CSN08704

Telecommunications

4. Analysis of Digital Pulses

Data, Audio, Video and Images

http://asecuritysite.com/comms

Prof Bill Buchanan

CSN08704

Telecommunications

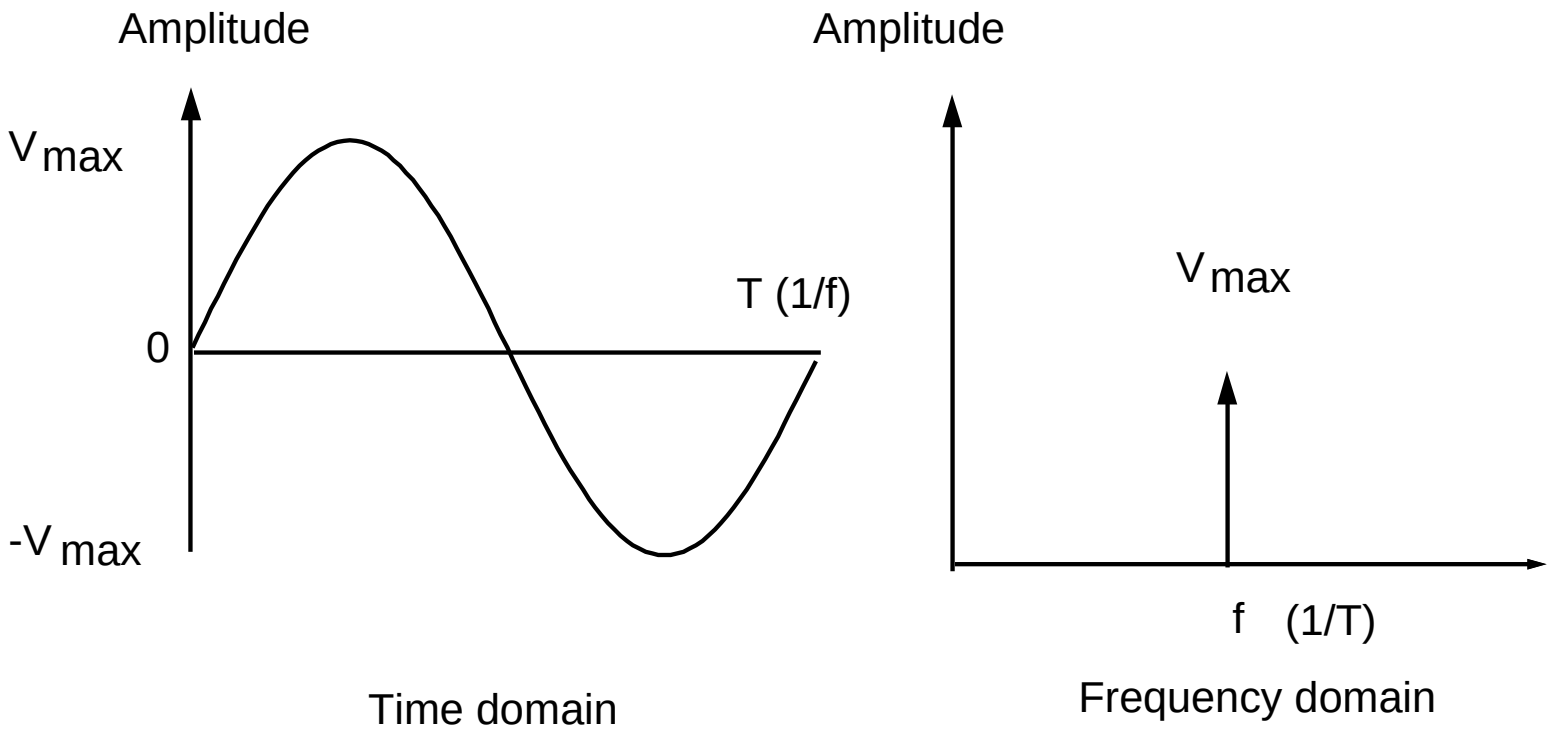
4. Analysis of Digital Pulses: Frequency and Time Domain

