ADVANCED COMMUNICATION

[ETT-601]

6TH SEM ETC ENGG.

Under SCTEVT ,Odisha

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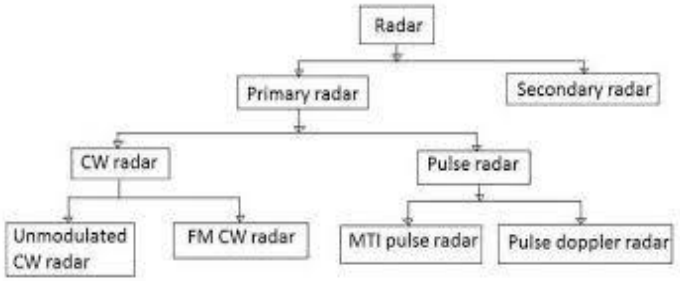
CHAPTER-1

2MARKS QUESTION

Q. WHAT IS RADAR AND ITS CLASSIFICATION? [2016s]

RADAR stands for Radio Detection and Ranging System. It is basically an electromagnetic system used to detect the location and distance of an object from the point where the RADAR is placed.

classification:



Q.DEFINE DOPPLER EFFECT AND WHERE IT IS USED?[2016S,2019S]

Doppler Effect. The frequency of the received signal will increase, when the target moves towards the direction of the Radar. The frequency of the received signal will decrease, when the target moves away from the Radar

The Doppler effect is used in some types of radar, to measure the velocity of detected objects.

Q.WHAT IS THE FUNCTION OF DUPLEXER?[2017W]

A duplexer is an electronic device that allows bi-directional (duplex) communication over a single path. In radar and radio communications systems, it isolates the receiver from the transmitter while permitting them to share a common antenna. Most radio repeater systems include a duplexer.

Q.WRITE THE DIFFERENT APPLICATION OF RADAR?[2017W]

- In air defense it is used for target detection, target recognition and weapon control (directing the weapon to the tracked targets).
- In missile system to guide the weapon.
- Identifying enemy locations in map.
- To control air traffic near airports. The Air Surveillance RADAR is used to detect and display the aircraft's position in the airport terminals.
- To guide the aircraft to land in bad weather using Precision Approach RADAR.
- To scan the airport surface for aircraft and ground vehicle positions

- Remote Sensing: RADAR can be used for observing weather or observing planetary positions and monitoring sea ice to ensure smooth route for ships.
- To guide the space vehicle for safe landing on moon
- To observe the planetary systems
- To detect and track satellites
- To monitor the meteors

Q.WRITE DOWN THE PERFORMANCE FACTOR OF RADAR.[2019S]

The performance of a radar system can be judged by the following:

(1) the maximum range at which it can see a target of a specified size,

(2) the accuracy of its measurement of target location in range and angle,

(3) its ability to distinguish one target from another,

(4) its ability to detect the desired target echo .

5MARKS QUESTION

Q.DERIVE THE RADAR RANGE EQUATION.[2016S,2017W,2019S]

Derivation of Radar Range Equation

The standard form of Radar range equation is also called as simple form of Radar range equation. Now, let us derive the standard form of Radar range equation.

We know that power density is nothing but the ratio of power and area. So, the power density, P_{di} a distance, R from the Radar can be mathematically represented as −

$$P_{di}=P_t/4\Pi R^2$$—(1) Where, P_T is the amount of power transmitted by the Radar transmitter

The above power density is valid for an isotropic Antenna. In general, Radars use directional Antennas. Therefore, the power density, P_{dd} due to directional Antenna will be −

$$P_{dd}=P_tG/4\Pi R^2–(2)$$

Target radiates the power in different directions from the received input power. The amount of power, which is reflected back towards the Radar depends on its cross section. So, the power density P_{de} echo signal at Radar can be mathematically represented as −

$$P_{de}=P_{dd}\ /(\sigma 4\Pi R^2)\text{----}(3)$$

Substitute, Equation 2 in Equation 3.

$$P_{de}=(P_tG/4\pi R^2)/(\sigma 4\pi PR^2)$$ --- (4)

The amount of power, $P_r$received by the Radar depends on the effective aperture, Ae of the receiving Antenna.

$P_r=P_{de}Ae$------(5)

Substitute, Equation 4 in Equation 5.

$P_r=(P_tG/4\pi R^2)/(\sigma 4\pi R^2)A_e$

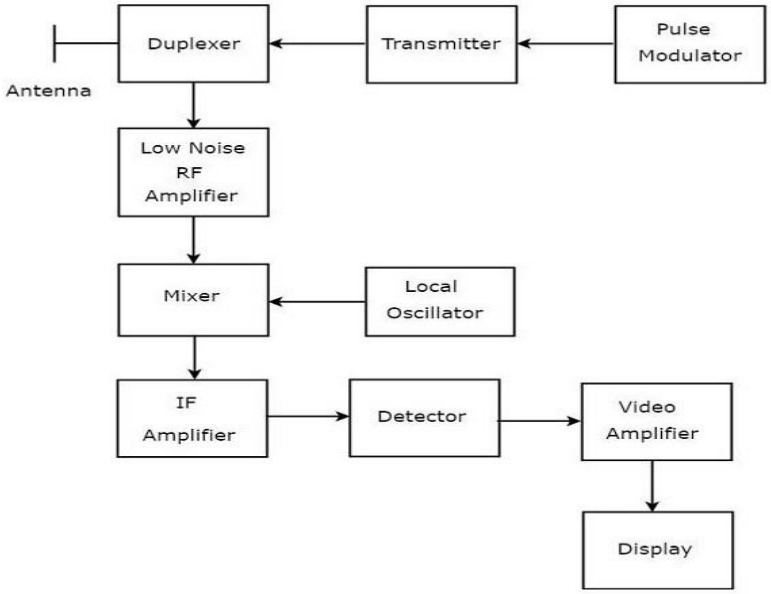
$\Rightarrow Pr=P_tG/\sigma Ae(4\pi)^2R^4$

$\Rightarrow R^4=P_tG/\sigma Ae(4\pi)^2Pr$

$\Rightarrow R=[P_tG\sigma Ae/(4\pi)^2Pr]^{1/4}$-------6

Q.EXPLAIN THE BLOCK DIAGRAM OF PULSE RADAR SYSTEM WITH A NEAT BLOCK DIAGRAM.[2016S,2017W,2019S]

Pulse Radar uses single Antenna for both transmitting and receiving of signals with the help of Duplexer. Following is the block diagram of Pulse Radar −



Function of each block of Pulse Radar −

- **Pulse Modulator** − It produces a pulse-modulated signal and it is applied to the Transmitter.
- **transmitter** − It transmits the pulse-modulated signal, which is a train of repetitive pulses.
- **Duplexer** − It is a microwave switch, which connects the Antenna to both transmitter section and receiver section alternately. Antenna transmits the pulse-modulated signal, when theduplexer connects the Antenna to the transmitter. Similarly, the signal, which is received by

Antenna will be given to Low Noise RF Amplifier, when the duplexer connects the Antenna to Low Noise RF Amplifier.

