Assignment 4: Chapter 3

Question 1

Provide the informal definition of the following terms **in your own words,** and also mention the units and equations of each if applicable:

1.1 Period (T)
1.2 Wavelength (λ)
1.3 Frequency (f)
1.4 Amplitude
1.5 Phase
1.6 Bandwidth (B)
1.7 Bit Rate
1.8 Bit Length
1.9 Attenuation
1.10 Distortion
1.11 Noise
1.12 Signal-to-noise ratio (SNR)
1.13 Throughput
1.14 Latency (Delay)
1.15 Transmission time
1.16 Queueing time
1.17 Processing time
1.18 Propagation time
1.19 Jitter
1.20 Broadband transmission or modulation

Question 2

Write the following differences:

- Periodic vs Non-periodic
- Analog vs digital signals

Question 3

Complete the following table by checking whether the statements are true or false:

Sl	Statement(s)	True/False
1.	Frequency and period are the inverse of each other.	
2.	Frequency is the rate of change with respect to wavelength.	
3.	If a signal does not change at all, its frequency is one.	
4.	If a signal changes instantaneously, its frequency is infinite.	
5.	Phase describes the position of the waveform relative to time 0.	
6.	The wavelength is the distance a simple signal can travel in one period.	
7.	A complete sine wave in the time domain can be represented by one single spike in the frequency domain.	
8.	If the composite signal is non-periodic, the decomposition gives a combination of sine waves with discrete frequencies.	
9.	A composite signal is made of many simple sine waves.	
10.	A complete sine wave in the time domain can be represented by one single spike in the frequency domain.	
11.	A sine wave with a phase of 90° starts at time 0 with a peak amplitude. The amplitude is increasing.	
12.	A sine wave with a phase of 180° is shifted to the left by a ½ cycle. However, note that the signal does not really exist before time 0.	
13.	Bit rate is the same as bits-per-second.	
14.	A vertical line in the time domain means a frequency of infinity (sudden change in time); a horizontal line in the time domain means a frequency of zero (no change in time).	
15.	A digital signal is a composite analog signal with an infinite bandwidth.	
16.	If we need to send bits faster, we need as less bandwidth as possible.	
17.	If the available channel is a bandpass channel, we can send the digital signal directly to the channel.	
18.	When a signal, simple or composite, travels through a medium, it loses some of its energy in overcoming the resistance of the medium.	
19.	Increasing the levels of a signal increases the reliability of the system.	
20.	The Shannon capacity gives us the upper limit; the Nyquist formula tells us how many signal levels we need.	

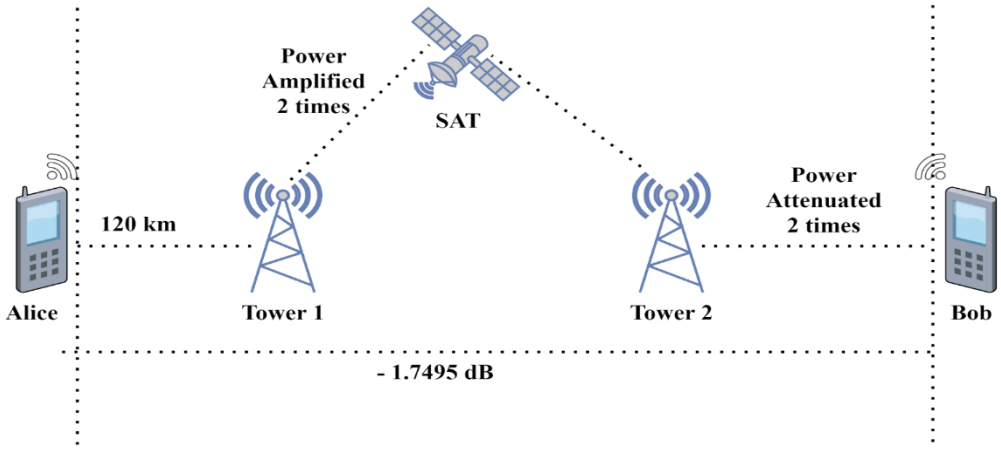
Question 4

What are the two contexts of bandwidth that we use in Networking?

Question 5

Alice is calling Bob through a hybrid communication system as shown in the following figure. Suppose the signal power is 600 mW at Alice's phone. The power loss rate from Alice to Tower 1 is 1 mW/km. The final attenuation from Alice to Bob is -1.7495 dB.

Calculate the attenuation for the signal transmitted from SAT to Tower 2.



Question 6

Suppose you are sending a doc file containing 15 pages at a speed of 64kbps through a noiseless channel. Each page includes 80 characters and the doc file has been encoded using ASCII [8 bit]. The channel through which the file is being shared has 17 levels. The signal strength of the channel is 245 W.

I. **Calculate** the bandwidth of the channel in Hz.

II. If the capacity of the channel is 20% less than the noiseless channel's bitrate, **calculate** the power of noise.

III. **Find** out the transmission delay to send the file if the noiseless channel's bitrate is considered as the bandwidth of the device.

Question 7

What is the difference between baseband and broadband transmission? Which type of channel is used by these transmission techniques?

If a non-periodic signal having the lowest frequency of 120 kHz has a bandwidth of 55000 Hz, then calculate the highest frequency contained in that signal. Draw the frequency domain diagram of this signal whose maximum amplitude is 15 V.