Data, Audio, Video and Images

http://asecuritysite.com/comms

Prof Bill Buchanan

Signals



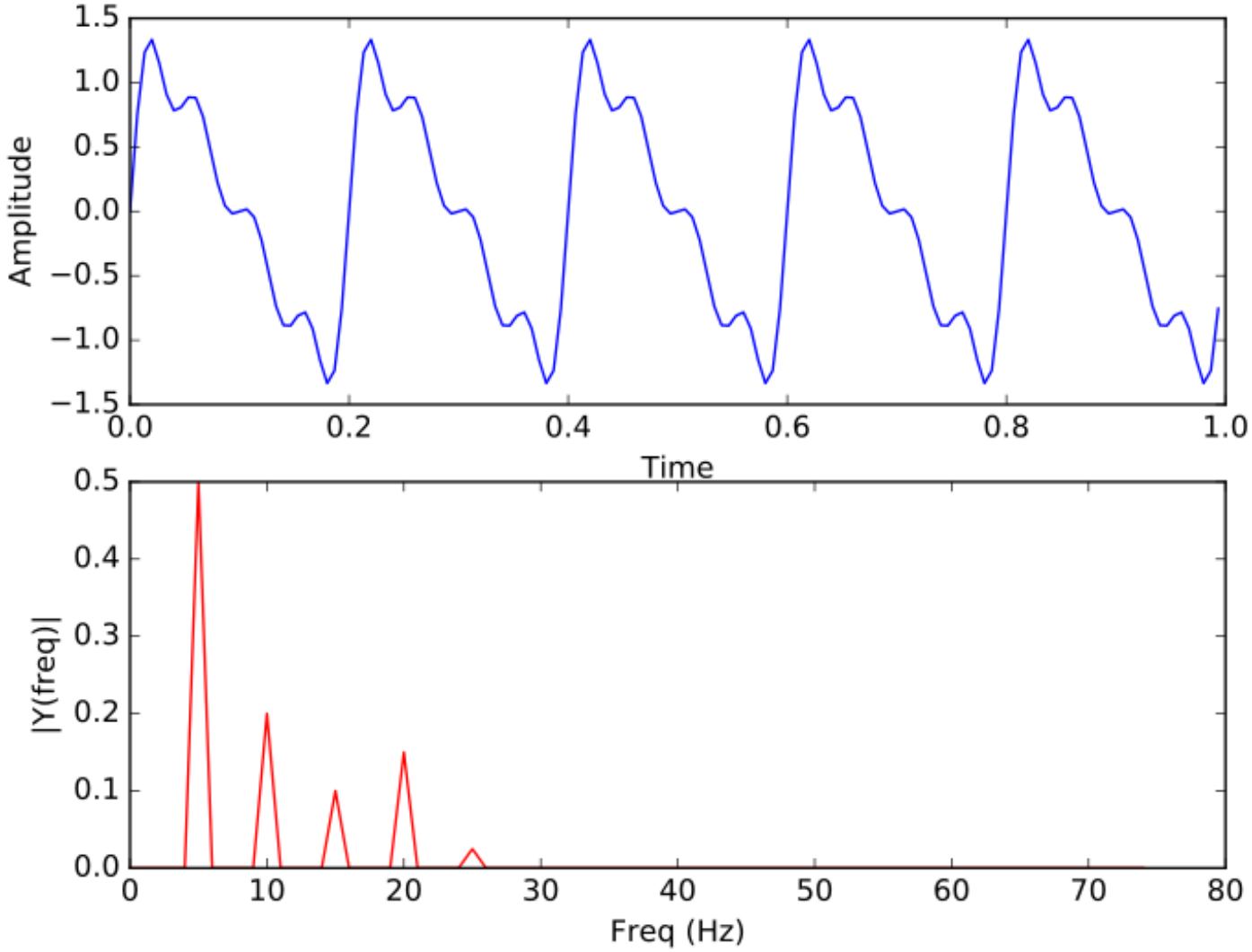
$$V(t)=V\sin(2\pi ft+\theta)$$

Repetitive Signals

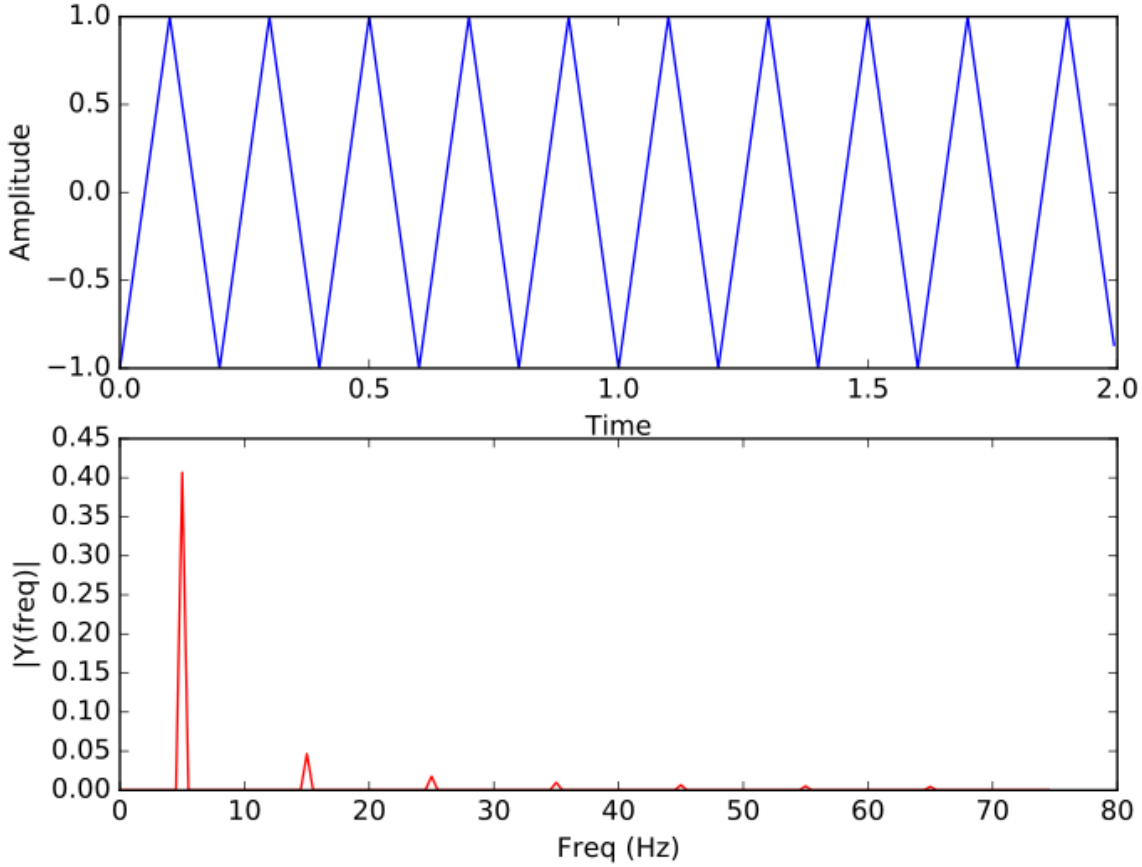
$$f(t) = A_0 + A_1 \cos \omega_1 t + A_2 \cos 2\omega_1 t + \ldots + A_N \cos N\omega_1 t$$
$$+ B_1 \sin \omega_1 t + B_2 \sin 2\omega_1 t + \ldots + B_N \sin N\omega_1 t$$

