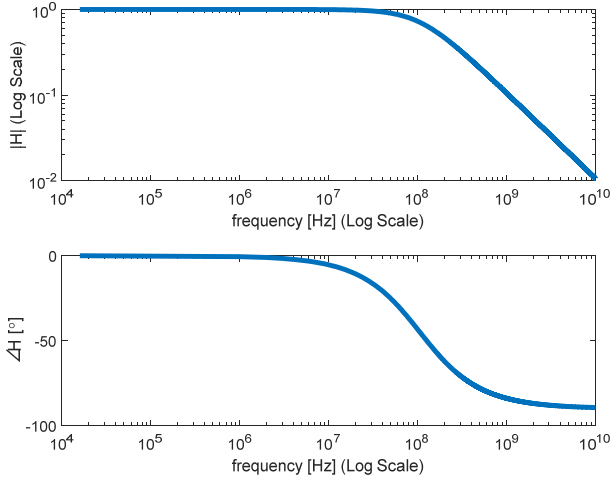
Half-wave symmetric functions

$a_k,\ b_k = 0$ for even k

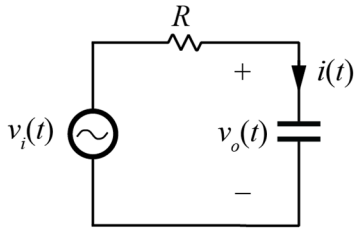


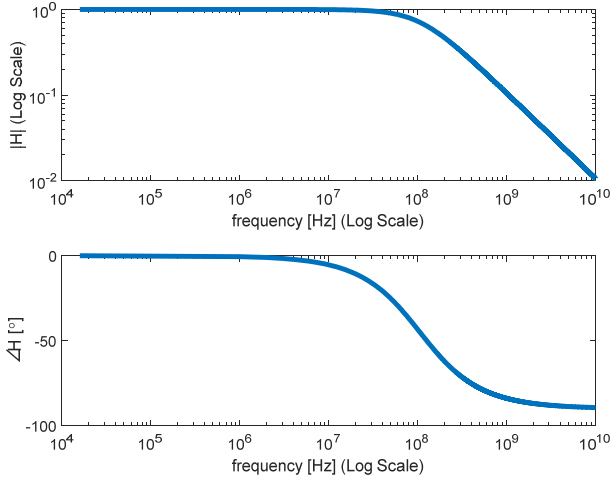
Application: Digital Communication



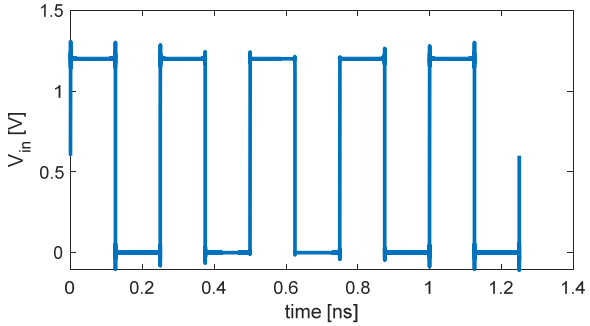


Application: Digital Communication

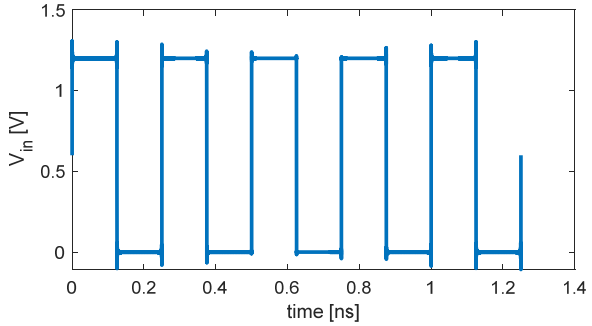


