

Ex-3.6 // A sine wave is offset $\frac{1}{6}$ cycle with respect to time 0. What is its phase in degrees and radians?

Ans: 1 complete cycle = 360°

$$\therefore \frac{1}{6} \text{ " " } = 360^\circ \times \frac{1}{6} = 60^\circ \text{ (Ans.)}$$

$$= \frac{\pi}{3} \text{ rad (Ans.)}$$

Ex-3.16 A digital signal has eight levels. How many bits are needed per level?

Ans: Number of bits per level = $\log_2 L$

$$= \log_2 8$$

$$= \log_2 2^3$$

$$= 3 \text{ (Ans.)}$$

3.18

Assume we need to download text documents at the rate of 100 pages per second. A page has 24 lines, and 80 characters each line. What is the required bit rate of the channel?

Ans:

$$\text{Bit rate} = 100 \times 24 \times 80 \times 8$$

$$= 1.5 \text{ Mbps}$$

$$\begin{array}{|l} \hline 1 \text{ character} \\ = 8 \text{ bits} \end{array}$$

Ex-3.26

A signal travels through a transmission medium and its power is reduced to one half. What is attenuation?

Ans:

$$\begin{aligned}\text{Attenuation} &= 10 \log_{10} \left(\frac{\text{Output power}}{\text{Input power}} \right) \\ &= 10 \log_{10} \left(\frac{0.5P}{P} \right) \\ &= -3 \text{ dB} \quad (1588)\end{aligned}$$

Ex-3.31

The power of a signal is 10 mW and the power of the noise is 1 μ W. What is the value of SNR and SNR_{dB}?

Solution:

$$\begin{aligned}\text{SNR} &= \frac{\text{Signal power}}{\text{Noise power}} = \frac{10000 \mu\text{W}}{1 \mu\text{W}} \quad \left| \begin{array}{l} 10 \text{ mW} \\ = 10000 \mu\text{W} \end{array} \right. \\ &= 10000 \quad (Am.) \\ \text{SNR}_{\text{dB}} &= 10 \log_{10} (\text{SNR}) \\ &= 10 \log_{10} (10000) = 10 \log_{10} 10^4 = 40 \text{ dB} \quad (Am.)\end{aligned}$$

Ex-3.32

What is the values of SNR and SNR_{dB} for a noiseless channel?

Ans: $\text{SNR} = \frac{\text{Signal power}}{\text{Noise power}}$

$\Rightarrow \text{SNR} = \frac{\text{Signal power}}{0}$

$\therefore \text{SNR} = \infty$

And $\text{SNR}_{\text{dB}} = 10 \log_{10} (\infty) = \infty$

Noiseless channel

Noise power = 0 Watt

① Noiseless channel: Nyquist Bit Rate = $2 \times \text{Bandwidth} \times \log_2 L$

② Noisy channel: Shannon capacity, C = $\text{Bandwidth} \times \log_2 (1 + \text{SNR})$

3.34

Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with two signal levels. What is the maximum bit rate?

Ans: Bit Rate = $2 \times B \times \log_2 L$
 $= 2 \times 3000 \times \log_2 2$
 $= 6000 \text{ bps (Ans.)}$

$L = 2$
 $B = 3000 \text{ Hz}$

3.41

We have a channel with a 1-MHz bandwidth. The SNR for this channel is 63. What are the appropriate bit rate and signal level?

Ans: $C = B \log_2 (1 + \text{SNR})$
 $= 10^6 \log_2 (1 + 63)$
 $= 10^6 \times \log_2 2^6$

$= 6 \times 10^6 \text{ bps}$
 $= 6 \text{ Mbps}$

Shannon capacity always uses upper limit

So, take $C = 4 \text{ Mbps}$

$\therefore \text{Bit rate} = 2 \times B \times \log_2 L$

$\Rightarrow 4 = 2 \times 1 \times \log_2 L$

$\Rightarrow \log_2 L = 2$

$\therefore L = 4$

3.44

A network with bandwidth of 10 Mbps can pass only an average of 12,000 frames per minute with each frame carrying an average of 10000 bits. What is the throughput?

Ans: Throughput = $(12000 \times 10000) / 60 = 2 \text{ Mbps}$.

NB: 10 Mbps Bandwidth, 2Mbps Throughput

(B > T) always. Throughput: actual measurement how fast we send data.

$$\textcircled{1} \text{ propagation Time} = \frac{\text{Distance}}{\text{propagation speed}} = \frac{S}{V}$$

$$\textcircled{2} \text{ Transmission Time} = \frac{\text{message size}}{\text{Bandwidth}}$$

3.45 What is the propagation time if the distance between the two points is 12,000 km? Assume the propagation speed is $2.4 \times 10^8 \text{ m/s}$ in cable.

Ans: We know,

$$\begin{aligned} \text{propagation time} &= \frac{\text{Distance}}{\text{propagation speed}} \\ &= \frac{12000 \times 1000}{2.4 \times 10^8} = 0.05 \text{ s} \\ &= 50 \text{ ms (Ans.)} \end{aligned}$$

3.46 What are the propagation time and the transmission time for 2.5 KB message, where, bandwidth is 1 Gbps, distance between sender & receiver is 12000 km and speed of light $2.4 \times 10^8 \text{ m/s}$

$$\text{Ans: propagation time} = \frac{\text{distance}}{\text{prop. speed}} = \frac{12000 \times 1000}{2.4 \times 10^8} = 50 \text{ ms}$$

$$\text{Transmission time} = \frac{\text{message size}}{\text{bandwidth}} = \frac{2.5 \times 10^3 \times 8}{10^9} = 0.02 \text{ ms}$$

ANE
2021

How long does it take to send a file of 500000 bits from host A to host B over a circuit switched network.

- All links are 1.5 Mbps, Each link uses TDM with 16 slots and 300 msec to establish end-to-end circuit.

(16 marks)

$$\text{Ans: Transmission time} = \frac{\text{Message size}}{\text{Bandwidth}} = \frac{5 \times 10^5}{0.9375 \times 10^6} = 5.333 \text{ Sec}$$

$$\therefore \text{Total time} = (5.33 + 0.3) = 5.63 \text{ Sec}$$

$$\begin{aligned} \text{Bandwidth} &= \frac{1.5}{16} \\ &= \frac{1.5 \times 10^6}{16} \text{ Mbps} \\ &= 0.09375 \times 10^6 \\ &= 0.9375 \times 10^5 \text{ bps} \end{aligned}$$

① Bit rate = $2 \times \text{Sampling rate} \Rightarrow B = 2f_s$

② Relation between bit per sample & SNR_{dB} is $\Rightarrow \text{SNR}_{dB} = 6.02n_b + 1.76$ dB

4.14

We want to digitize the human voice. What is the bit rate, assuming 8 bits per sample?

Ans: Bit rate = $2 \times f_s = 2 \times 4000$ Samples/s

= 8000 samples/s

= 8000×8 bps

= 64 Kbps (Ans.)



A speech signal has a total duration of 10 s. It is sampled at the rate of 8 KHz and then encoded. The SNR is 40 dB. Calculate minimum storage capacity needed to accommodate this digitized speech signal.

Ans: $\text{SNR}_{dB} = 6.02n_b + 1.76$

$\Rightarrow 40 = 6.02n_b + 1.76$

$\Rightarrow n_b = \frac{38.24}{6.02} = 6.35$

$\therefore n_b \approx 7$

So, at 10 sec. total sample = $10 \times 8000 = 8 \times 10^4$

$\therefore$ Minimum storage capacity = $8 \times 7 \times 10^4$ bps

= 560 Kbps