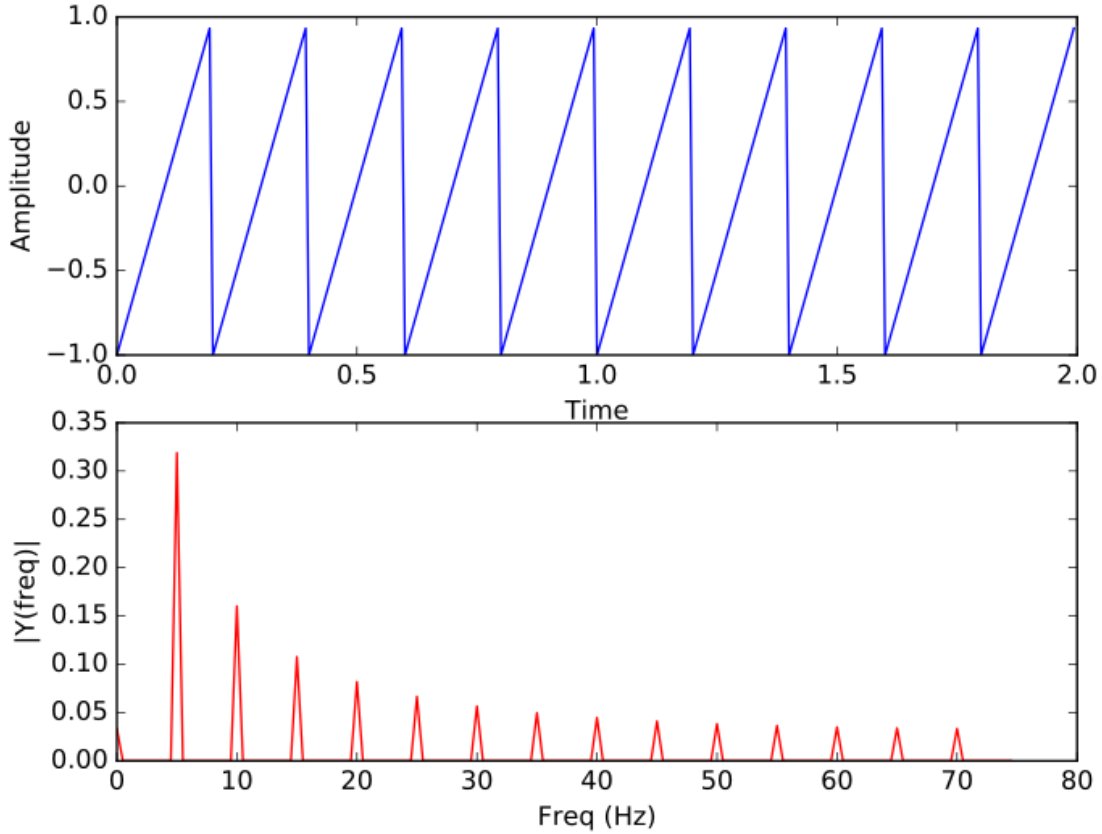
Repetitive Signals

- 1 1st, 0.4 2nd, 0.2 3rd.
- 0.4 4th, 0.05 5th.
- Link.

