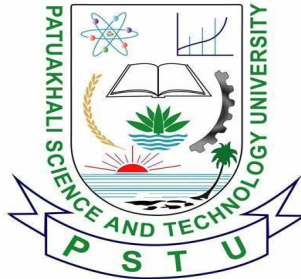


PATUAKHALI SCIENCE AND TECHNOLOGY UNIVERSITY



COURSE CODE: CCE-211

Course Title: Data Communication and Networking

SUBMITTED TO:

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Assignment Topic: Chapter Three (Physical Layer)

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Q3-1. What is the relationship between period and frequency?

Answer: Period, $T = 1/\text{Frequency, } f$

Q3-2. What does the amplitude of a signal measure? What does the frequency of a signal measure? What does the phase of a signal measure?

Answer:

The amplitude of a signal measures its strength or intensity. It represents the maximum displacement of the signal from its baseline.

The frequency of a signal measures how many complete cycles of the waveform occur in a given unit of time (Hz).

The phase of a signal measures the relative timing of the waveform compared to a reference point. (radian or degree)

Q3-3. How can a composite signal be decomposed into its individual frequencies?

Answer:

If the composite signal is periodic, the decomposition gives a series of signals with discrete frequency. If the composite signal is non-periodic, the decomposition gives a combination of sine waves with continuous frequency.

Q3-4. Name three types of transmission impairment.

Answer:

1. Attenuation
2. Distortion
3. Noise

Q3-5. Distinguish between baseband transmission and broadband transmission.

Answer:

Baseband: digital to digital

Broadband: digital to analog

Q3-6. Distinguish between a low-pass channel and a band-pass channel.

Answer:

Low-pass channel: a bandwidth that starts from zero.

Band-pass channel: doesn't start from zero.

Q3-7. What does the Nyquist theorem have to do with communications?

Answer:

Nyquist theorem ensures accurate signal reconstruction in communications by setting minimum sampling rates.

Q3-8. What does the Shannon capacity have to do with communications?

Answer:

The Shannon capacity determines the maximum data rate achievable over a communication channel, shaping the design of efficient communication systems.

Q3-9. Why do optical signals used in fiber optic cables have a very short wave length?

Answer:

To minimize signal attenuation and maximize data transmission capacity.

Q3-10. Can we say whether a signal is periodic or nonperiodic by just looking at its frequency domain plot? How?

Answer: Yes.

Non-periodic: a continuous frequency distribution

Periodic: exhibit discrete spectral lines at harmonics of a fundamental frequency.

Q3-11. Is the frequency domain plot of a voice signal discrete or continuous?

Answer: Continuous.

Q3-12. Is the frequency domain plot of an alarm system discrete or continuous?

Answer: Discrete.

Q3-13. We send a voice signal from a microphone to a recorder. Is this baseband or broadband transmission?

Answer: Baseband.

Q3-14. We send a digital signal from one station on a LAN to another station. Is this baseband or broadband transmission?

Answer: Broadband.

Q3-15. We modulate several voice signals and send them through the air. Is this base band or broadband transmission?

Answer: Broadband.

P3-1. Given the frequencies listed below, calculate the corresponding periods. **a.** 24 Hz **b.** 8 MHz **c.** 140 KHz

Answer:

a. For 24 Hz: $T = 1/24 = 0.0417$ seconds $T = 241 = 0.0417$ seconds

b. For 8 MHz: $T = 1/8 \times 10^6 = 1.25 \times 10^{-7}$ seconds $T = 8 \times 10^6 = 1.25 \times 10^{-7}$ seconds

c. For 140 KHz: $T = 1/140 \times 10^3 = 7.14 \times 10^{-6}$ seconds

$T = 140 \times 10^3 = 7.14 \times 10^{-6}$ seconds

P3-2. Given the following periods, calculate the corresponding frequencies. **a.** 5 s **b.** 12 μ s **c.** 220 ns

Answer:

a. For 5 s: $f = 1/5 = 0.2$ Hz $f = 51 = 0.2$ Hz

b. For 12 μ s: $f = 1/12 \times 10^{-6} = 83.3$ MHz $f = 12 \times 10^{-6} = 83.3$ MHz

c. For 220 ns: $f = 1/220 \times 10^{-9} = 4.55$ GHz $f = 220 \times 10^{-9} = 4.55$ GHz

P3-3. What is the phase shift for the following?

