Department of Electrical Engineering
Final-Assignment
Date: 22/06/2020

Course Details

Course Title: Advance Computer Networks **Module:** 3rd
Instructor: Sir naeem ahmad jan **Total Marks:** 50

Student Details

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Q1.	(a)	The Advanced Mobile Phone System (AMPS) uses two bands. The first band, 800 to 850 MHz, is used for sending; and 860 to 910 MHz is used for receiving. Each user has a bandwidth of 60 KHz in each direction. The 3-KHz voice is modulated using FM, creating 60 KHz of modulated signal. How many people can use their cellular phones simultaneously?	Marks 6
	(b)	Express a period of 1 ms in microseconds, and express the corresponding frequency in kilohertz and A sine wave is offset one-fourth of a cycle with respect to time zero. What is its phase in degrees and radians?	Marks 4
Q2.	(a)	Explain wave division multiplexing and it’s applications?	Marks 5
	(b)	Nine channels, each with a 99-KHz bandwidth, are to be multiplexed together. What is the minimum bandwidth of the link if there is a need for a guard band of 13 KHz between the channels to prevent interference?	Marks 5
Q3.	(a)	A constellation diagram consists of sixteen equally spaced points on a circle. If the bit rate is 4800 bps, what is the baud rate?	Marks 5
	(b)	Given a bandwidth of 7000 Hz for a 128-PSK signal, what are the baud rate and bit rate?	Marks 5
Q4.		Explain wireless propagation methods & wireless transmission waves? We need to send 265kbps over a noiseless channel with a bandwidth of 20KHz. How many signal levels do we need?	Marks 10
Q5.		What is the difference between Shannon & Nyquist Capacity? Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with 4 signal levels, the maximum bit rate can be ?	Marks 10

Ans # 1 : (a)

Each band is 50 MHz

If we divide 50 MHz into 60 KHz,

Note: Mega = 10^6 , Kilo = 10^3

= 50*10^6 / 60*10^3

we get 833.33.

In reality, the band is divided into 832 channels.

42 of these are used for control which means only 790 channels are available for cellular phone users.

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Ans # 1 : (b)

Milli second = 10^{-3} S

Micro second = 10^{-6} S

Kilo = 10^3

1 ms = 1 *10^{-3} S

We can also write

= 10^{-3} * 10^3 * 10^{-3} S

= 10^3 * 10^{-6} S

= 10^3 µs

1 ms = 10^3 µs

As 1 ms = 10^{-3} S

As f =1 / t

so

f = 1 / 10^{-3} Hz

f = 10^3 Hz

f= 1000 Hz

f = 1 KHz

a sin wave is offset one forth of a cycle with respect to time zero its phase in degree is:

As Complete cycle is 360°

Therefore, ¼ cycle is ¼ * 360 = **90°**

a sin wave is offset one forth of a cycle with respect to time zero its phase in radian is:

$90° * \frac{2\pi}{360} = \frac{\pi}{2} =$ **1.5708 radian**

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Ans#2 : (a)

Wavelength division multiplexing

In fiber-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e., colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.

The term WDM is commonly applied to an optical carrier, which is typically described by its wavelength, whereas frequency-division multiplexing typically applies to a radio carrier which is more often described by frequency. This is purely conventional because wavelength and frequency communicate the same information. Specifically, frequency (in Hertz, which is cycles per second) multiplied by wavelength (the physical length of one cycle) equals the velocity of the carrier wave. In vacuum, this is the velocity of light, usually denoted by the lower case letter, c. In glass fiber, it is substantially slower, usually about 0.7 times c. The data rate, which ideally might be at the carrier frequency, in practical systems is always a fraction of the carrier frequency. A WDM system uses a multiplexer at the transmitter to join the several signals together and a DE multiplexer at the receiver to split them apart. With the right type of fiber, it is possible to have a device that does both simultaneously and can function as an optical add-drop multiplexer. The optical filtering devices used have conventionally been etalons (stable solid-state single-frequency Fabry–Pérot interferometers in the form of thin-film-coated optical glass). As there are three different WDM types, whereof one is called "WDM", the notation "xWDM" is normally used when discussing the technology as such.

The concept was first published in 1978, and by 1980 WDM systems were being realized in the laboratory. The first WDM systems combined only two signals. Modern systems can handle 160 signals and can thus expand a basic 100 Gbit/s system over a single fiber pair to over 16 Tbit/s. A system of 320 channels is also present (12.5 GHz channel spacing, see below.)