- **Low Noise RF Amplifier** − It amplifies the weak RF signal, which is received by Antenna. The output of this amplifier is connected to Mixer.
- **Local Oscillator** − It produces a signal having stable frequency. The output of Local Oscillator is connected to Mixer.
- **Mixer** − We know that Mixer can produce both sum and difference of the frequencies that are applied to it. Among which, the difference of the frequencies will be of Intermediate Frequency (IF) type.
- **IF Amplifier** − IF amplifier amplifies the Intermediate Frequency (IF) signal. The IF amplifier shown in the figure allows only the Intermediate Frequency, which is obtained from Mixer and amplifies it. It improves the Signal to Noise Ratio at output.
- **Detector** − It demodulates the signal, which is obtained at the output of the IF Amplifier.
- **Video Amplifier** − As the name suggests, it amplifies the video signal, which is obtained at the output of detector.
- **Display** − In general, it displays the amplified video signal on CRT screen.

7 MARKS QUESTION

Q.EXPLAIN THE OPERATION OF MTI RADAR? [2019s]

Principle: When it is desired to remove the clutter due to stationary targets an MTI radar is employed.The basic principle of MTI radar is to compare a set of received echoes witrh those received during the previous sweep.Moving targets will give change of phase and are not cancelled. Thus clutter due to stationary targets both manmade and natural is removed from the display and this allows easier detection of moving targets.

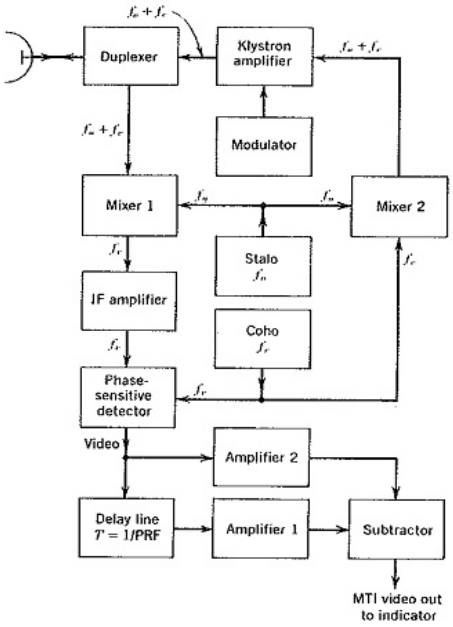


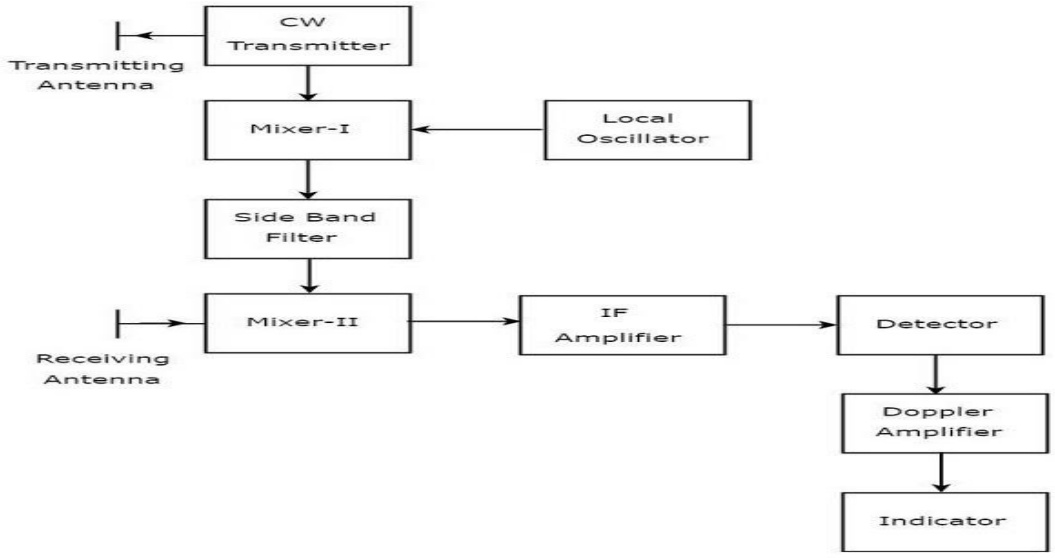
FIGURE 16-12 Block diagram of MTI radar using power amplifier output.

The transmitted frequency in the Moving Target Indicator Radar Block Diagram of Figure 16-12 is the sum of the outputs of two oscillators, produced in mixer 2. The first is the stab, or stable local oscillator The second is the coho, or coherent oscillator, operating at the same frequency as the intermediate frequency and providing the coherent signal, which is used as will be explained. Mixers 1 and 2 are identical, and both use the same local oscillator (the stab); thus phase relations existing in their inputs are preserved in their outputs. This makes it possible to use the Doppler shift at the JF, instead of the less convenient radio frequency f0 + fc... The output of the IF amplifier and a reference signal from the coho are fed to the phase-sensitive detector, a circuit very similar to the phase discriminator.

The coho is used for the generation of the RF signal, as well as for reference in the phase detector, and the mixers do not introduce differing phase shifts. The transmitted and reference signals are locked in phase and are said to be coherent; hence the name of the coho. Since the output of this detector is phase-sensitive, an output will be obtained for all fixed or moving targets.

Q.DRAW THE BLOCK DIAGRAM OF CW RADAR AND EXPLAIN THE FUNCTION OF EACH BLOCK.[2016S,2019S]

The Radar, which operates with continuous signal (wave) for detecting non-stationary targets, is called Continuous Wave Radar or simply CW Radar. This Radar requires two Antennas. Among which, one Antenna is used for transmitting the signal and the other Antenna is used for receiving the signal.



