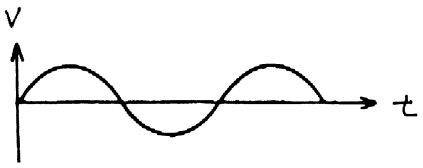
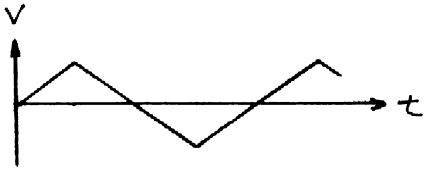
Tutorial 2 - Signal and Spectra

1. State, with reasons, whether the following are analog or digital signals.

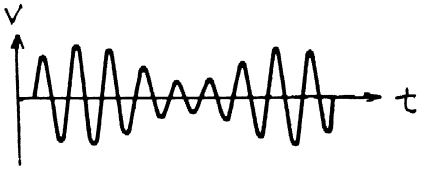
(a)



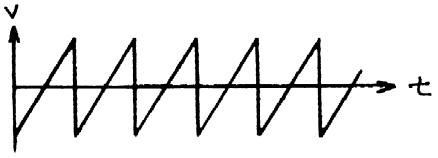
(e)



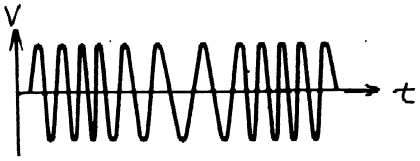
(b)



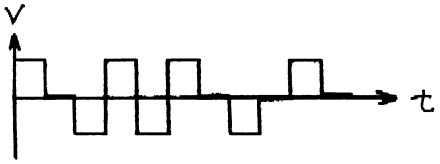
(f)



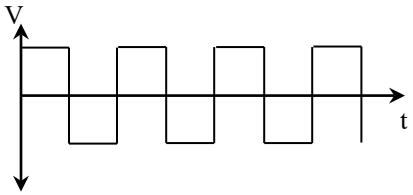
(c)



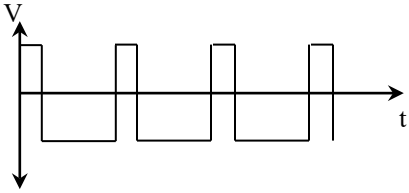
(g)



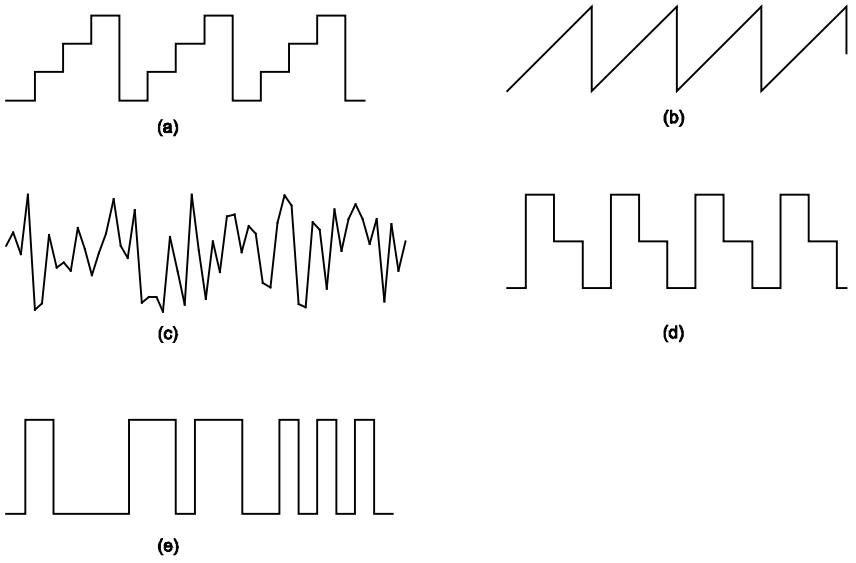
(d)



(h)



2. State with reason whether the following signals are periodic or non-periodic. Indicate the period, T for the periodic signals.



3. (a) What is the DC level of the signal in Figure T2.1?

   (b) Sketch the single-sided and double-sided amplitude spectrum for the sinusoidal waveform in Figure T2.1.

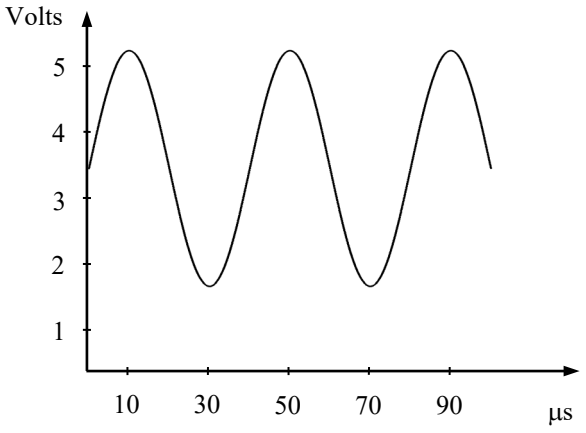


Figure T2.1 A sinusoidal waveform

4. The trigonometric Fourier series of the square wave in Figure T2.2 is given by

$$v(t) = \frac{4A}{\pi}\left(\sin\omega_0 t + \frac{\sin 3\omega_0 t}{3} + \frac{\sin 5\omega_0 t}{5} + \cdots\right)$$

Sketch the single-sided and double-sided amplitude spectrum of the signal up to the fifth harmonic. Indicate the frequency and peak amplitude of each component.

