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SECTION:

5D (ALPHA)

ROLL NO:

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SUBJECT:

DATA COMMUNICATION AND NETWORKS

Q1) Review Questions.

① What is the relationship between period and frequency?

To find the frequency you simply count the number of vibrations each second. An alternative way to do the counting is to find out how long one complete vibration takes and then to calculate how many of these you can get in one second.

Whereas, the time for one complete vibration is called Period. and is measured in seconds.

② What does the amplitude of a signal measure?
What does the frequency of a signal measure?
What does the phase of a signal measure?

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 waveform relative to time zero.

③ Name three types of transmission impairment?

There are the following three types of transmission impairments:

- Attenuation.
- Delay Distortion.
- Noise.

④ Distinguish between baseband and broadband transmission:

Baseband transmission uses digital signaling while broadband transmission uses analog signals in the form of optical or electromagnetic waves over multiple transmission frequencies.

⑤ Distinguish between a low-pass and a band-pass channel.

A low-pass channel has a bandwidth starting from zero whereas a band-pass channel has a bandwidth that doesnot start from zero.

⑥ What does the Nyquist theorem have to do with communications?

It uses in communication for converting the analog to digital. And it provides mathematical function to determine the max bit rate. It also doubles the bandwidth equals to ~~highest~~ double the highest data rate.

⑦ What does the Shannon capacity have to do with communications?

It defines the maximum amount of information, or data capacity which can be sent over any channel or medium.

(8) Can we say if a signal is periodic or non-periodic by just looking at its frequency domain plot? How?

The given signal may be periodic if its frequency spectrum having the fundamental time period repeats at regular intervals of time. The given signal is non periodic when the signals frequency is random and it is not defined as in sine wave or cosine wave.

(9) Is the frequency domain plot of a voice signal discrete or continuous?

The frequency domain of a voice signal is normally continuous because voice is a non-periodic signal.

(10) Is the frequency domain plot of an alarm system discrete or continous?

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

EXERCISE QUESTIONS:-

① Given the frequencies listed below, calculate the corresponding periods.

(a) 24Hz.

$$T = 1/f = 1/24$$

$$T = 41.6\ ms$$

(b) 8 MHz.

$$T = 1/f = 1/8\times10^{6}$$

$$T = 125\ nS$$

(c) 140 KHz.

$$T = 1/f = 1/140\times10^{3}$$

$$T = 7.1\ \mu s$$

② Given the following periods, calculate the corresponding frequencies.

(a) 5 s

$$F = 1/5 = 0.2\ Hz$$

(b) 12 microsec

$$F = 1/12\times10^{-6} = 83333.3\ Hz$$

(c) 220ns

$$F = \frac{1}{220\times10^{-9}} = 4545454.5\ Hz.$$

③ What is the phase shifting for the following.

(a) A sine wave with the maximum amplitude at time zero.

Phase Shift = 0°

(b) A sine wave with the maximum amplitude with 1/4 cycle.