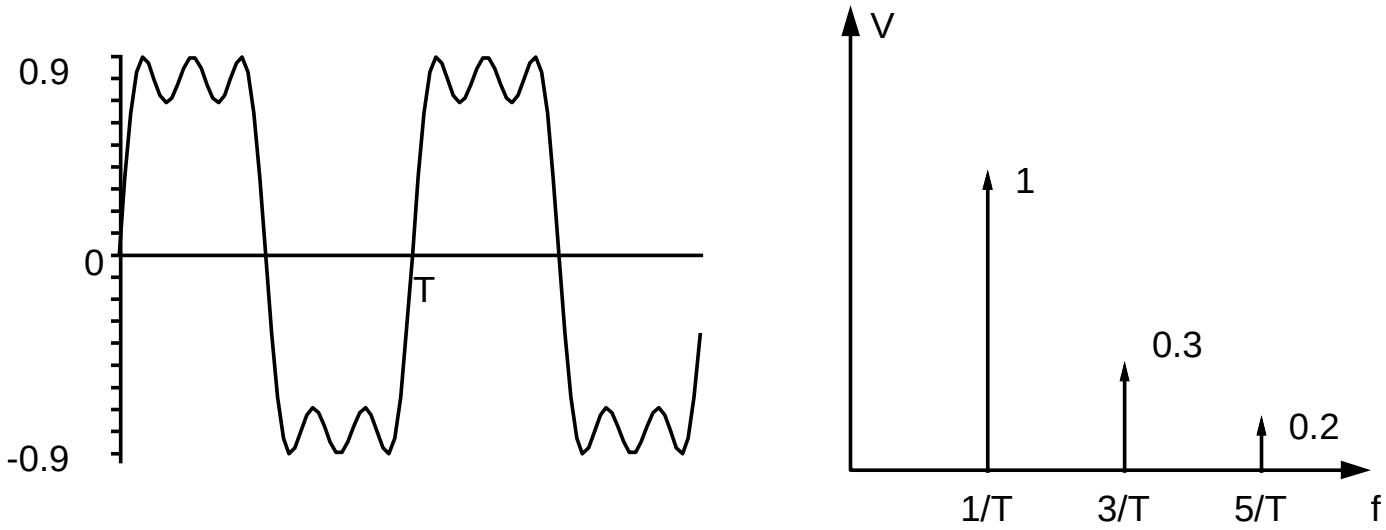


Repetitive Signals





Example

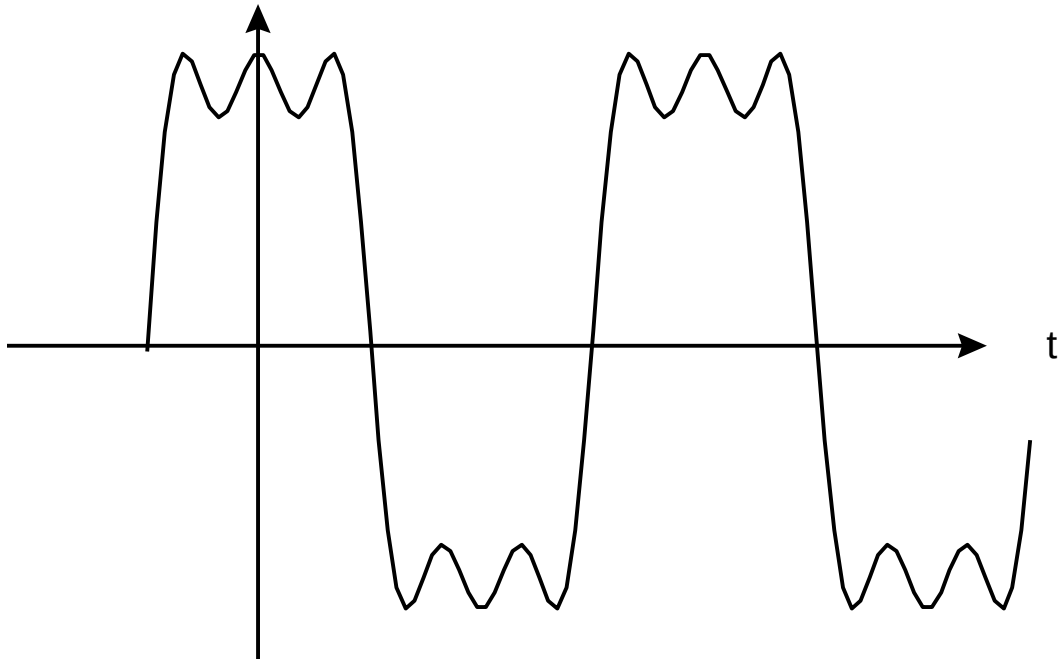


Time domain

Frequency domain

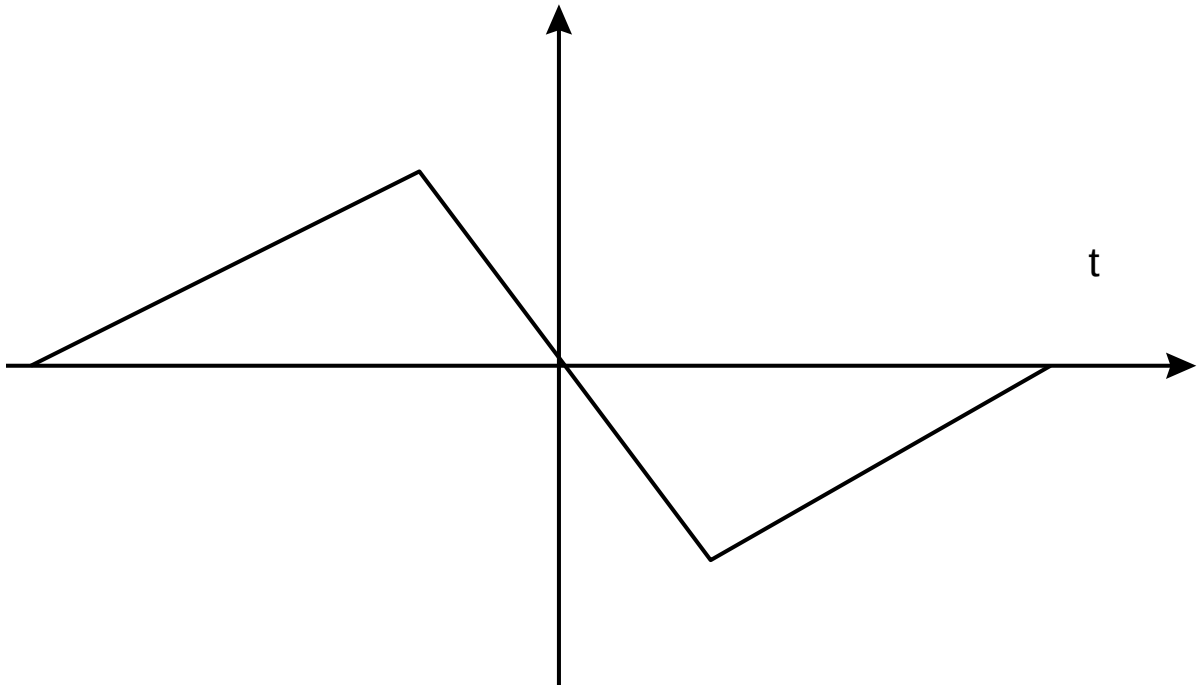
$$f(t)=\sin(\omega_1 t)+0.3\sin(3\omega_1 t)+0.2\sin(5\omega_1 t)$$

Even Symmetry



$$f(t) = A_0 + A_1 \cos \omega_1 t + A_2 \cos 2\omega_1 t + \ldots + A_N \cos N\omega_1 t$$

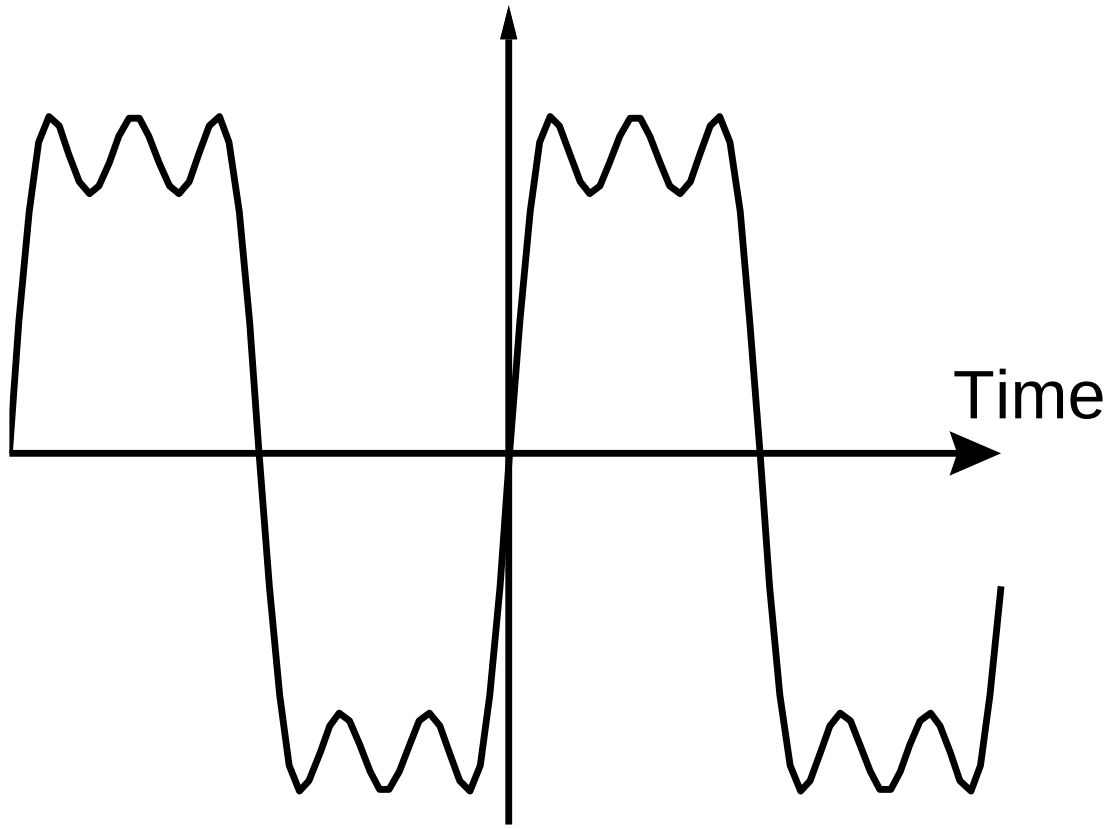
Odd Symmetry



$$f(t) = B_1 \sin \omega_1 t + B_2 \sin 2\omega_1 t + \ldots + B_N \sin N\omega_1 t$$

Half Symmetry

- No even harmonics … just odd harmonics.