The block diagram of CW Doppler Radar contains a set of blocks and the function of each block is mentioned below.

CW Transmitter − It produces an analog signal having a frequency of fo. The output of CW Transmitter is connected to both transmitting Antenna and Mixer-I.

Local Oscillator − It produces a signal having a frequency of fl. The output of Local Oscillator is connected to Mixer-I.

Mixer-I − Mixer can produce both sum and difference of the frequencies that are applied to it. The signals having frequencies of fo and fl are applied to Mixer-I. So, the Mixer-I will produce the output having frequencies fo+fl or fo−fl.

Side Band Filter − As the name suggests, side band filter allows a particular side band frequencies − either upper side band frequencies or lower side band frequencies. The side band filter shown in the above figure produces only upper side band frequency, i.e., fo+fl.

Mixer-II − Mixer can produce both sum and difference of the frequencies that are applied to it. The signals having frequencies of fo+fl and fo±fd are applied to Mixer-II. So, the Mixer-II will produce the output having frequencies of 2fo+fl±fd or fl±fd.

IF Amplifier − IF amplifier amplifies the Intermediate Frequency (IF) signal. The IF amplifier shown in the figure allows only the Intermediate Frequency, fl±fd and amplifies it.

Detector − It detects the signal, which is having Doppler frequency, fd.

Doppler Amplifier − As the name suggests, Doppler amplifier amplifies the signal, which is having Doppler frequency, fd.

Indicator − It indicates the information related relative velocity and whether the target is inbound or outbound.

Q.WRITE A SHORT NOTE ON GPS SYSTEM.[2019S]

The Global Positioning System (GPS) is a network of about 30 satellites orbiting the Earth at an altitude of 20,000 km. ... These signals, travelling at the speed of light, are intercepted by your GPS receiver, which calculates how far away each satellite is based on how long it took for the messages to arrive.

Space Segment:

GPS consists of a network of 24 active satellites located nearly 20000 kilometres above the Earth's surface. Each satellite broadcasts different signals which can be tracked by a GPS receiver on earth, which are then analyzed by the GPS receiver to determine its precise location. The signals operate in all weather conditions but can't penetrate through solid objects, so GPS receivers perform best when they have a clear view of the sky.

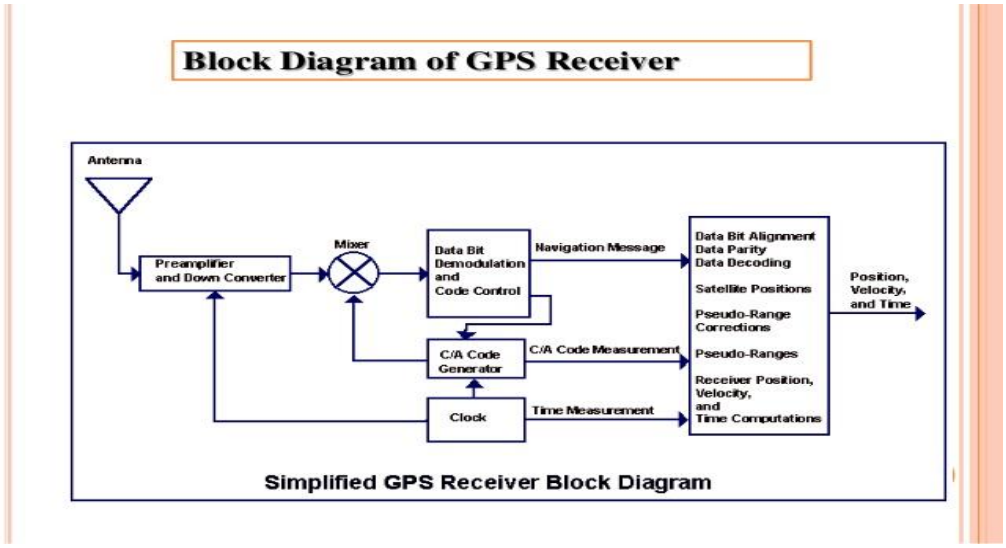
Control Segment:

GPS contains a control segment which has a system of tracking stations located around the world. The master control facility is located at Schriever Air Force Base in Colorado. It receivers come in all different shapes and sizes, are widespread and are affordable. Today, GPS receivers can be found in watches, phones, tablets, computers, cars and a wide variety of other devices. This segment consists of:

- A master control station
- An alternate master control station
- Six dedicated monitor stations
- Four dedicated ground stations

User Segment:

The GPS user segment has user segment and GPS receivers. These receivers transform SV signals into velocity, position and time estimates. It needs four satellites to measure the Four dimensions of X, Y, Z and time. GPS receivers are helpful in navigation, time dissemination, positioning and some other research. Navigation is the key function of GPS. it is useful for ships, aircraft and even ground vehicles.



Chapter 2

2 marks questions

Q.WHAT IS THE MEANING OF GEOSTATIONARY?[2016s]

GEOSTATIONARY means being or having an equatorial orbit at an altitude of about 22,300 miles (35,900 kilometers) requiring an angular velocity the same as that of the earth so that the position of a satellite in such an orbit is fixed with respect to the earth.

Q.WHAT IS GEOSTATIONARY SATELLITES?[2017W]

A geostationary satellite is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometers (22,300 miles) directly over the equator, that revolves in the same direction the earth rotates (west to east).

Q.WHAT IS SATELLITE ORBIT?[2017W]

An orbit is a regular, repeating path that one object in space takes around another one. An object in an orbit is called a satellite. A satellite can be natural, like Earth or the moon. Many planets have moons that orbit them.

Q.DEFINE UPLINK AND CROSS LINK?[2019S]

The communication going from a satellite to ground is called downlink, and when it is going from ground to a satellite it is called uplink. When an uplink is being received by the spacecraft at the same time a downlink is being received by Earth, the communication is called two-way.