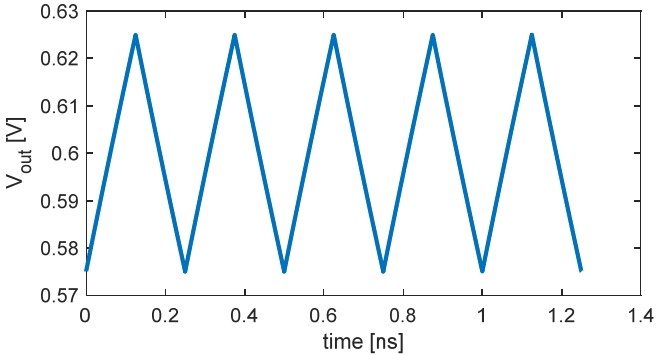


Applying Superposition

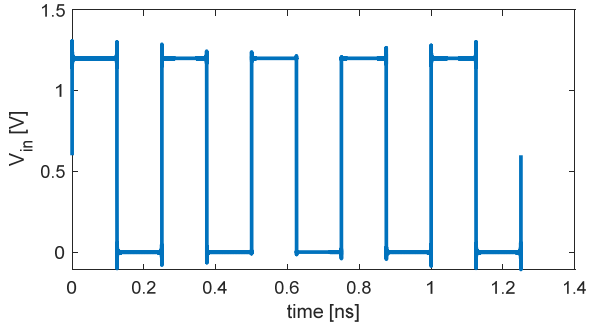


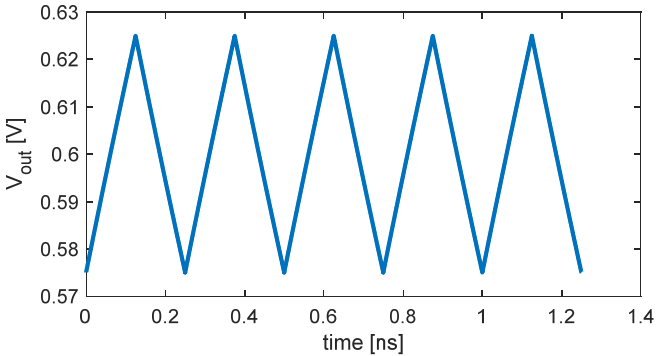
Calculated Output Voltage

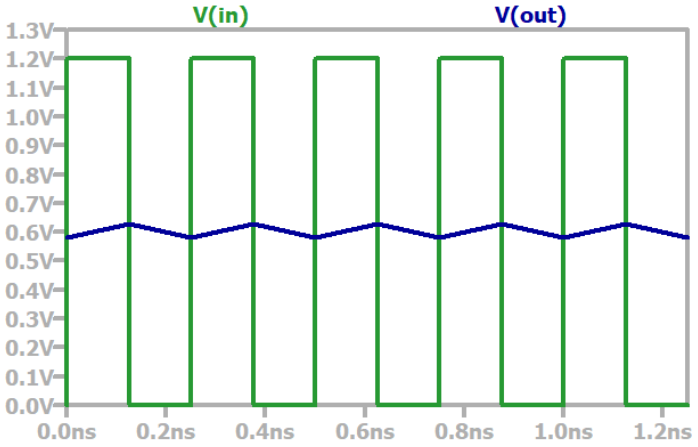


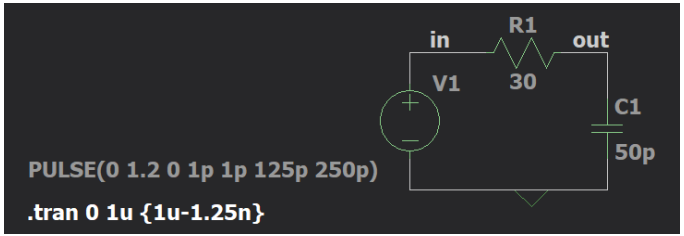


Simulation Verification

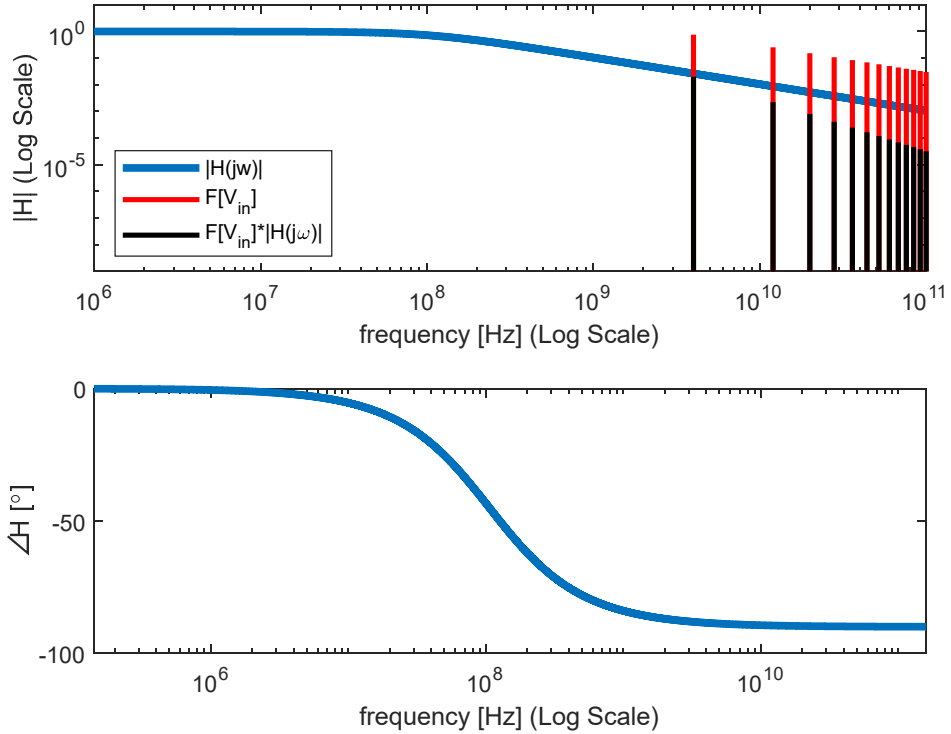