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

b. A sine wave with maximum amplitude after 1/4 cycle

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

Answer:

a. 0 degree

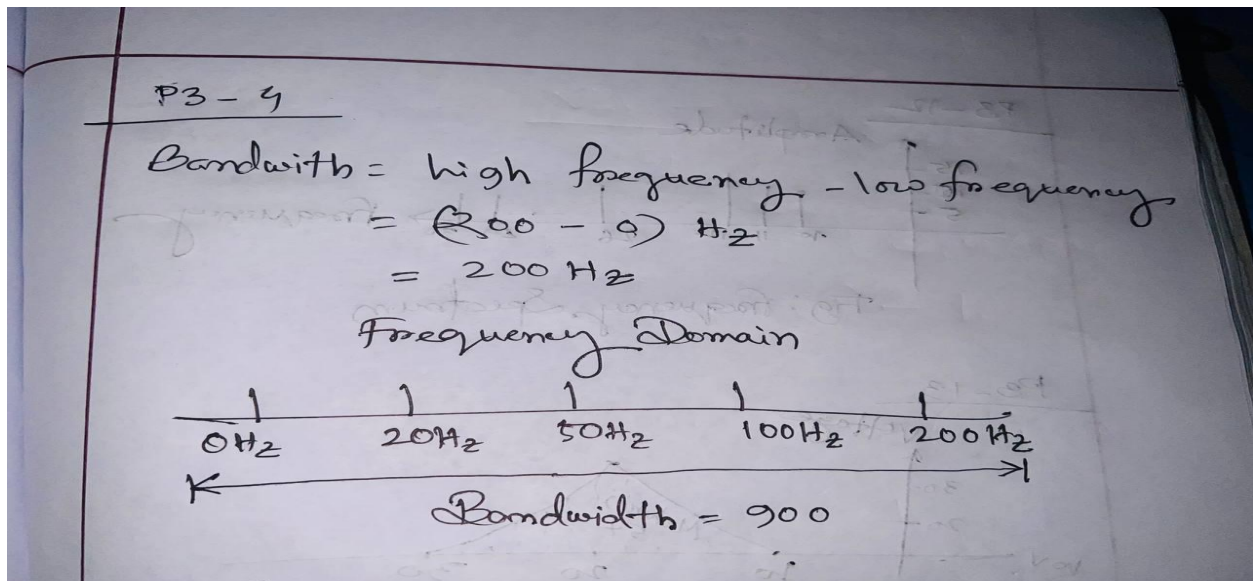
b. 90 degree

c. 270 degree

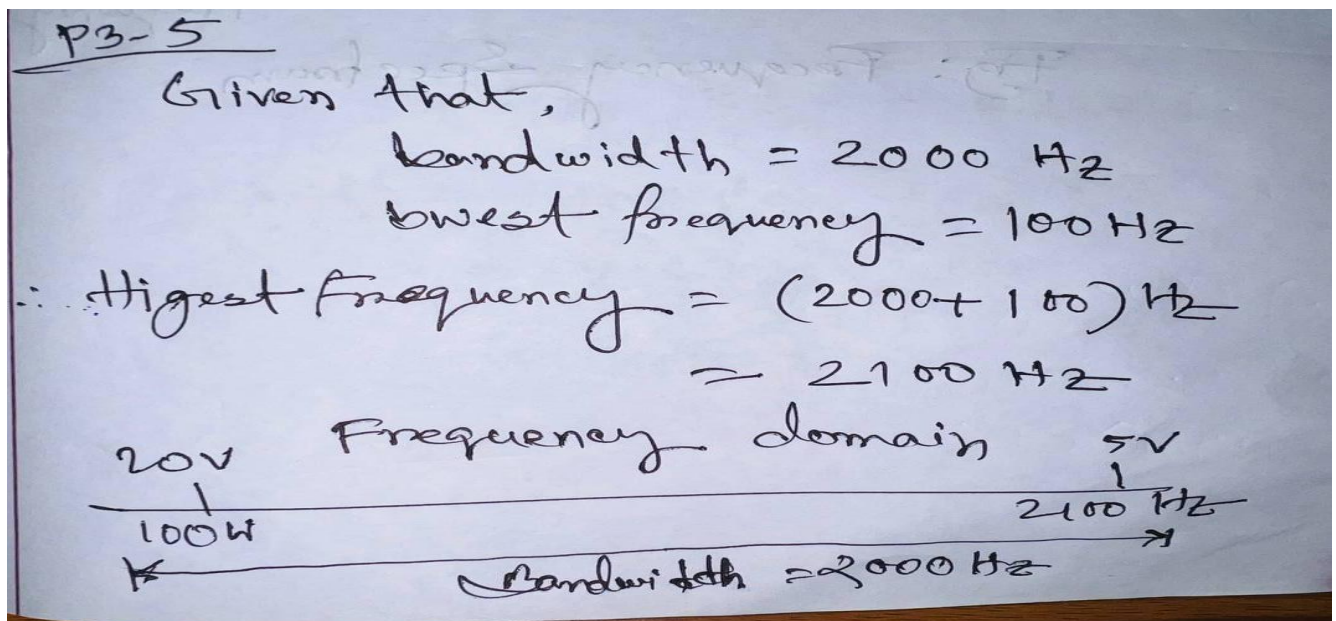
P3-4. What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100, and 200 Hz? All peak amplitudes are the same. Draw the bandwidth.