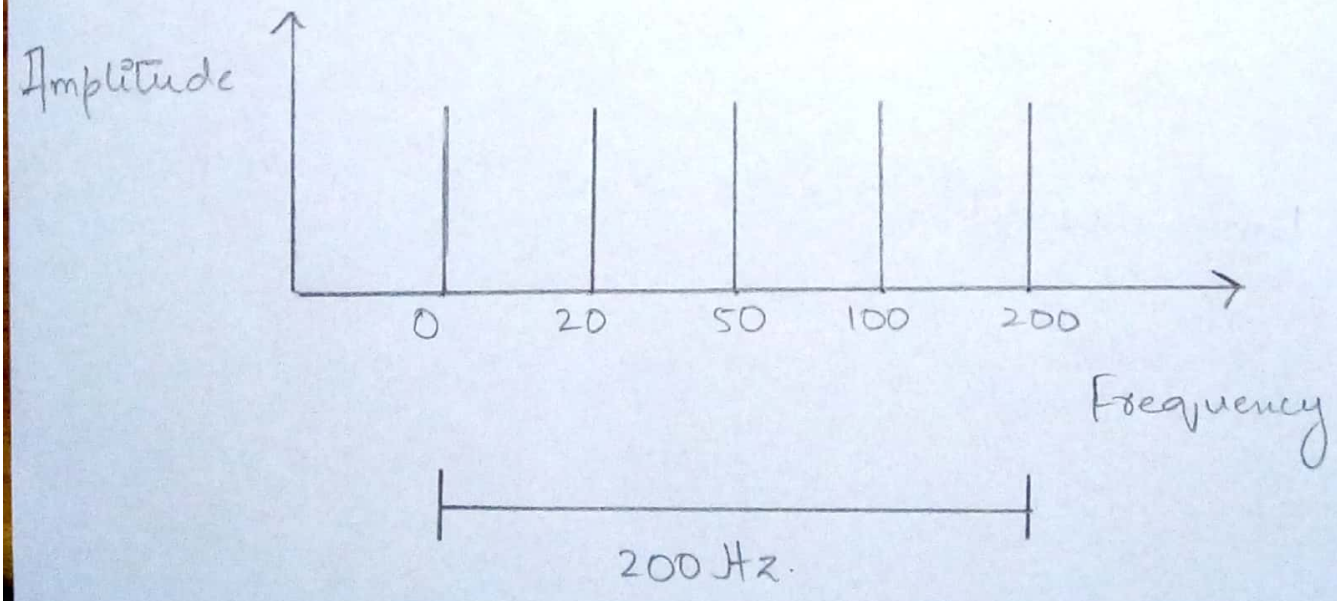
Phase Shift = $\frac{1}{4} \times 360 = 90^\circ$

(c) A sine wave with zero amplitude after 3/4 cycle and increasing.

Phase Shift = $\frac{3}{4} \times 360 = 270^\circ$

④ What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100 and 200 Hz? All peak amplitudes are the same. Draw the bandwidth.

$B = f_H - f_L = 200 - 0 = 200\,Hz$



⑤ A device is sending out data at the rate of 1000 bps.

(a) How long does it take to send out 10 bits?

Bit interval $= \frac{1}{1000} = 0.001$ s.

(b) How long does it take to send out a single character (8 bits).

Time to send 10 bits $= 10 \times 0.001 = 0.01$ s.

(c) How long does it take to send out a file of 100,000 characters?

Time

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⑤ A device is sending out data at the rate of 1000 bps.

Bit interval $= \frac{1}{1000} = 0.001$ s.

(a) How long does it take to send out 10 bits?

Time to send 10 bits $= 10 \times 0.001 = 0.01$ s.

(b) How long does it take to send out a single character (8 bits)

Time to send 8 bits $= 8 \times 0.001 = 0.008$ s.

(c) How long does it take to send out a file of 100,000 characters?

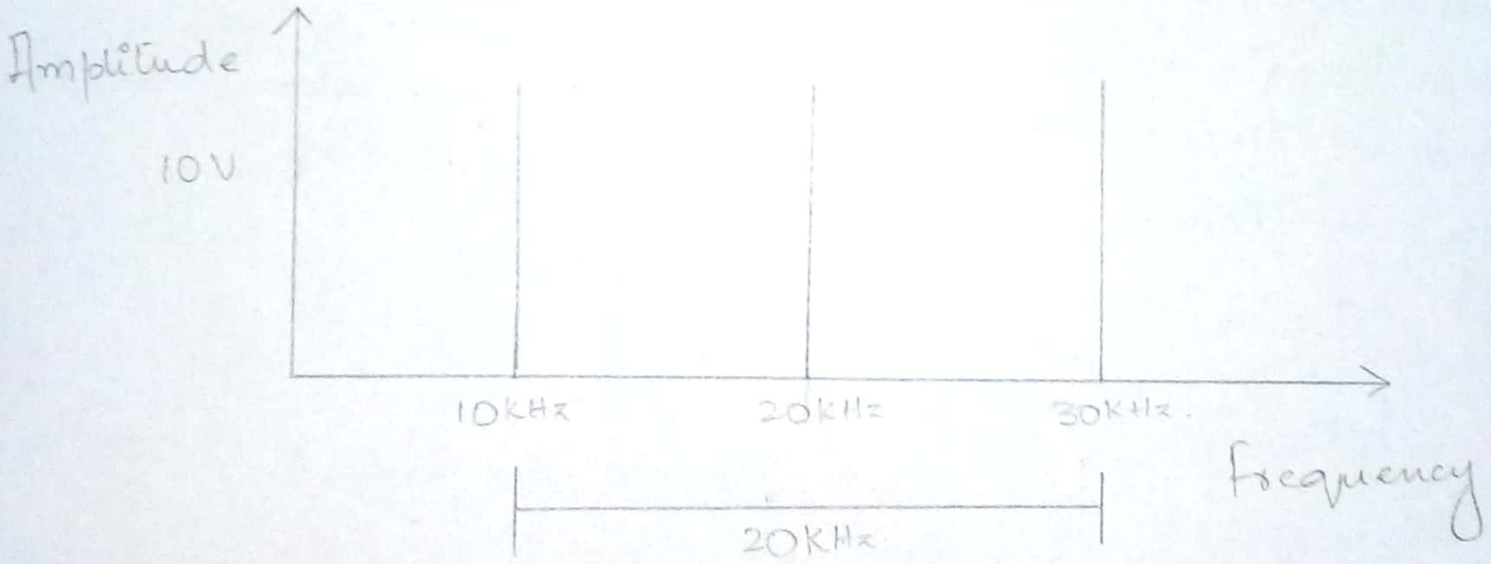
If 1 character is equal to 8 bits.