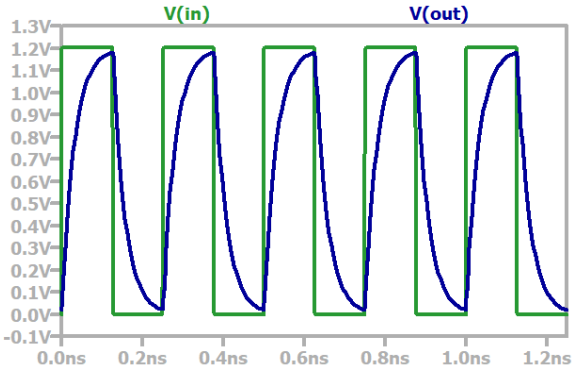


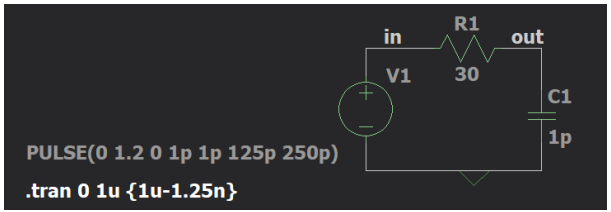




Frequency Domain Interpretation




V(in)
V(out)
1.3V
1.2V
1.1V
1.0V
0.9V
0.8V
0.7V
0.6V
0.5V
0.4V
0.3V
0.2V
0.1V
0.0V
-0.1V
0.0ns
0.2ns
0.4ns
0.6ns
0.8ns
1.0ns
1.2ns


in
R1
out
V1
30
C1
1p
PULSE(0 1.2 0 1p 1p 125p 250p)
.tran 0 1u {1u-1.25n}