CSN08704

Telecommunications

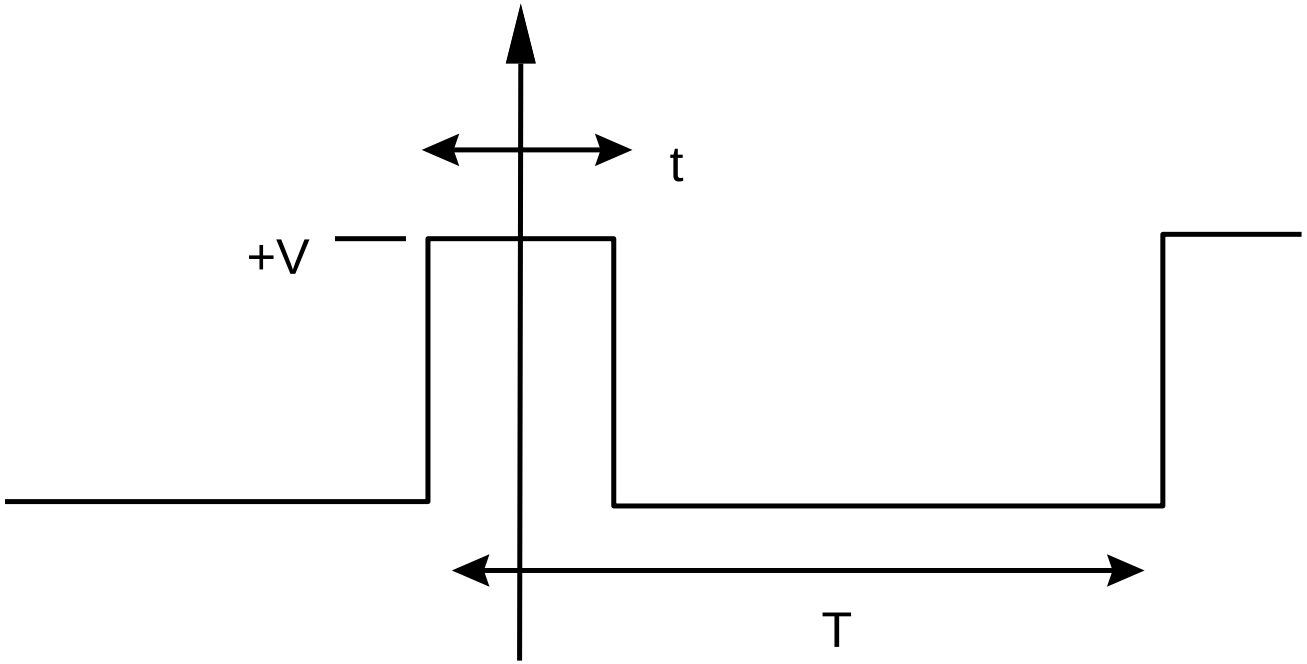
4. Analysis of Digital Pulses: Pulse Analysis