Therefore,

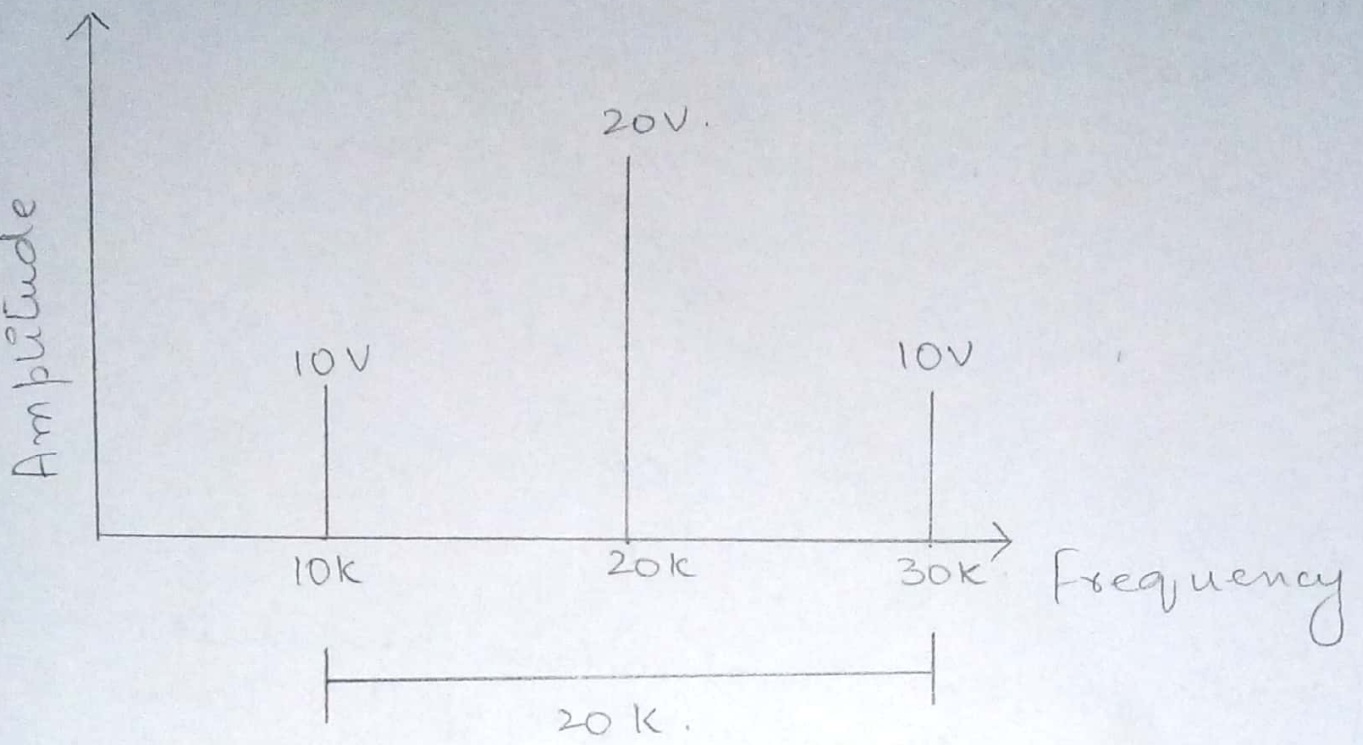
100,000 characters are equal to 800,000 bits.