Answer:

The bandwidth = high frequency - low frequency = 200 Hz - 0 Hz = 200 Hz



P3-5. A periodic composite signal with a bandwidth of 2000 Hz is composed of two sine waves. The first one has a frequency of 100 Hz with a maximum amplitude of 20 V; the second one has a maximum amplitude of 5 V. Draw the bandwidth:



P3-6. Which signal has a wider bandwidth, a sine wave with a frequency of 100 Hz or a sine wave with a frequency of 200 Hz?

Answer: The bandwidth of both signals are the same.

P3-7. What is the bit rate for each of the following signals?

- a. A signal in which 1 bit lasts 0.001 s
- b. A signal in which 1 bit lasts 2 ms
- c. A signal in which 10 bits last 20 μ s

Answer: bit rate = $1 / (\text{bit duration})$

- a. 1000bps
- b. 500bps
- c. 500,000bps

P3-8. A device is sending out data at the rate of 1000 bps.

- a. How long does it take to send out 10 bits?
- b. How long does it take to send out a single character (8 bits)?
- c. How long does it take to send a file of 100,000 characters?

Answer: bit duration = bit / bit rate

- a. $10/1000 = 0.01\text{s}$
- b. $8/1000 = 0.008\text{s}$
- c. $(100,000 \times 8) / 1000 = 800\text{s}$

P3-9. What is the bit rate for the signal in Figure 3.35?

Answer:

There are 8bits in 16ns.

So, bit rate = $8 / 16 \times 10^{-9} = 500\text{Mbps}$.

P3-10. What is the frequency of the signal in Figure 3.36?

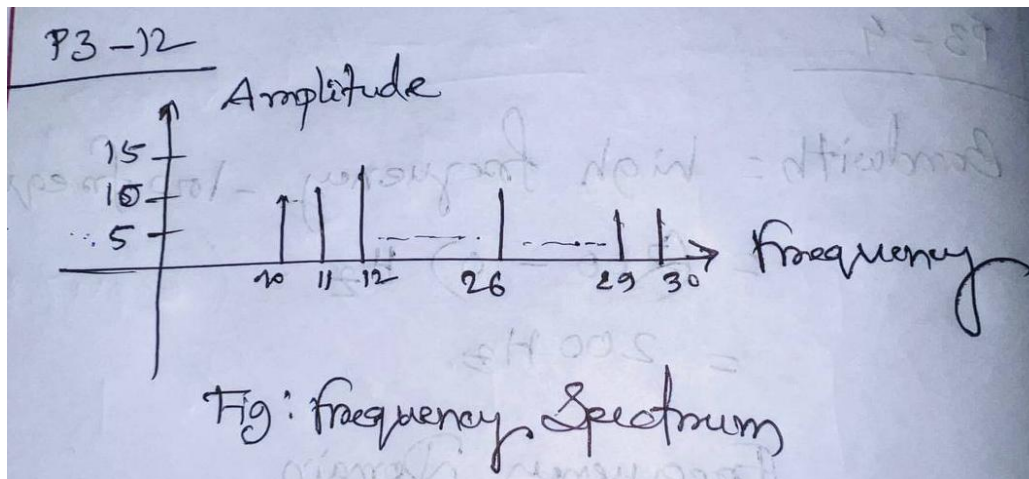
Answer: Frequency: $8 / (4 \times 10^{-6}) = 2 \times 10^6 \text{ Hz}$

P3-11. What is the bandwidth of the composite signal shown in Figure 3.37?