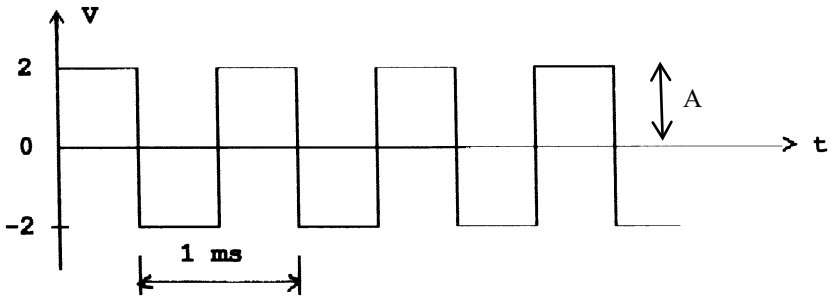


Figure T2.2 A square wave

5. Sketch the amplitude spectrum of rect (t).

6. Sketch x(t) whose frequency spectrum is given below in Figure. T2.3.

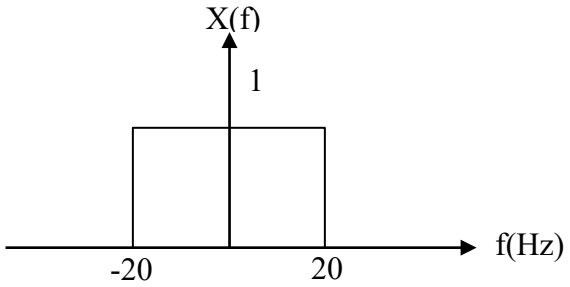


Figure T2.3

7. State the main difference between the amplitude spectrums of periodic and non periodic signals.

8. Express 2W of power in dBW and dBm. Show all the steps clearly.

9. Show that 0 dBW = 30 dBm

10. A zero DC rectangular wave with a fundamental frequency of 4 kHz is bandlimited to the first 5 components. What is its bandwidth after bandlimiting?

11. The trigonometric Fourier series of a waveform x(t) is given below.

$$x(t) = \frac{1}{2} - \frac{1}{\pi}\sum_{n=1}^{\infty}\frac{\sin n4000\pi t}{n}$$

(a) Sketch its double-sided amplitude spectrum up to the 4th harmonic.
(b) If the signal from part (a) is passed through an ideal BPF shown in Figure T2.4, sketch the resultant waveform and its amplitude spectrum.

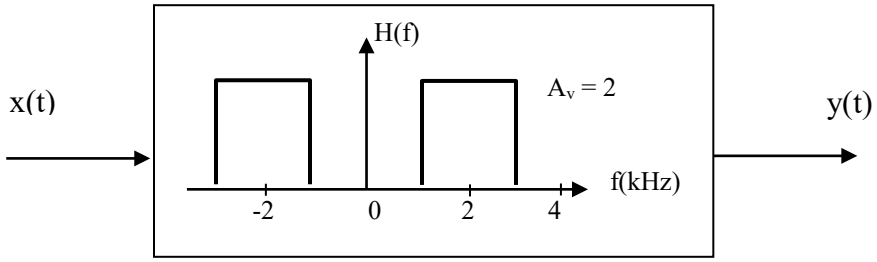


Figure T2.4

12. The trigonometric Fourier series of a waveform which repeats itself every 125 μs is given by

$$v(t) = 0.4 + \frac{0.8\sin 0.2\pi \cos\omega_0 t}{0.2\pi} + \frac{0.8\sin 0.4\pi \cos 2\omega_0 t}{0.4\pi}$$

$$+ \frac{0.8\sin 0.6\pi \cos 3\omega_0 t}{0.6\pi} + \frac{0.8\sin 0.8\pi \cos 4\omega_0 t}{0.8\pi} + \ldots$$

(a) Draw the double-sided amplitude spectrum, showing the amplitude and frequency of each component.

(b) Draw the resultant spectrum if the signal is passed through the BPF shown in Figure T2.5. The BPF has a passband from 8 kHz to 32 kHz.

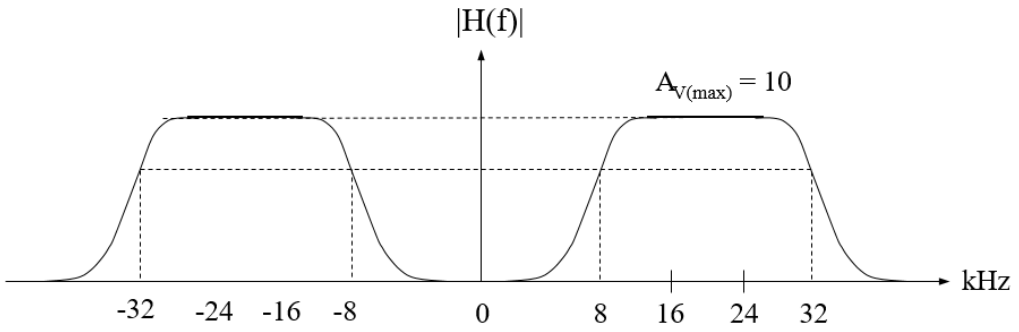


Figure T2.5 BPF