WDM systems are popular with telecommunications companies because they allow them to expand the capacity of the network without laying more fiber. By using WDM and optical amplifiers, they can accommodate several generations of technology development in their optical infrastructure without having to overhaul the backbone network. Capacity of a given link can be expanded simply by upgrading the multiplexers and DE multiplexers at each end.

This is often done by use of optical-to-electrical-to-optical (O/E/O) translation at the very edge of the transport network, thus permitting interoperation with existing equipment with optical interfaces.

Most WDM systems operate on single-mode fiber optical cables which have a core diameter of 9 µm. Certain forms of WDM can also be used in multi-mode fiber cables (also known as premises cables) which have core diameters of 50 or 62.5 µm.

Early WDM systems were expensive and complicated to run. However, recent standardization and better understanding of the dynamics of WDM systems have made WDM less expensive to deploy.

Optical receivers, in contrast to laser sources, tend to be wideband devices. Therefore, the DE multiplexer must provide the wavelength selectivity of the receiver in the WDM system.

Applications of Wavelength Division Multiplexing:

- WDM multiply the effective bandwidth of a fiber optic communications system
- A fiber optic repeater device called the erbium amplifier can make WDM a cost-effective and it is the long-term solution.
- This reduces the cost and increases the capacity of the cable to carry data.
- Wavelength Division Multiplexing (WDM) uses multiple wavelengths (colors of light) to transport signals over a single fiber.
- It uses light of different colours to create a number of signal paths.
- It uses Optical prisms to separate the different colours at the receiving end and optical prisms does not require power source.
- These systems used temperature stabilized lasers to provide the needed channels count.

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Ans#2 : (b)

we have 9 Number of Channels

For 9 channels, we need at least 8 guard bands.

each channel have 99Khz Bandwidth

Guard band =13Khz

This means that the bandwidth is

(9 × 99) + (8 × 13) = **995kHz**

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Ans#3 : (a)

4 bits are transmitted with each signal i-e 16 = 2^4 and bit rate is 4800 bps given in question

As Baud rate = bit rate/bits per signal

Therefore, put values of bit rate and bits per signal in formula

Baud rate = 4800/4 = **1200 Baud**

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Ans#3 : (b)

For PSK the baud rate is the same as the bandwidth, which means the baud rate is **7000 Baud**,

but in 128 PSK the bit rate is 7 times the baud rate as 7 bits are transmitted with each signal i-e $128 = 2^7$

so Bit rate = 7 x 7000 = **49000 bps**

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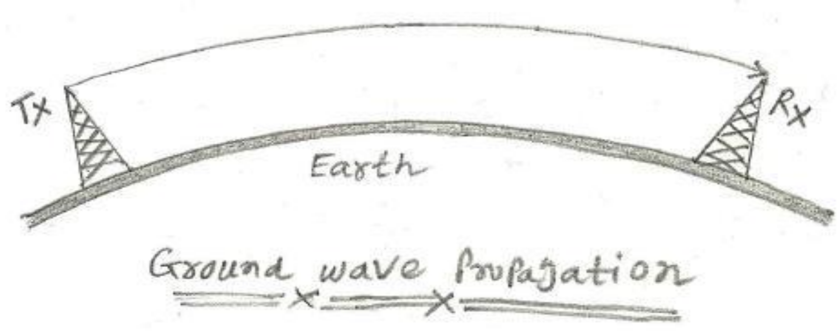
Ans#4 :

Wireless propagation methods are

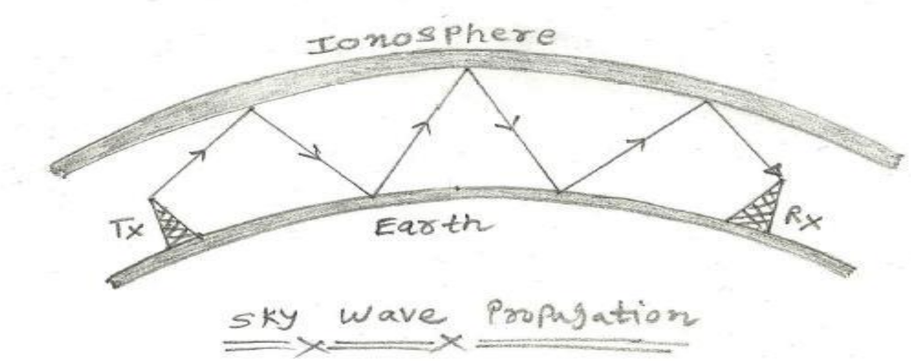
- **Ground Wave Propagation**
- **Sky Wave Propagation**
- **Line of sight Propagation**