Data, Audio, Video and Images

http://asecuritysite.com/comms

Prof Bill Buchanan

Repetitive Pulse Stream

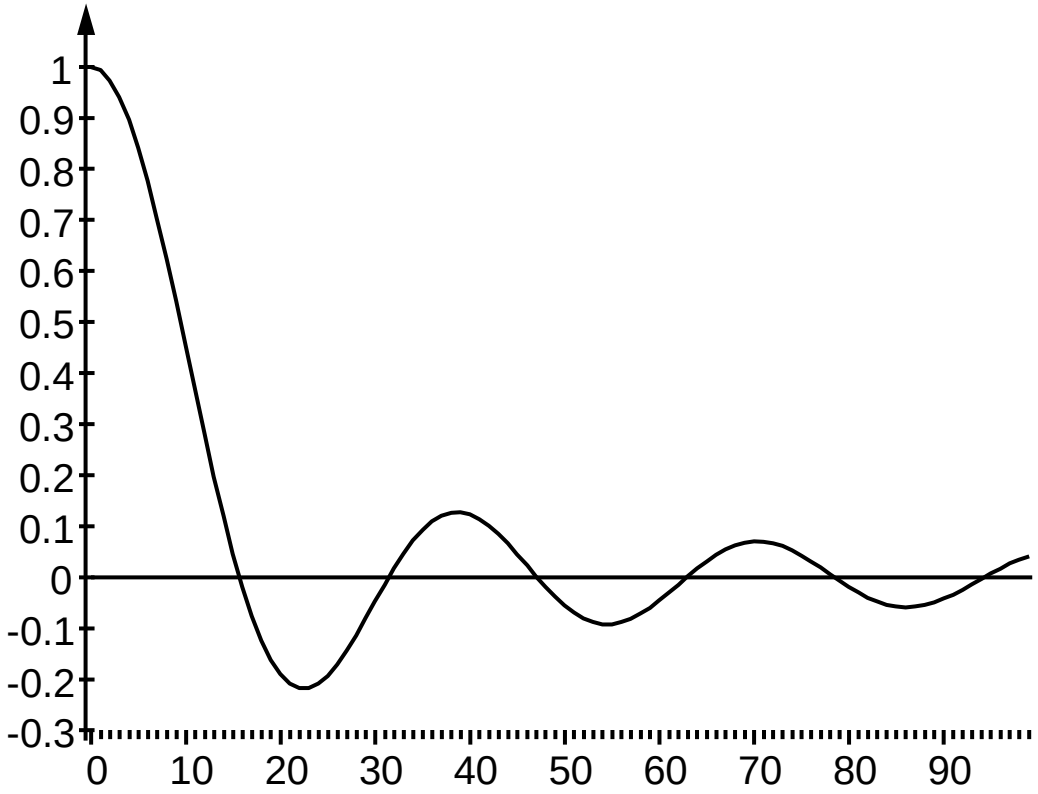


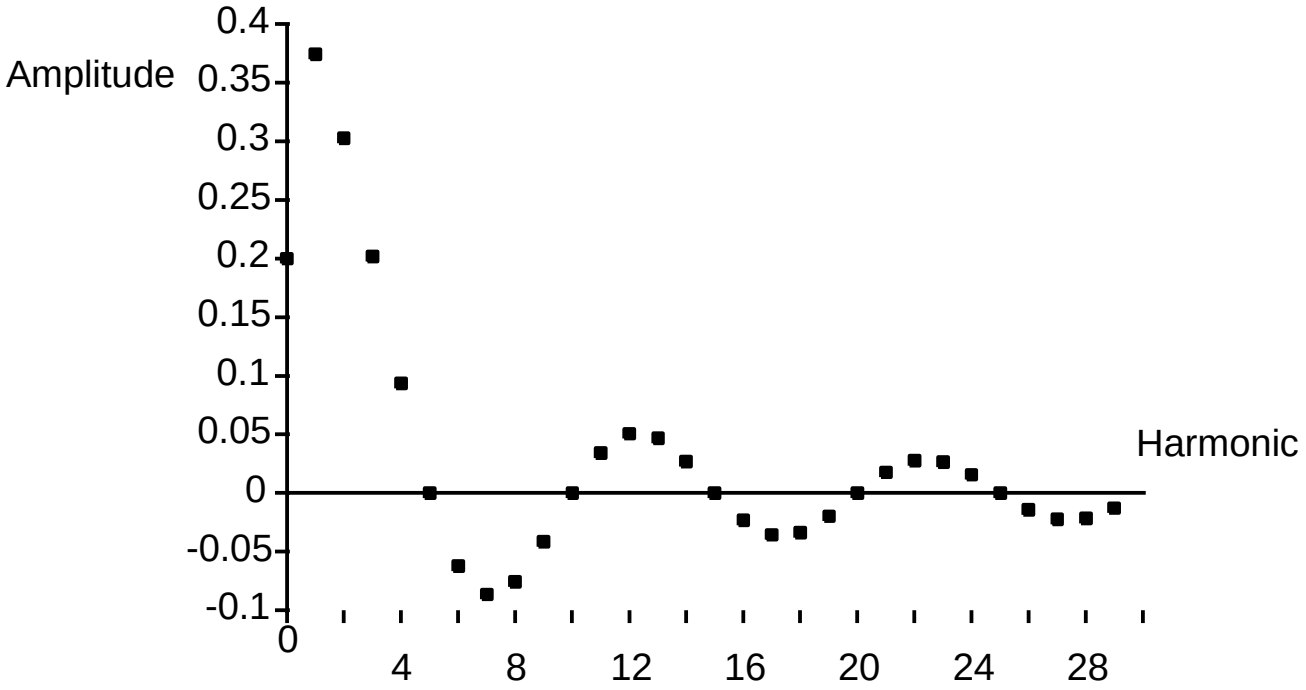
$$Duty\ Cycle = \frac{t}{T}$$

$$v(t) = \frac{V\tau}{T} + \sum_{n=1}^{n=\infty} V_n \cos(n2\pi f_1 t) \qquad V_n = \frac{2V\tau}{T} \cdot \frac{\sin Nx}{x} \qquad x = \frac{\pi\tau}{T}$$

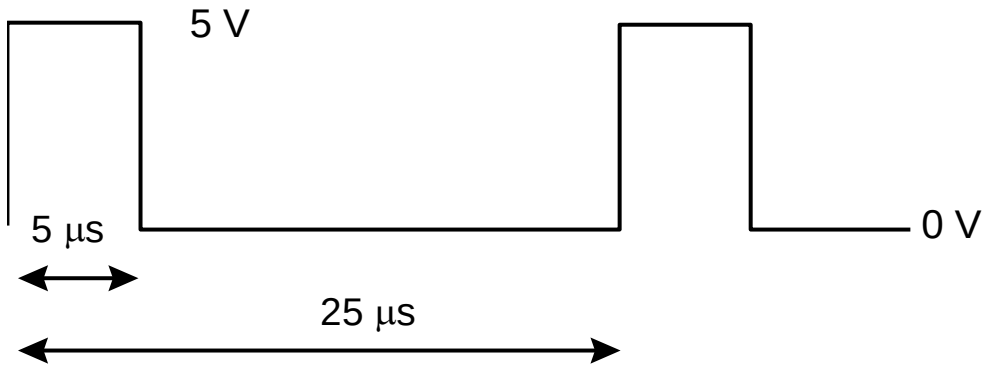
Sin(x)/x

$$V_n = \frac{2V\tau}{T} \cdot \frac{\sin Nx}{x} \qquad x = \frac{\pi\tau}{T}$$





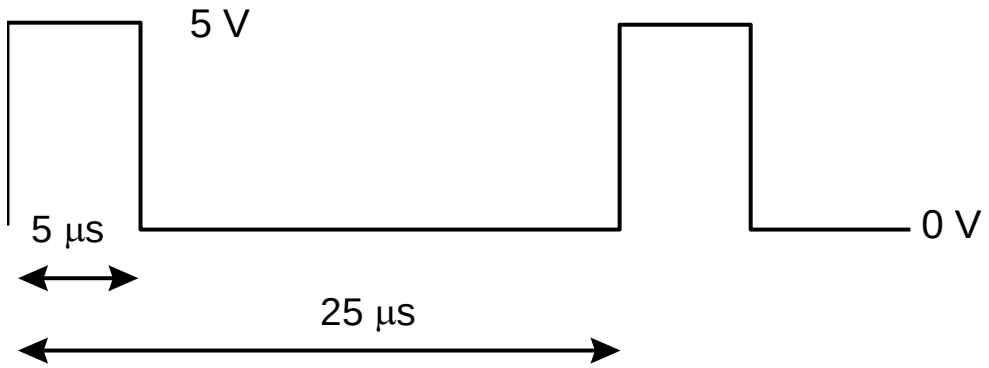
Worked Example



$$v(t)=\frac{Vt}{T}+\sum_{N=1}^{\infty}\left[\frac{2Vt}{T}.\frac{\sin(N\pi\,t/T)}{N\pi\,t/T}\right]\cos(N\omega_1 t)$$