5 MARKS QUESTION

Q.EXPLAIN THE OPERATION OF DBS?[2016S][2019S]

Direct broadcasting satellite systems

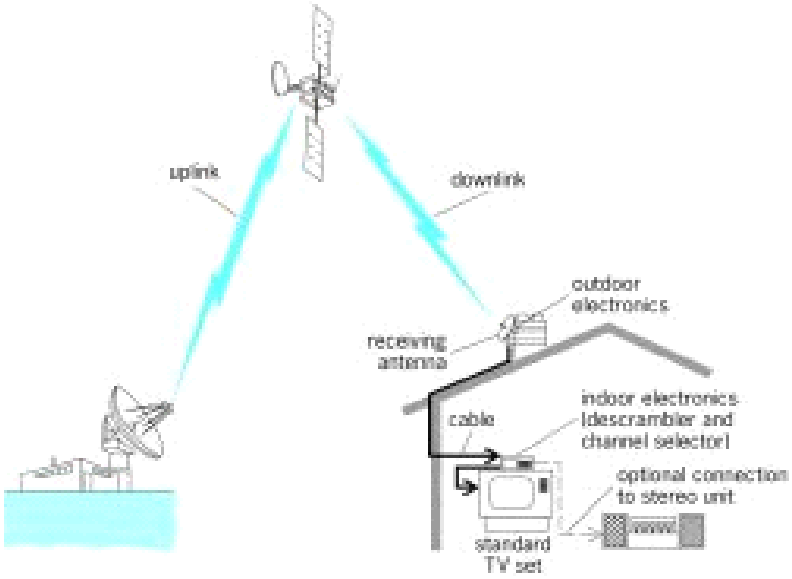
Systems for transmitting television and other program material via satellite directly to individual homes and businesses. Direct broadcasting satellite (DBS) systems operate at microwave frequencies, in a portion of the Ku band

DBS systems use a satellite in geostationary orbit to receive television signals sent up from the Earth's surface, amplify them, and transmit them back down to the surface. The satellite also shifts the signal frequency, so that a signal sent up to the satellite in the 17.3–17.8-GHz uplink band is transmitted back down in the 12.2–12.7-GHz downlink band. The downlink signal is picked up by a receive antenna located atop an individual home or office; these antennas are usually in the form of a parabolic dish, but flat square phased-array antennas are sometimes used, and may eventually become commonplace. The receive antenna may be permanently pointed at the satellite, which is at a fixed point in the sky, in a geostationary orbit.

It is difficult to build receivers to operate at the microwave downlink frequencies, so the signal from the dish antenna is first passed to a downconverter, usually mounted outdoors on the antenna, that shifts it to (typically) the 0.95–1.45-GHz band. This signal is then conducted by cable to the receiver atop the

television set. The receiver contains the channel selector, as well as a decoder to permit the user to view authorized channels. The receiver is connected by an additional cable to the television set

A typical direct broadcasting satellite contains 16 transponders, or amplifiers, the maximum permitted under present regulations, each with a radio-frequency power output in the range 120–240 W.



Q.GEOSYNCHRONOUS ORBIT.[2017W]

A geosynchronous orbit is a high Earth orbit that allows satellites to match Earth's rotation. Located at 22,236 miles (35,786 kilometers) above Earth's equator, this position is a valuable spot for monitoring weather, communications and surveillance.

At geosynchronous orbit, the “ring” around Earth can accommodate a number of satellites — 1,800 altogether. Because the satellite orbits at the same speed that the Earth is turning, the satellite seems to stay in place over a single longitude, though it may drift north to south

Satellites are designed to orbit Earth in one of three basic orbits defined by their distance from the planet: low Earth orbit, medium Earth orbit or high Earth orbit. The higher a satellite is above Earth (or any other world for that matter), the slower it moves. This is because of the effect of Earth's gravity; it pulls more strongly at satellites that are closer to its center than satellites that are farther away.

A satellite in geosynchronous orbit can see one spot of the planet almost all of the time. For Earth observation, this allows the satellite to look at how much a region changes over months or years.

Q.EXPLAIN SATELLITE FREQUENCY ALLOCATION AND FREQUENCY BANDS.[2017W]

There are a number of radio frequency ranges in use in satellite communications such as C, X, Ku, Ka and even EHG and V-band.

EARTHSTATION FREQUENCIES

BAND	FREQUENCY
IF	70 - 150 Mhz

L 800 - 2150 MHz

SATELLITE FREQUENCIES (Ghz)

BAND	DOWNLINK	UPLINK
C	3.700 - 4.200	5.925 - 6.425

L BAND

Global Positioning System (GPS) carriers and also satellite mobile phones, such as Iridium; Inmarsat providing communications at sea, land and air; WorldSpace satellite radio.

S-band (2–4 GHz)

Weather radar, surface ship radar, and some communications satellites, especially those of NASA for communication with ISS and Space Shuttle. In May 2009, Inmarsat and Solaris mobile (a joint venture between Eutelsat and Astra) were awarded each a 2×15 MHz portion of the S-band by the European Commission.

C-band (4–8 GHz)

Primarily used for satellite communications, for full-time satellite TV networks or raw satellite feeds. Commonly used in areas that are subject to tropical rainfall, since it is less susceptible to rainfade than Ku band (the original Telstar satellite had a transponder operating in this band, used to relay the first live transatlantic TV signal in 1962).

X-band (8–12 GHz)

Primarily used by the military. Used in radar applications including continuous-wave, pulsed, single-polarisation, dual- polarisation, synthetic aperture radar and phased arrays. X-band radar frequency sub-bands are used in civil, military and government institutions for weather monitoring, air traffic control, maritime vessel traffic control, defence tracking and vehicle speed detection for law enforcement.

Ku-band (12–18 GHz)

Used for satellite communications. In Europe, Ku-band downlink is used from 10.7 GHz to 12.75 GHz for direct broadcast satellite services, such as Astra.