Ground Wave Propagation



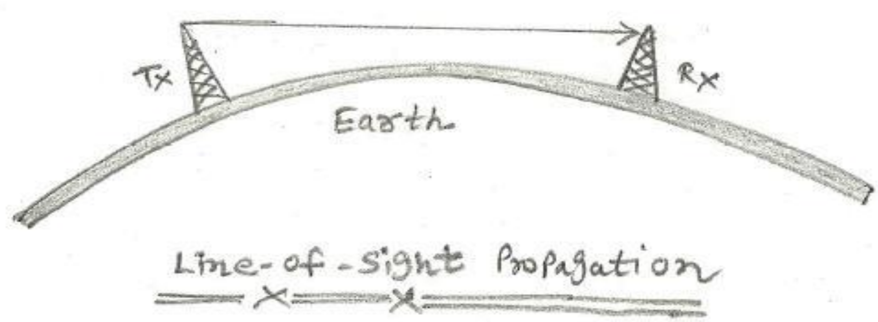
Frequencies up to about 2MHz fall in this category of propagation. Here waves follow contour/curvature of the Earth, this is due to EM waves induce current in the earth's surface. This causes wave front to bend towards the earth and follow/propagate earth's surface. Typical applications include AM radio broadcasting, direction finding, submarine communication, home control systems, analog telephone lines, long range navigation and more.

Sky Wave Propagation



Frequencies between 2 MHz and 30 MHz fall in this category of propagation. Here ionosphere above earth's surface reflect the transmitted wave and hence it gets propagated due to reflection. Typical applications include amateur radio,CB radio, international broadcasting, military communication and long range aircraft/ship communication.

Line of sight Propagation



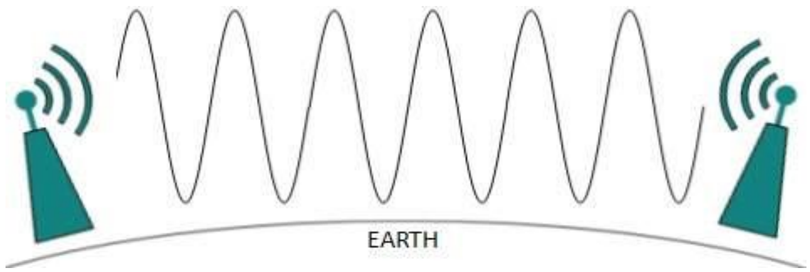
Frequencies above 30 MHz fall in this category of propagation. Here signal above 30MHz are not reflected by ionosphere and here it is transmitted based on line-of-sight concept. For satellite application, it is transmitted from earth station antenna to the satellite antenna. for ground based wireless link, communication happens when both the transmit(TX) and receive(Rx) antennas are in the line of sight of each other. Typical applications include VHF/UHF television, FM broadcast, optical communication, Infrared LANs, terrestrial wireless link, radar, cellular telecom, PCS, WLL and more.

Wireless Transmission Waves are

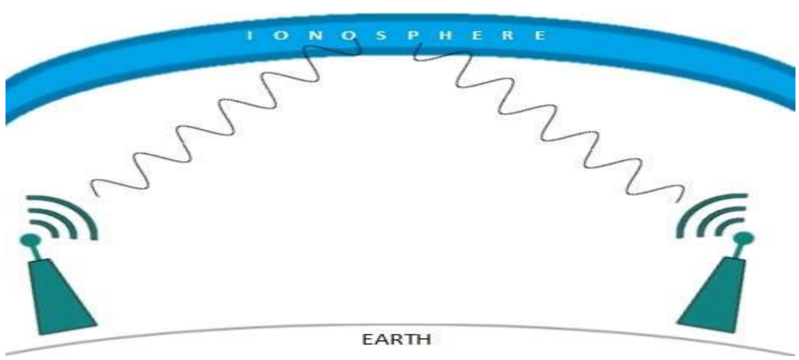
- Radio Waves
- Microwave
- Infrared

Radio Transmission

- Radio frequency is easier to generate and because of its large wavelength it can penetrate through walls and structures alike. Radio waves can have wavelength from 1 mm – 100,000 km and have frequency ranging from 3 Hz (Extremely Low Frequency) to 300 GHz (Extremely High Frequency). Radio frequencies are sub-divided into six bands.
- Radio waves at lower frequencies can travel through walls whereas higher RF can travel in straight line and bounce back.The power of low frequency waves decreases sharply as they cover long distance. High frequency radio waves have more power.
- Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers, over the earth's surface.