Question 8

An aperiodic composite signal has a bandwidth of 300 kHz, with a middle frequency of 210 kHz and peak amplitude of 25 V. The two extreme frequencies have an amplitude of zero. Draw the frequency domain of the signal.

Question 9

Suppose, a transmission line is 10 km long. Along this line, any signal deteriorates at an average rate of 3 W/km throughout the transmission. To prevent the signal from degrading too much, a 15x (15 times) amplifier is placed at 6 km distance from source. The signal strength at source is 20W.

Calculate attenuation in each part of the transmission medium and find the total attenuation.

[Hint. There are three segments in the overall transmission medium]

Question 10

A communication channel operates in a noisy environment where the average signal power is 1533 W and the average noise power is 3 W. The channel has a bandwidth of 1 MHz.

I. Calculate the theoretical maximum capacity of the channel.
II. If the system operates at a bit rate that is 75% of the maximum capacity, determine the number of signal levels required to achieve this bit rate.

Question 11

You are sending a non-periodic composite signal to your friend who lives 94 km apart through a transmission channel. The signal can be decomposed into sine waves where the highest and lowest time periods of the waves are 500 ms and 4 ms respectively. All the sine waves have a peak amplitude of 5V. The speed of the medium is 900 m/s.

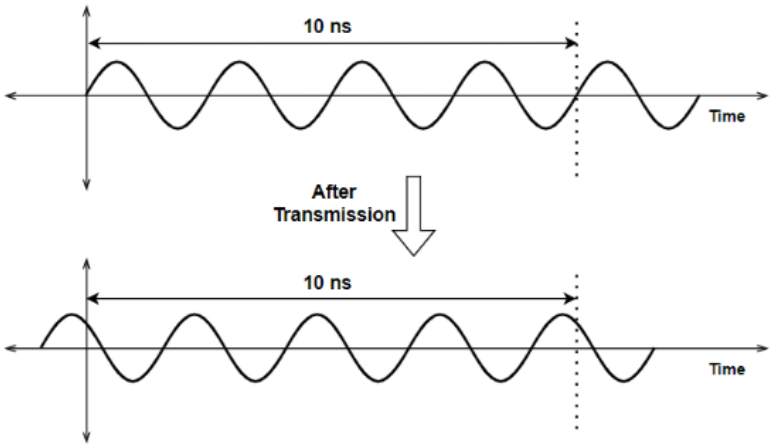
I. Draw the composite analog signal in the frequency domain representation.
II. Calculate the propagation delay of the channel.

Question 12

Suppose a network administrator wants to improve a channel with a higher bandwidth. How is the rate improved if he doubles the SNR?

Question 13

I. Find the frequency and time period of the given signal.



II. Can you relate any kind of transmission impairment with the scenario in the given figure? Justify your answer.

Question 14

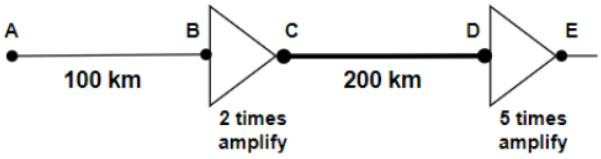
Assume, we have a channel with a 5 GHz bandwidth with 800 mW noise. If the signal strength is 36 W, what are the appropriate bit rate and signal level?

Question 15

Suppose you want to send a pdf file containing 12 pages to your friend through a 5 Mbps optical fiber line. A page is an average of 25 lines with 80 characters. Assume that the distance between you and your friend is 8000 km. There are two routers in the transmission path and each has 5 ms of processing time on average. Determine the latency of the transmission. (Light travels at 2.8 × 108 m/s)

Question 16

Suppose the signal power is 6 MW at point A. The power loss rate at the wire from A to B is 3 kW/km and from C to D is 0.04 dB/km. Calculate the total change of signal power in decibel and comment if the power is being amplified/attenuated.



Question 17

A telecom company has a bandwidth of 4.5 kHz (0.3 to 4.8 kHz) assigned for voice calls. If the signal-to-noise ratio in dB is 37 then what is the theoretical highest bit rate of the company? How many levels are required to achieve the bit rate?

Question 18

Consider a communication channel that requires to send 108 GB within 8 hours. The link operates on signals with frequency range from 800 KHz to 13 MHz. If the link is perfect, i.e., no noise is introduced in the link:

I. **Determine** the number of voltage levels needed to fulfill the requirement.
II. In practice, there is no noise free channel. Suppose, the strength of the noise power is 30mW which is 20 times weaker than the signal power. **What** will be the channel capacity considering the noise

Question 19

A document takes 0.5 minutes to download over a communication channel, assuming the channel is completely noiseless. The data rate of the channel is 10 Mbps and the bandwidth is 1.5 MHz, analyze the following aspects

I. **Calculate** the number of characters present in the document.
II. **Determine** the value of the signal Level.

Question 20

A periodic composite signal is characterized by a bandwidth of 20 kHz and a starting (minimum) frequency of 25 kHz. The signal exhibits peak amplitudes of 12 V, 18 V, and 24 V corresponding to the lowest, highest, and midpoint frequencies within its range, respectively. Calculate the maximum frequency. Draw the frequency domain plot.