Ka-band (26–40 GHz)

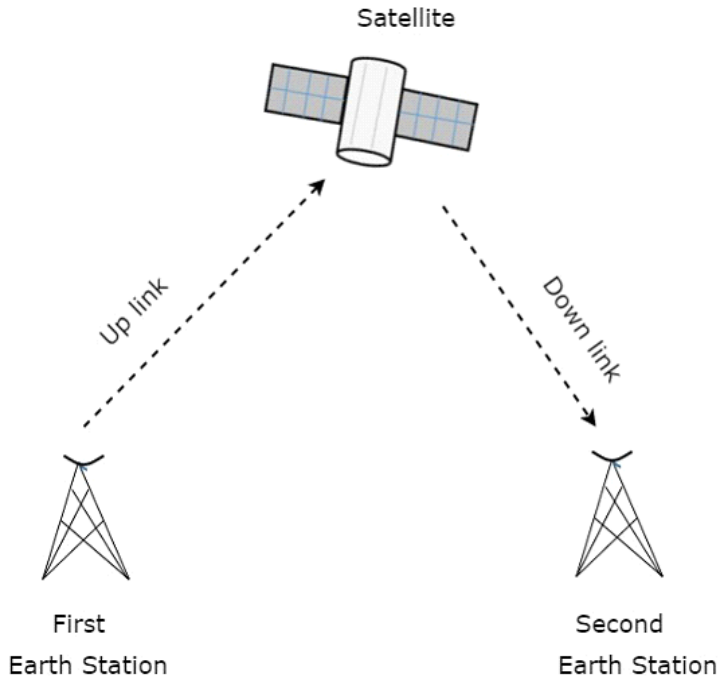
Communications satellites, uplink in either the 27.5 GHz and 31 GHz bands, and high-resolution, close-range targeting radars on military aircraft.

Q.DESCRIBE GENERAL STRUCTUREOF SATELLITE LINK SYSTEM. [2017W,2019S]

A satellite is a body that moves around another body in a particular path. A communication satellite is nothing but a microwave repeater station in space. It is helpful in telecommunications, radio and television along with internet applications.

A repeater is a circuit, which increases the strength of the received signal and then transmits it. But, this repeater works as a transponder. That means, it changes the frequency band of the transmitted signal from the received one.

The frequency with which, the signal is sent into the space is called as Uplink frequency. Similarly, the frequency with which, the signal is sent by the transponder is called as Downlink frequency. The following figure illustrates this concept clearly.



The transmission of signal from first earth station to satellite through a channel is called as uplink. Similarly, the transmission of signal from satellite to second earth station through a channel is called as downlink.

Uplink frequency is the frequency at which, the first earth station is communicating with satellite. The satellite transponder converts this signal into another frequency and sends it down to the second earth station. This frequency is called as Downlink frequency. In similar way, second earth station can also communicate with the first one.

The process of satellite communication begins at an earth station. Here, an installation is designed to transmit and receive signals from a satellite in an orbit around the earth. Earth stations send the information to satellites in the form of high powered, high frequency (GHz range) signals.

The satellites receive and retransmit the signals back to earth where they are received by other earth stations in the coverage area of the satellite. Satellite's footprint is the area which receives a signal of useful strength from the satellite.

7 MARKS QUESTION

Q.DISCUSS SATELLITE ORBITAL PATTERN LEO,MEO,AND GEO.[2019S,2016S,2017W]

Satellite should be properly placed in the corresponding orbit after leaving it in the space. It revolves in a particular way and serves its purpose for scientific, military or commercial. The orbits, which are assigned to satellites with respect to earth are called as Earth Orbits. The satellites present in those orbits are called as Earth Orbit Satellites.

We should choose an orbit properly for a satellite based on the requirement. For example, if the satellite is placed in lower orbit, then it takes less time to travel around the earth and there will be better resolution in an onboard camera. Similarly, if the satellite is placed in higher orbit, then it takes more time to travel around the earth and it covers more earth's surface at one time.

Following are the three important types of Earth Orbit satellites –

- Geosynchronous Earth Orbit Satellites
- Medium Earth Orbit Satellites
- Low Earth Orbit Satellites

Geosynchronous Earth OrbitSatellites

A Geo-synchronous Earth Orbit (GEO) Satellite is one, which is placed at an altitude of 22,300 miles above the Earth. This orbit is synchronized with a side real day (i.e., 23 hours 56 minutes). This orbit can have inclination and eccentricity.

It may not be circular. This orbit can be tilted at the poles of the earth. But, it appears stationary when observed from the Earth. These satellites are used for satellite Television.

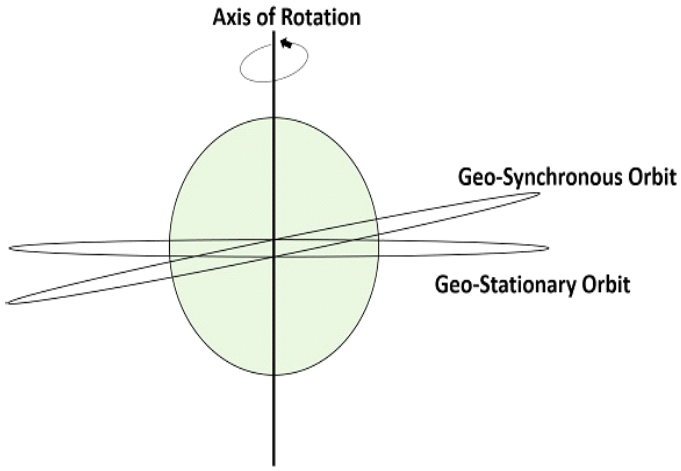
The same geo-synchronous orbit, if it is circular and in the plane of equator, then it is called as Geostationary orbit. These Satellites are placed at 35,900kms (same as Geosynchronous) above the Earth's Equator and they keep on rotating with respect to earth's direction (west to east).

The satellites present in these orbits have the angular velocity same as that of earth. Hence, these satellites are considered as stationary with respect to earth since, these are in synchronous with the Earth's rotation.

The advantage of Geostationary orbit is that no need to track the antennas in order to find the position of satellites.

Geostationary Earth Orbit Satellites are used for weather forecasting, satellite TV, satellite radio and other types of global communications.

The following figure shows the difference between Geo-synchronous and Geo-stationary orbits. The axis of rotation indicates the movement of Earth.



Medium Earth Orbit Satellites

Medium Earth Orbit (MEO) satellites will orbit at distances of about 8000 miles from earth's surface. Signals transmitted from a MEO satellite travel a shorter distance. Due to this, the signal strength at the receiving end gets improved. This shows that smaller and light weight receiving terminals can be used at the receiving end.

Transmission delay can be defined as the time it takes for a signal to travel up to a satellite and back down to a receiving station. In this case, there is less transmission delay. Because, the signal travels for a shorter distance to and from the MEO satellite.

For real-time communications, the shorter the transmission delay, the better will be the communication system. As an example, if a GEO satellite requires 0.25 seconds for a round trip, then MEO satellite requires less than 0.1 seconds to complete the same trip. MEOs operate in the frequency range of 2 GHz and above.