$$V_{DC}=V_{pk}\ \frac{t}{T}=5.\frac{5}{25}=1\ V$$

Worked Example



$$f_1 = \frac{1}{T} = \frac{1}{25 \times 10^{-6}} = 40\ kHz$$

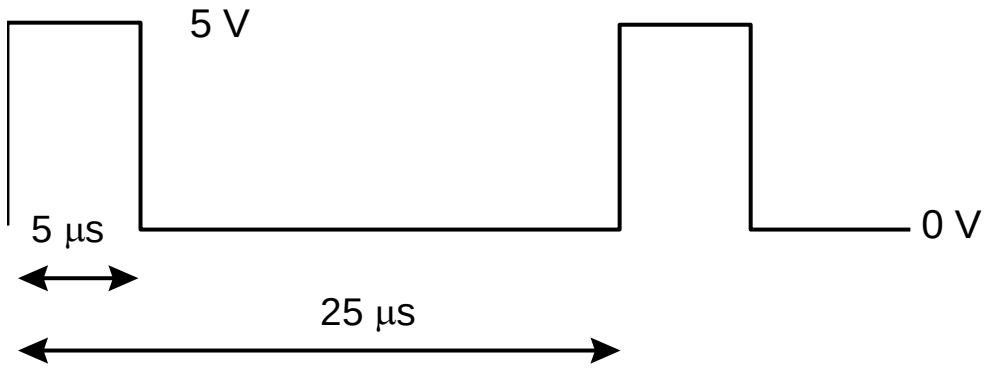
$$f_2 = 80\ kHz$$

$$f_3 = 120\ kHz$$

$$f_4 = 160\ kHz$$

$$f_5 = 200\ kHz$$

Worked Example

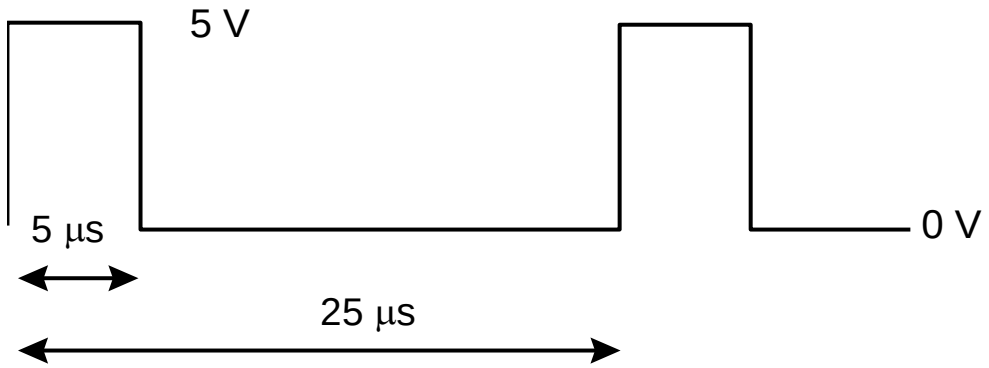


$$V_N = \frac{2Vt}{T} \cdot \frac{\sin(N\pi\, t/T)}{N\pi\, t/T}$$

$$V_N = \frac{2 \times 5 \times 5}{25} \cdot \frac{\sin(0.2N\pi)}{0.2N\pi}$$

$$= \frac{3.18}{N} \cdot \sin(0.63N) \quad \text{V}$$

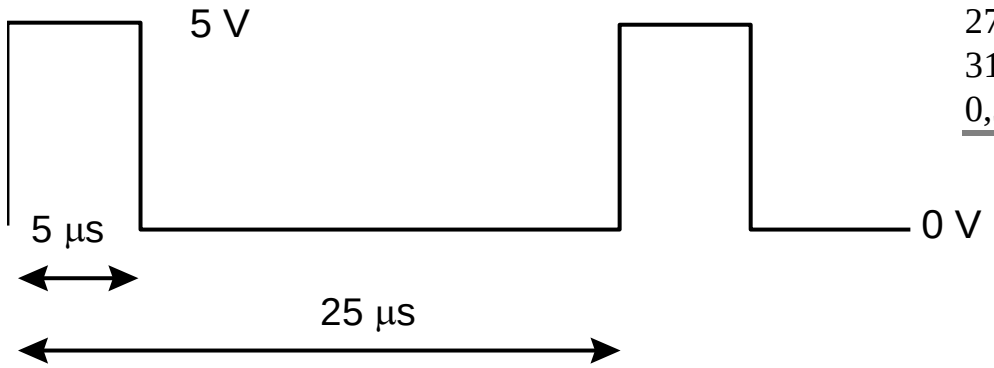
N	*f (kHz)*	*V amplitude (Volts)*
1	40	1.87
2	80	1.51
3	120	1.01
4	160	0.47
5	200	0



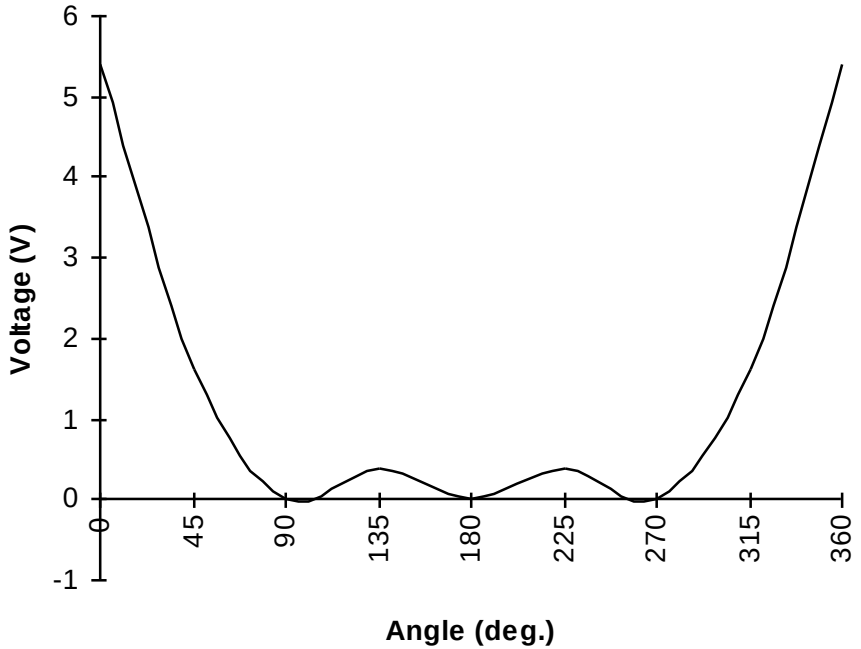
$$v_i(t) = 1 + 1.87\sin(\omega_1 t) + 1.51\sin(2\omega_1 t) + 1.01\sin(3\omega_1 t) + 0.47\sin(4\omega_1 t) + \ldots\ldots$$

ωt (°)	V_0	V_1	V_2	V_3	Σ
	1	1.77 cosωt	1.51 cos2ωt	1.01 cos3ωt	
45	1	1.32	0	–0.71	1.61
90	1	0	–1.51	0	–0.51
135	1	–1.32	0	0.71	0.39
180	1	–1.87	1.51	–1.01	–0.37
225	1	–1.32	0	0.71	0.39
270	1	0	–1.51	0	–0.51
315	1	1.32	0	–0.71	1.61
0,360	1	1.87	1.51	1.01	5.39