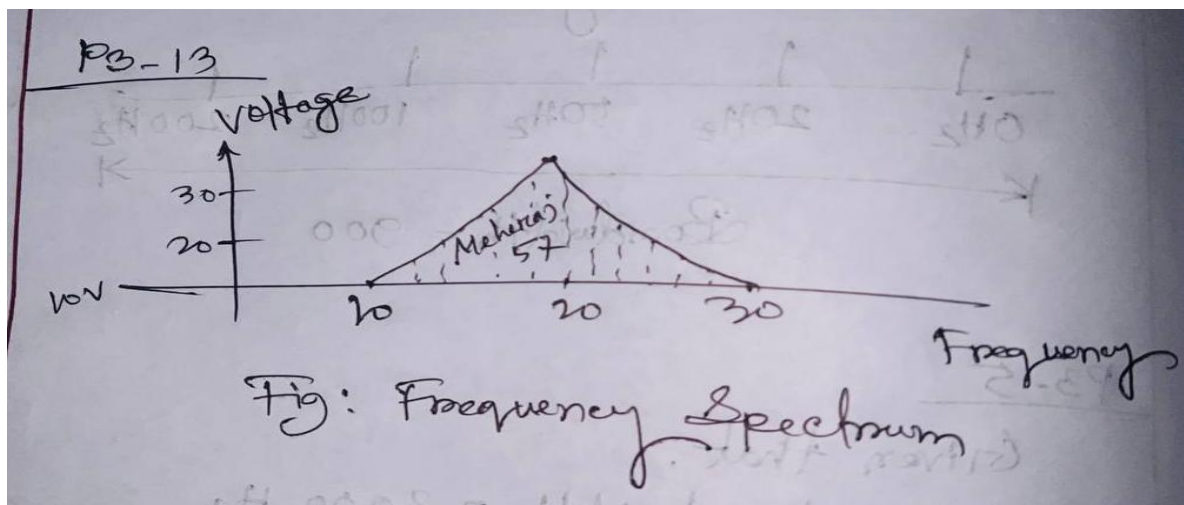
Answer:

Bandwidth: $5 \times 5 = 25$ Hz

P3-12. A periodic composite signal contains frequencies from 10 to 30 KHz, each with an amplitude of 10 V. Draw the frequency spectrum.



P3-13. A nonperiodic composite signal contains frequencies from 10 to 30 KHz. The peak amplitude is 10 V for the lowest and the highest signals and is 30 V for the 20-KHz signal. Assuming that the amplitudes change gradually from the minimum to the maximum, draw the frequency spectrum.



P3-14. A TV channel has a bandwidth of 6 MHz. If we send a digital signal using one channel, what are the data rates if we use one harmonic, three harmonics, and

five harmonics?

Answer:

One harmonic means two waves (in positive half and negative half)

So one harmonic means $2 \times 6 = 12$ Mbps

Three harmonic means $6 \times 6 = 36$ Mbps

Five harmonic means $10 \times 6 = 60$ Mbps.

P3-15. A signal travels from point A to point B. At point A, the signal power is 100 W. At point B, the power is 90 W. What is the attenuation in decibels?

Answer:

$$\begin{aligned}\text{Attenuation (dB)} &= 10 \times \log_{10} \left(\frac{P_{\text{out}}}{P_{\text{in}}} \right) \\ &= 10 \times \log_{10} (90/100) \\ &= -0.45 \text{ dB}\end{aligned}$$

P3-16. The attenuation of a signal is -10 dB. What is the final signal power if it was originally 5 W?

Answer:

$$\begin{aligned}\text{Attenuation} &= 10 \log_{10} \frac{P}{5} \text{ dB} = -10 \\ &= 0.5 \text{ W}\end{aligned}$$

P3-17. A signal has passed through three cascaded amplifiers, each with a 4 dB gain. What is the total gain? How much is the signal amplified?

Answer:

I don't know what's the solution is that..... :)

P3-18. If the bandwidth of the channel is 5 Kbps, how long does it take to send a frame of 100,000 bits out of this device?

Answer:

$$\text{Transmission time} = 100,000 / (5 \times 1000) = 20 \text{ sec}$$

P3-19. The light of the sun takes approximately eight minutes to reach the earth. What is the distance between the sun and the earth?

Answer:

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$= (3 \times 10^8 \text{ m/s}) \times 8 \times 60 \text{ s} = 1.44 \times 10^{11} \text{ meters}$$

P3-20. A signal has a wavelength of 1 μm in air. How far can the front of the wave travel during 1000 periods?