These satellites are used for High speed telephone signals. Ten or more MEO satellites are required in order to cover entire earth.

Low Earth Orbit Satellites

Low Earth Orbit LEO) satellites are mainly classified into three categories. Those are little LEOs, big LEOs, and Mega-LEOs. LEOs will orbit at a distance of 500 to 1000 miles above the earth's surface. These satellites are used for satellite phones and GPS.

This relatively short distance reduces transmission delay to only 0.05 seconds. This further reduces the need for sensitive and bulky receiving equipment. Twenty or more LEO satellites are required to cover entire earth.

Little LEOs will operate in the 800 MHz (0.8 GHz) range. Big LEOs will operate in the 2 GHz or above range, and Mega-LEOs operates in the 20-30 GHz range.

The higher frequencies associated with Mega-LEOs translates into more information carrying capacity and yields to the capability of real-time, low delay video transmission scheme.

CHAPTER-3

2 MARKS QUESTION

Q.DEFINE OPTICAL COMMUNICATION?[2016S]

Optical communication is any type of communication in which light is used to carry the signal to the remote end, instead of electrical current. Optical communication relies on optical fibers to carry signals to their destinations.

Q.WHAT IS NUMERICAL APERATURE?[2016S]

Numerical aperture (NA) is defined as being equal to n sin θ, where n is the refractive index of the medium between the objective lens and the object ($n \cong 1$ for air) and θ is half the angular aperture (or acceptance angle of image-forming rays) of the objective lens (Jenkins and White 1957).

Q.WRITE DOWN ANY TWO APPLICATIONS OF OPTICAL FIBERS.[2016S]

Applications. Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication and cable television signals. It is also used in a multitude of other industries, including medical, defense/government, for data storage, and industrial/commercial.

Q.DEFINE MULTIPLE ACCESSING AND NAME VARIOUS TYPES?[2016S,2019S]

Multiple access schemes are used to allow many mobile users to share simultaneously a finite amount of radio spectrum.

three types of multiple access techniques.

FDMA (Frequency Division Multiple Access)

TDMA (Time Division Multiple Access)

CDMA (Code Division Multiple Access)

Q.WHAT IS OPTICAL FIBER?[2017W]

An optical fiber is a thin fiber of glass or plastic that can carry light from one end to the other. The study of optical fibers is called fiber optics, which is part of applied science and engineering.

Q.DEFINE ACCEPTANCE ANGLE.[2017W]

The acceptance angle of an optical fiber is defined based on a purely geometrical consideration (ray optics): it is the maximum angle of a ray (against the fiber axis) hitting the fiber core which allows the incident light to be guided by the core.

Q.DEFINE MODE OF OPERATION?[2019S]

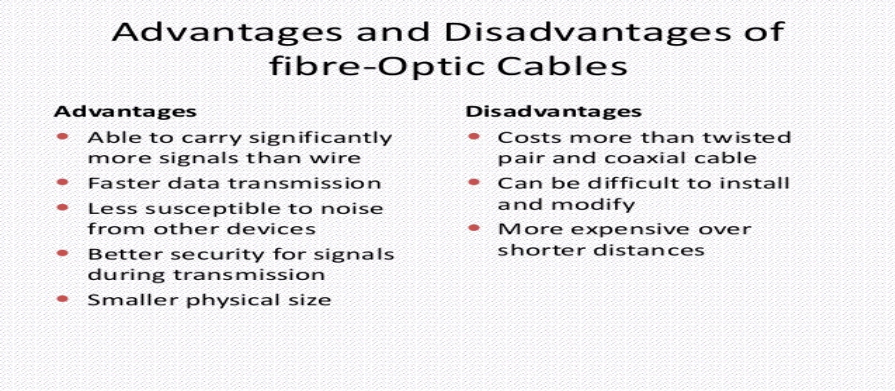
The manner in which radio signals travel from a transmitting antenna to a receiving antenna, such as ground wave, sky wave, direct wave, ground reflection, or scatter Is called modes of operation.

Q.WHAT IS WLDM?[2019S]

Wavelength division multiplexing (WDM) is a technique of multiplexing multiple optical carrier signals through a single optical fiber channel by varying the wavelengths of laser lights. WDM allows communication in both the directions in the fiber cable.

5 MARKS QUESTION

Q.COMPARE THE ADVANTAGES AND DISADVANTAGE OF OPTICAL FIBER CABLES?[2016S,2019S



Q.DESCRIBE THE THREE TYPES OF OPTICAL FIBER CONFIGURATION.[2016S,2019S]

Types of Fiber optics:

Generally optical fiber is classified into two categories based on: the number of modes, and the refractive index. These are explained as following below.

1. On the basis of the Number of Modes:

It is classified into 2 types:

(a). **Single-mode fiber**:

In single-mode fiber, only one type of ray of light can propagate through the fiber. This type of fiber has a small core diameter (5um) and high cladding diameter (70um) and the difference between the refractive index of core and cladding is very small. There is no dispersion i.e. no degradation of the signal during traveling through the fiber. The light is passed through it through a laser diode.

(b). **Multi-mode fiber**:

Multimode fiber allows a large number of modes for the light ray traveling through it. The core diameter is generally (40um) and that of cladding is (70um). The relative refractive index difference is also greater than single mode fiber. There is signal degradation due to multimode dispersion. It is not suitable for long-distance communication due to large dispersion and attenuation of the signal.

2. **On the basis of Refractive Index**:

It is also classified into 2 types:(a). **Step-index optical fiber**:

The refractive index of core is constant. The refractive index of the cladding is also constant. The rays of light propagate through it in the form of meridional rays which cross the fiber axis during every reflection at the core-cladding boundary.

(b). **Graded index optical fiber**:

In this type of fiber, the core has a non-uniform refractive index that gradually decreases from the center towards the core-cladding interface. The cladding has a uniform refractive index. The light rays propagate through it in the form of skew rays or helical rays. it is not cross the fiber axis at any time.

Q.EXPLAIN THE BASIC PRINCIPLE OF PIN PHOTODIODE?[2016S,2017W]

A p–i–n photodiode, also called PIN photodiode, is a photodiode with an intrinsic (i) (i.e., undoped) region in between the n- and p-doped regions. Most of the photons are absorbed in the intrinsic region, and carriers generated therein can efficiently contribute to the photocurrent.

