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Assignment1

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* The power we use at home has a frequency of 60 Hz. The period of this sine wave can be determine as follow

$$\Rightarrow T = \frac{1}{f} = \frac{1}{60} = 0.0166\,s = 0.0166 \times 10^{3}\,ms = 16.6\,ms$$

* The period of a signal is 100 ms. what is its frequency in kilohertz?

⇒ First we change 100ms to seconds, and then we calculate the freaunce from the Period

$$100\,ms = 100 \times 10^{-3}\,s = 10^{-1}\,s$$

$$f = \frac{1}{T} = \frac{1}{10^{-1}}\,Hz = 10\,Hz = 10 \times 10^{-3}\,kHz = 10^{-2}\,kHz$$

* A sine wave is $\frac{1}{6}$ cycle with respect to time 0 what is its phase in degrees and radians?

⇒ We know that 1 complete cycle is 360°. Therefore 1/6 cycle is

$$\frac{1}{6} \times 360 = 60^\circ = 60 \times \frac{2\pi}{260} \text{ rad} = \frac{\pi}{3} \text{ rad} = 1.046 \text{ rad}$$

* If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700 and 900 Hz, what is its bandwith. Draw the spectrum. assuming all components have a maximum amplitude of 10V.

⇒ Let f_n be the highest frequency, f_0 the lowest frequency, and B the bandwidth. Then

$$B = f_n - f_1 = 900 - 100 = 800 \text{ Hz}.$$

* A Periodic signal has a bandwidth of 20Hz. The higest frequency? Draw spectrum if the signal contains frequencies of the same amplitude

⇒ Let f_n be the highest frequency, f_0 the lowest frequency, and B the bandwith. Then,

$B = f_n - f_0 \Rightarrow 20 = 60 - f_i$

$\Rightarrow f_i = 60 - 20 = 40\ Hz$

* A digital signal has eight levels. How many bits are needed per level? We calculate the number of bits from the following formula. Each signal level is represented by 3 bits.

$\Rightarrow$ number of bits per level $= \log_2 8 = 3$

* Assume we need to download text document at the rate of 100 pages per second. What is the required bit rate of the channel?

$\Rightarrow$ A page is an average of 24 lines with 80 characters in each line. If we Assume the one character requires 8 bits, the bit rate is

$$100 \times 24 \times 80 \times 8 = 1536000 \text{ bps}$$

$$= 1.536 \text{ Mbps}$$

* A digitized voice channel as we will see in chapter 4 is made by digitizing 4-kHz bandwidth analog voice signal, we need to sample the signal at twice the highest frequency (two samples per hertz). we assume that each sample requires 8 bits. what is the required bit rate?

⇒ The bit rate can be calculated as

$$2 \times 4000 \times 8 = 64000 \text{ bps} = 64 \text{ kbps}.$$

* What is the bit rate for high-defination TV?

⇒ HDTV uses digital signals to broadcast high quality video signal. The HDTV screen is normally ratio 16:9. which mean the screen is wider. There are 1920 by 1080

Pixel per Screen. and screen is renewed 30 times per second. Twenty-four bits represent one colour pixel. we can calculate $1920 \times 1080 \times 30 \times 24 = 1,492,992,000 = 1.5$ Gbs The Tv station reduce this rate to 20 to 45 Mbps. through compression.

* What is the required bandwidth of a low-pass channel if weed to spend 1 Mbps by using base-band transmission?

→ The answer depend of accuracy desired.

(a) The minimum bandwidth, a rough approximation is B = bit rate/2, or 500 kHz. We need a low-pass channel with frequencies between 0 and 500 KHz.

(b) A better result can be achieved by using the first and the third harmonics

the required bandwidth $B = 3 \times 500\ kHz = 1.5\ MHz$

(c) A still better result can be achieved by using the first, third and fifth harmonics with $B = 5 \times 500\ kHz = 2.5\ MHz$.

* We have a low-pass channel with bandwidth 100 kHz, what is the maximum bit rate of this channel?

⇒ The maximum bit rate can be achieved if we use the first harmonic. The bit rate is 2 times the available bandwidth or 200 kHz.

* Suppose a signal travels through a transmission medium and its power is reduced to one-half. this means that $P_2 = \frac{1}{2} P_1$, in this case, the attention (loss of power) can be calculated as

$$\Rightarrow 10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{0.5 P_1}{P_1} = 10 \log_{10} 0.5$$

$$= 10(-0.3) = -3dB$$

* The power of signal is 10 mw and the power of the noise is 1 μW, what are the values of SNR and SNR_{dB}?

⇒ The values of SNR and SNR_{dB} can be calculated as

$$SNR = \frac{10,000\ \mu W}{1\ mW} = 10,000$$

$$SNR_{dB} = 10 \log_{10} 10,000 = 10 \log_{10} 10^4 = 40$$

* What are the propagation time and the transmittion time for a 2.5 kbyte message (an email) if the bandwidth of network is 1 Gbps? Assume that the distance between the sender and the receive is 12000 km

that light travel at 2.4×10^8 m/s.

Propagation time $= \frac{12000 \times 100}{2.4 \times 10^8} = 50$ ms

transmission time $= \frac{2500 \times 8}{10^7} = 0.020$ ms.

Review question answer

(I) Frequency and Period are the inverse of each other $T = \frac{1}{f}$ and $f = \frac{1}{T}$.

(II) The amplitude of a signal measures the value of the signal at any point The frequency of a signal refers to the number of periods in one second. The phase describes the position of the wave from relative to time zero.

(III) Using Fourier analysis, Fourrier series give the frequency domain of a periodic signal, fourrier analysis give the freqaency of a non perridic signal

(IV) Three types of transmission impairment are attenuation, distortion and noise.

(V) Baseband transmisson means sending a digital or an analog signal without modulation using a low pass channel. Baseband transmission means modulating a digital or an analog signal using band-pass channel.

(VI) A low-pass channel has a bandwidth staring from zero, a band-pass channel has a band with that does not start from zero.

(VII) The Nyquist theorem defines the maximum bit rate of a noiseless channel.

(VIII). The shannon capacity determines the theoretical maximum bit rate of a noisy channel.

(IX) Optical signal have very high frequency. A high frequency means short wavelength cause the wave length the inversely proportional to the frequency ($\lambda = \frac{v}{f}$).

(X) A signal is periodic if its frequency domain plot a discrete, a signal is non periodic if its frequency domain plot is continuous.

(XI) The frequency domain of voice signal is normally continuous because voice is a nonperiodic signal.

(XII) An alarm system is normally periodic. Its frequency domain plot is therefore discrete.

(xiii) This is base band transmission because no modulation is involed.

(xiv) This is baseband transmission because no modulation is invalved.

(xv) This is broadband transmission because it involves modution.

31. The attenuation of a signal is -10dB. What is the final sigal power if it was orginally 5w?

$$\Rightarrow -10 = 10 \log_{10}\left(\frac{P_2}{5}\right)$$

$$\Rightarrow 10_{10}\left(\frac{P_2}{5} = -1\right.$$

$$\Rightarrow P_2/5 = 10^{-1}$$

$$\therefore P_2 = 0.5\,w$$