Worked Example

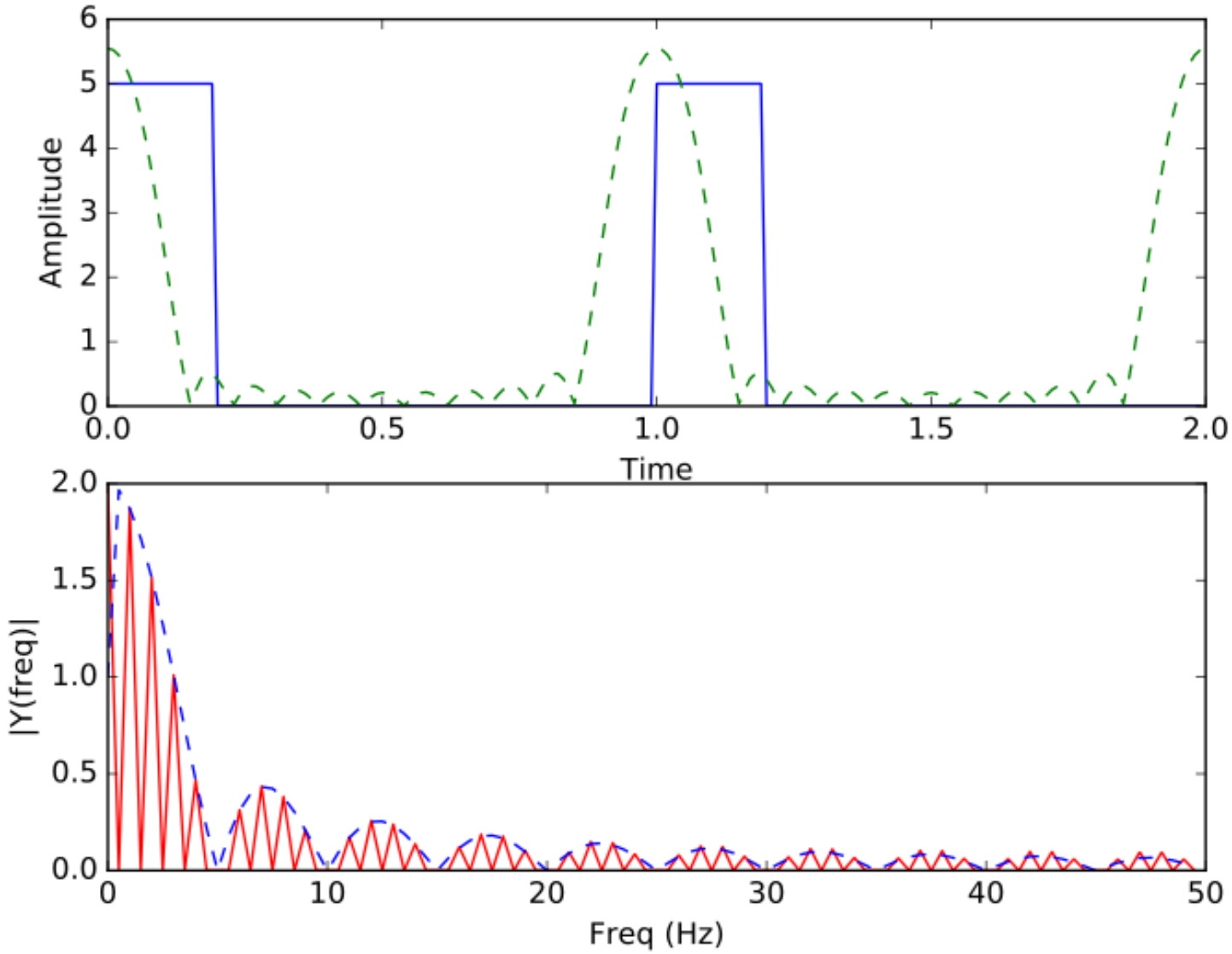


ωt (°)	V_0	V_1	V_2	V_3	Σ
	1	1.77 cosωt	1.51 cos2ωt	1.01 cos3ωt	
45	1	1.32	0	–0.71	1.61
90	1	0	–1.51	0	–0.51
135	1	–1.32	0	0.71	0.39
180	1	–1.87	1.51	–1.01	–0.37
225	1	–1.32	0	0.71	0.39
270	1	0	–1.51	0	–0.51
315	1	1.32	0	–0.71	1.61
0,360	1	1.87	1.51	1.01	5.39



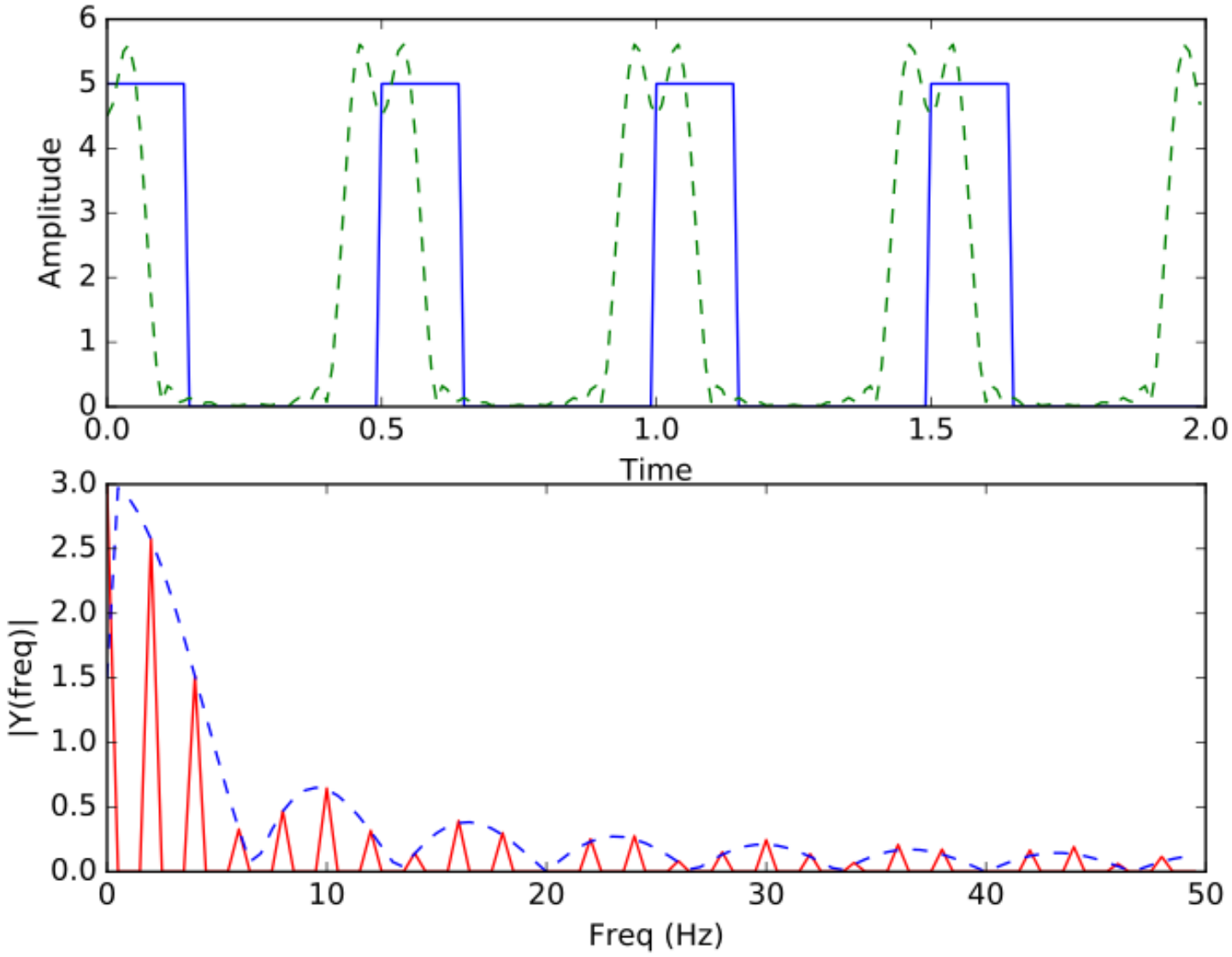
Example

- Duty cycle=0.2.
- Link.



Example

- Duty cycle=0.3.
- Link.



CSN08704

Telecommunications

4. Analysis of Digital Pulses

Data, Audio, Video and Images

http://asecuritysite.com/comms

Prof Bill Buchanan