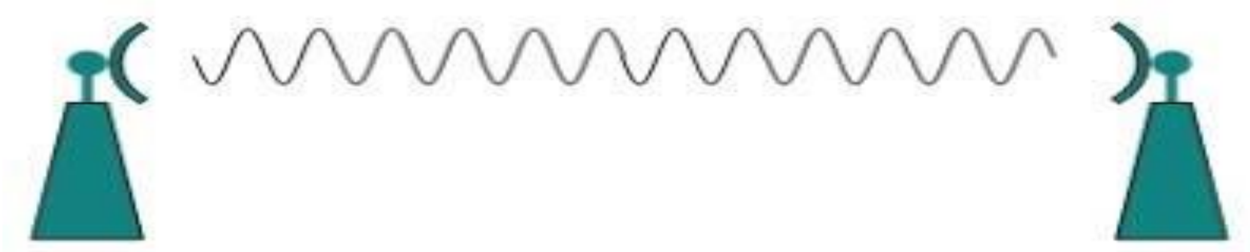
- Radio waves of high frequencies are prone to be absorbed by rain and other obstacles. They use Ionosphere of earth atmosphere. High frequency radio waves such as HF and VHF bands are spread upwards. When they reach Ionosphere, they are refracted back to the earth.



Microwave Transmission

Electromagnetic waves above 100 MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station. Because Microwaves travels in straight lines, both sender and receiver must be aligned to be strictly in line-of-sight.

Microwaves can have wavelength ranging from 1 mm – 1 meter and frequency ranging from 300 MHz to 300 GHz.



Microwave antennas concentrate the waves making a beam of it. As shown in picture above, multiple antennas can be aligned to reach farther. Microwaves have higher frequencies and do not penetrate wall like obstacles.

Microwave transmission depends highly upon the weather conditions and the frequency it is using.

Infrared Transmission

Infrared wave lies in between visible light spectrum and microwaves. It has wavelength of 700-nm to 1-mm and frequency ranges from 300-GHz to 430-THz.

Infrared wave is used for very short range communication purposes such as television and it’s remote. Infrared travels in a straight line hence it is directional by nature. Because of high frequency range, Infrared cannot cross wall-like obstacles.

Numerical

We can use nyquist formula

$N_{max} = 2 * B * Log_2 L$

$265000 = 2 * 20000 * Log_2 L$

$265000 = 40000 * Log_2 L$

$Log_2 L = 6.625$ $L = 26.625 = 98.7$ levels

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Ans#5:

A very important consideration in data communications how fast we can send data. in bits per second, over a channel. Data rate depends on three factors

(i) The band width available

(ii) The level of the signals we use

(iii) The quality of the channel (the level noise).

Two theoretical formulas were developed to calculate the data rate- one by Nyquist for a no1seless channel, another by Shannon for a noisy channel.

Noiseless Channel: Nyquist Bit Rate -

For a noiseless channel, the Nyquist bit rate formula defines the theoretical maximum bit rate

r = 2 X B X log2 L

In this formula, B is the bandwidth of the channel, L is the number of signal levels used to represent data, and r is the bit rate in bits per second.

According to the formula, we might think that, given a specific bandwidth, we can have any bit rate we want by increasing the number of signal levels.
Although the idea is theoretically correct, practically there is a limit. When we increase the number of signal levels, we impose a burden on the receiver. If the number of levels in a signal is just 2, the receiver can easily distinguish between a 0 and a 1. If the level of a signal is 64, the receiver must be very sophisticated to distinguish between 64 different levels. In other words, increasing the levels of a signal reduces the reliability of the system.

Noisy Channel: Shannon Capacity

In reality, we cannot have a noiseless channel; the channel is always noisy. In 1944, Cloude-shannon introduced a formula called the shannon capacity, to determine the theoretical highest data rate for a noisy Channel.

C = B *x* Iog2(1 + SNR)

In this formula B is the bandwidth of the channel, SNR is the signal-to noise ratio, and C is the capacity of the channel in bits per second. Note that the Shannon formula there is no indication of the signal level, which means that no matter how many levels we have. We cannot achieve a data rate higher than the capacity of the channel. in other words, the formula defines a characteristic of the channel, not the method of transmission.

In conclusion, we can say for channel capacity that the Shannon capacity gives us the' upper limit while the Nyquist formula tells us how many signal levels we need.

Numerical

As Bit Rate = 2 * Bandwidth * $\log_2 L$

Bit rate = 2 *3000***** $\log_2 4$

Bit rate = 12000 bps

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End