The working principle of a photodiode is, when a photon of ample energy strikes the diode, it makes a couple of an electron-hole. This mechanism is also called as the inner photoelectric effect. If the absorption arises in the depletion region junction, then the carriers are removed from the junction by the inbuilt electric field of the depletion region. Therefore, holes in the region move toward the anode, and electrons move toward the cathode, and a photocurrent will be generated. The entire current through the diode is the sum of the absence of light and the photocurrent. So the absent current must be reduced to maximize the sensitivity of the device.

Q.WRITE SHORT NOTE ON PIN DIODE.[2016S]

A PIN diode is a one kind of diode with an undoped, wide intrinsic semiconductor region between a P-type and N-type semiconductor region. These regions are normally heavily doped as they are used for Ohmiccontacts.The wider intrinsic region is indifference to an ordinary p–n diode.

The working principle of the PIN diode exactly same as a normal diode. The main difference is that the depletion region, because that normally exists between both the P & N regions in a reverse biased or unbiased diode is larger. In any PN junction diode, the P region contains holes as it has been doped to make sure that it has a majority of holes. Likewise the N-region has been doped to hold excess electrons.

The layer between the P & N regions includes no charge carriers as any electrons or holes merge As the depletion region of the diode has no charge carriers it works as an insulator. The depletion region exists within a PIN diode, but if the PIN diode is forward biased, then the carriers come into the depletion region and as the two carrier types get together, the flow of current will start.

When the PIN diode is connected in forward biased, the charge carriers are very much higher than the level of intrinsic carrier's attention. Due to this reason the electric field and the high level injection level extends deeply into the region. This electric field assists in speeding up of the moving of charge carriers from P to N region, which consequences in quicker operation of the PIN diode, making it an appropriate device for high frequency operations.

Q.EXPLAIN THE BASIC PRINCIPLE OF AVALANCHE PHOTODIODE?[2017W]

The avalanche photodiode possesses a similar structure to that of the PN or PIN photodiode. An avalanche diode structure similar to that of a Schottky photodiode may also be used but the use of this version is much less common.

The main difference of the avalanche photodiode to other forms of photodiode is that it operates under a high reverse bias condition. This enables avalanche multiplication of the holes and electrons created by the photon / light impact.

As a photon enters the depletion region and creates a hole electron pair, these charge carriers will be pulled by the very high electric field away from one another. Their velocity will increase to such an extent that when they collide with the lattice, they will create further hole electron pairs and the process will repeat.

The avalanche action enables the gain of the diode to be increased many times, providing a very much greater level of sensitivity.

Q.EXPLAIN THE WORKING PRINCIPLE OF LASER WIH ITS USE.[2019S]

Laser" (rarely written as l.a.s.e.r.) is an acronym for "Light Amplification by Stimulated Emission of Radiation", coined in 1957 by the laser pioneer Gordon Gould.

Laser technology is at the core of the wider area of photonics, essentially because laser light has a number of very special properties:

It is usually emitted as a well directed laser beam which can propagate over long lengths without much divergence and can be focused to very small spots, where a high intensity is achieved.

It can have a very narrow optical bandwidth, whereas e.g. most lamps emit light with a very broad optical spectrum.

It may be emitted continuously, or alternatively in the form of short or ultrashort pulses, with durations from microseconds down to a few femtoseconds. The temporal concentration of energy – in addition to the potential of strong spatial confinement in a beam focus – allows for even far higher intensities to be generated.

WORKING PRINCIPLE

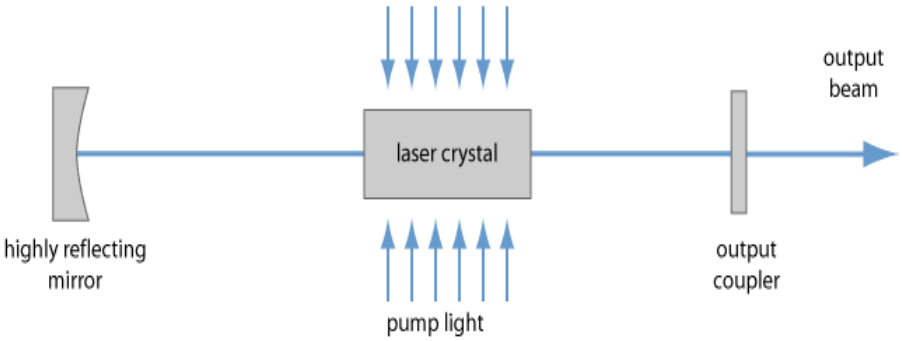
A laser oscillator usually comprises an optical resonator (laser resonator, laser cavity) in which light can circulate (e.g. between two mirrors), and within this resonator a gain medium (e.g. a laser crystal), which serves to amplify the light. Without the gain medium, the circulating light would become weaker and weaker in each resonator round trip, because it experiences some losses, e.g. upon reflection at mirrors. However, the gain medium can amplify the circulating light, thus compensating the losses if the gain is high enough. The gain medium requires some external supply of energy – it needs to be "pumped", e.g. by injecting light (optical pumping) or an electric current (electrical pumping → semiconductor lasers). The principle of laser amplification is stimulated emission.

A laser can not operate if the gain is smaller than the resonator losses; the device is then below the so-called laser threshold and only emits some luminescence light. Significant power output is achieved only for pump powers above the laser threshold, where the gain can reach the level of the resonator losses.

If the gain is larger than the losses, the power of the light in the laser resonator rises very rapidly, starting e.g. with low levels of light from fluorescence. Note that the resonator round-trip time is usually very small (e.g. a few nanoseconds, sometimes even much less), so that even a small net round-trip gain implies rapid exponential growth of the intracavity power. As high laser powers saturate the gain, the laser power will in the steady state reach a level so that the saturated gain just equals the resonator losses (→ gain clamping). Before reaching this steady state, a laser usually undergoes some relaxation oscillations. The threshold pump power is the pump power where the small-signal gain is just sufficient for lasing.