Time to send 800,000 bits. = $800{,}000 \times 0.001 = 800s$.

⑥ A periodic composite signal contains frequencies from 10-30 KHz. each with an amplitude of 10V. Draw the frequency spectrum.



⑦ A non-periodic composite signals contains frequency from 10 to 30 kHz. The peak amplitude is 10V for the lowest and the highest signals and is 30V for the 20kHz signal. Assuming that the amplitudes change gradually from minimum to maximum. Draw the frequency spectrum.



(8) Consider a noiseless channel with a bandwidth of 3000 Hz. Transmitting a signal with two signal levels. How maximum bit rate can be calculated.? Consider the same noiseless channel transmitting a signal with four signal levels. How maximum bit rate can be calculated?

$$C = 2W\log_2 L = 2(3000)\log_2 2 = 6000 \text{ bps}$$

For 4 levels :-

$$C = 2W\log_2 L = 2(3000)\log_2 4 = 12000 \text{ bp}$$

(9) We need to send 265 Kbps over a noiseless channel with a bandwidth of 20 kHz. How many signal levels do we need?

$$C = 2W \log_2 L$$

$$265 = 2 \times 20000 \times \log_2 L.$$

$$0.007 = \log_2 L.$$

$$L = 2^{0.007}$$

$$\boxed{L = 1.005}$$

(10) Consider an extremely noisy channel in which the value of the signal-to-noise ratio is almost zero. In other words, the noise is so strong that the signal is faint. For this channel how the capacity C is calculated

$$C = W \log_2 (1 + SNR)$$

$$C = W \log_2 (1 + 0)$$

$$C = W \log_2 (0)$$

$$C = 0$$

(11) The attenuation of a signal is -10 dB. What is the final signal power if it was originally 5W?

$$-10 = 10 \log_{10} \frac{P_2}{P_1}$$

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

$$0.1 = P_2/5$$

$$P_2 = 0.5\ W$$

(12) A line has a signal-to-noise ratio of 1000 and a bandwidth of 4000 KHz. What is the maximum data rate supported by this line.?

$$C = W \log_2 (1 + SNR)$$

$$C = (4000 \times 10^3) \log_2 (1 + 1000)$$

$$C = 39868905.04 \text{ bps}.$$

(13) We measure the performance of a telephone line. When the signal is 10V, the noise is 5mV. What is the maximum data rate supported by this telephone line?

$$C = W \log_2 \left(1 + \frac{S}{N}\right)$$

$$C = (4000) \log_2 \left(1 + \frac{10}{5 \times 10^{-3}}\right)$$

$$C = 43866.0 \text{ bps}$$

(14) If the peak voltage value of a signal is 20 times the peak voltage value of the noise, what is SNR? What is the SNRdB?

$$SNR = \frac{20N}{N}$$

$$SNR = 20.$$

$$SNRdB = 10 \log_{10} SNR.$$

$$SNRdB = 13.01.$$

(15) What is the theoretical capacity of a channel in each of the following cases:

(a) Bandwidth: 20 KHz, $SNR_{dB} = 40$

$$SNR_{dB} = 10 \log_{10} SNR.$$

$$40 = 10 \log_{10} SNR.$$

$$10^4 = SNR$$

$$SNR = 10000$$

$$\therefore C = (20 \times 10^3) \log_2 (10000)$$

$$C = 265754.2 \text{ bps}$$

(b) Bandwidth: 200 KHz $SNR_{dB} = 4$

$$SNR_{dB} = 10 \log_{10} SNR$$

$$4 = 10 \log_{10} SNR$$

$$SNR = 2.511$$

$$C = (200 \times 10^3) \log_2 (2.511)$$

$$C = 265652.4 \text{ bps}$$

(c) Bandwidth : 1 MHz $SNR_{dB} = 20$

$$SNR_{dB} = 10 \log_{10} SNR$$

$$20 = 10 \log_{10} SNR$$

$$SNR = 100$$

$$\therefore C = (1 \times 10^6) \log_2 (100)$$

$$C = 6643856.1 \text{ bps}$$