Answer:

$$\text{Total distance} = \text{Distance per period} \times \text{Number of periods}$$

$$\text{Total distance} = 1 \mu\text{m} \times 1000 \quad \text{Total distance} = 1 \mu\text{m} \times 1000$$

$$\text{Total distance} = 1000 \mu\text{m} \quad \text{Total distance} = 1000 \mu\text{m}$$

P3-21. 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?

Answer:

$$\text{Capacity} = B \cdot \log_2(1 + \text{SNR})$$

$$= 4000 \times 10^3 \cdot \log_2(1 + 1000) = 39868.90504 \text{ Kbps}$$

P3-22. We measure the performance of a telephone line (4 KHz of bandwidth). When the signal is 10 V, the noise is 5 mV. What is the maximum data rate supported by this telephone line?

Answer: Using Shannon theorem,

$$\text{Capacity} = B \cdot \log_2(1 + \text{SNR})$$

$$= 4000 \cdot \log_2(1 + 10/5 \cdot 10^3) = 11.53 \text{ bps}$$

P3-23. A file contains 2 million bytes. How long does it take to download this file using a 56-Kbps channel? 1-Mbps channel?

Answer:

$$\text{File size} = 2 \text{ million bytes} = 2000000 \cdot 8 \text{ bits} = 16000000 \text{ bits}$$

$$\text{For 56-Kbps, Channel speed } b = 56000 \text{ bps}$$

$$\text{Time} = 16000000 / 56000 = 285.714 \text{ s}$$

For 1-Mbps, Channel speed $b=1000000\text{bps}$

Time= $16000000 / 1000000=16\text{s}$

P3-24. A computer monitor has a resolution of 1200 by 1000 pixels. If each pixel uses 1024 colors, how many bits are needed to send the complete contents of a screen?

Answer:

Bits needed= $1200*1000*1024=1.22888*10^9$ bits

P3-25. A signal with 200 milliwatts power passes through 10 devices, each with an average noise of 2 microwatts. What is the SNR? What is the SNRdB?

P3-25

Given that,

$$\text{Signal Power} = 200 \text{ m.watts} = 200 \times 10^{-3} \text{ watts}$$

$$\text{No. of device} = 10$$

$$\begin{aligned} \text{Average noise per device} &= 2 \text{ microwatts} \\ &= 2 \times 10^{-6} \text{ watts} \end{aligned}$$

$$\begin{aligned} \therefore \text{Total Noise Power} &= 2 \times 10^{-6} \times 10 \\ &= 2 \times 10^{-5} \text{ watts} \end{aligned}$$

Now,

$$\begin{aligned} \text{SNR} &= \frac{\text{Signal power}}{\text{Total Noise power}} \\ &= \frac{200 \times 10^{-3}}{2 \times 10^{-5}} = 100 \end{aligned}$$

$$\begin{aligned} \therefore \text{SNR}_{\text{dB}} &= 10 \times \log_{10}(\text{SNR}) \\ &= 10 \times \log_{10} 10^2 \\ &= 20 \text{ dB} \end{aligned}$$

P3-28. We need to upgrade a channel to a higher bandwidth. Answer the following questions:

- How is the rate improved if we double the bandwidth?
- How is the rate improved if we double the SNR?

Answer:

- a. According to the Nyquist theorem, if we double the bandwidth, the data rate is also doubled.
- b. According to the Shannon theorem, if we double the SNR, the data rate increases proportionally to the logarithm of 2, which is approximately 0.3.

P3-29. We have a channel with 4 KHz bandwidth. If we want to send data at 100 Kbps, what is the minimum SNR_{dB}? What is the SNR?

Answer:

$$\text{SNR (linear)} = 10^{((C / B) - 1)}$$

where:

$$C = \text{Data rate (bps)} = 100000 \text{ bps}$$

$$B = \text{Bandwidth} = 4000 \text{ Hz}$$

Now,

$$\text{SNR (linear)} = 10^{((100000 / 4000) - 1)} \approx 15.85$$

Minimum SNR(dB):

$$\text{SNR(dB)} = 10 * \log_{10} (\text{SNR}) = 10 * \log_{10} (15.85) \approx 12.01 \text{ dB}$$

P3-30. What is the transmission time of a packet sent by a station if the length of the packet is 1 million bytes and the bandwidth of the channel is 200 Kbps?

Answer:

$$\text{Transmission time} = \text{message size} / \text{Bandwidth}$$

$$= (1 \times 10^6 * 8 \text{ bits}) / (200 * 10^3 \text{ bps})$$

$$= 40 \text{ seconds.}$$