Some fraction of the light power circulating in the resonator is usually transmitted by a partially

transparent mirror, the so-called output coupler mirror. The resulting beam constitutes the useful output of the laser. The transmission of the output coupler mirror can be optimized for maximum output power



7 MARKS QUESTION

Q.DISCUSS THE CODE DIVISION MULTIPLE ACCESSING AND ITS ADVANTAGES AND DISADVATAGES[.2016S]

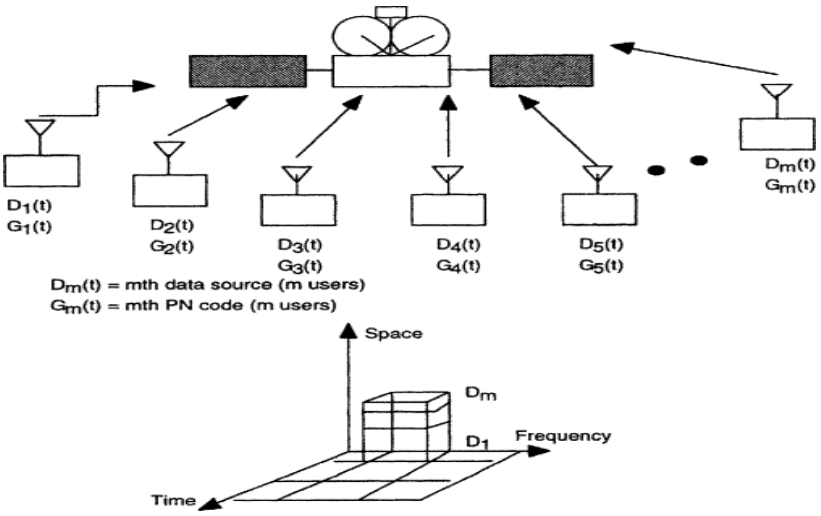
Code Division Multiple Access (CDMA) is a sort of multiplexing that facilitates various signals to occupy a single transmission channel. It optimizes the use of available bandwidth. The technology is commonly used in ultra-high-frequency (UHF) cellular telephone systems, bands ranging between the 800-MHz and 1.9-GHz.

CDMA allows up to 61 concurrent users in a 1.2288 MHz channel by processing each voice packet with two PN codes. There are 64 Walsh codes available to differentiate between calls and theoretical limits. Operational limits and quality issues will reduce the maximum number of calls somewhat lower than this value.

In fact, many different "signals" baseband with different spreading codes can be modulated on the same carrier to allow many different users to be supported. Using different orthogonal codes, interference between the signals is minimal. Conversely, when signals are received from several mobile stations, the base station is capable of isolating each as they have different orthogonal spreading codes.

The factors deciding the CDMA capacity are −

- Processing Gain
- Signal to Noise Ratio

- Voice Activity Factor
- Frequency Reuse Efficiency
- 

Advantages of CDMA

CDMA has a soft capacity. The greater the number of codes, the more the number of users. It has the following advantages −

- CDMA requires a tight power control, as it suffers from near-far effect. In other words, a user near the base station transmitting with the same power will drown the signal latter. All signals must have more or less equal power at the receiver
- Rake receivers can be used to improve signal reception. Delayed versions of time (a chip or later) of the signal (multipath signals) can be collected and used to make decisions at the bit level.
- Flexible transfer may be used. Mobile base stations can switch without changing operator. Two base stations receive mobile signal and the mobile receives signals from the two base stations.
- Transmission Burst − reduces interference.

Disadvantages of CDMA

The disadvantages of using CDMA are as follows −

- The code length must be carefully selected. A large code length can induce delay or may cause interference.
- Time synchronization is required.
- Gradual transfer increases the use of radio resources and may reduce capacity.

- As the sum of the power received and transmitted from a base station needs constant tight power control. This can result in several handovers.

Q.EXPLAIN THE WORKING PRINCIPLE OF LED.[2016S]

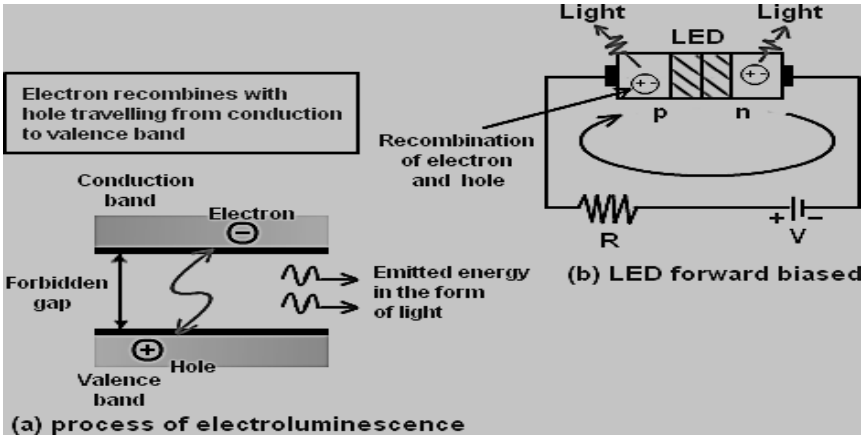
A light releasing diode is an electric component that emits light when the electric current flows through it. It is a light source based on semiconductors. When current passes through the LED, the electrons recombine with holes emitting light in the process. It is a specific type of diode having similar characteristics as the p-n junction diode. Which means that an LED allows the flow of current in its forward direction while it blocks the flow in the reverse direction. Light-emitting diodes are built using a weak layer of heavily doped semiconductor material. Based on the semiconductor material used and the amount of doping, an LED will emit a coloured light at a particular spectral wavelength when forward biased.

Working Principle of LED

The holes lie in the valence band, while the free electrons are in the conduction band. When there is a forward bias in the p-n junction, the electron which is a part of the n-type semiconductor material would overrun the p-n junction and join with the holes in the p-type semiconductor material. Therefore regarding the holes, the free electrons would be at the higher energy bands.

When this movement of free electron and hole takes place, there is a change in the energy level as the voltage drops from the conduction band to the valance band. There is a release of energy due to the motion of the electron. In standard diodes, the release of energy in the manner of heat. But in LED the release of energy in the form of photons that would emit the light energy. The entire process is known as electroluminescence, and the diodes are known as a light-emitting diode.

In LED, energy discharged in light form hinges on the forbidden energy gap. One could manipulate the wavelength of the light produced. Therefore, from its wavelength, the light colour and its visibility or cannot be controlled. The colour and wavelength of the light emitted can be determined by doping it with several impurities.

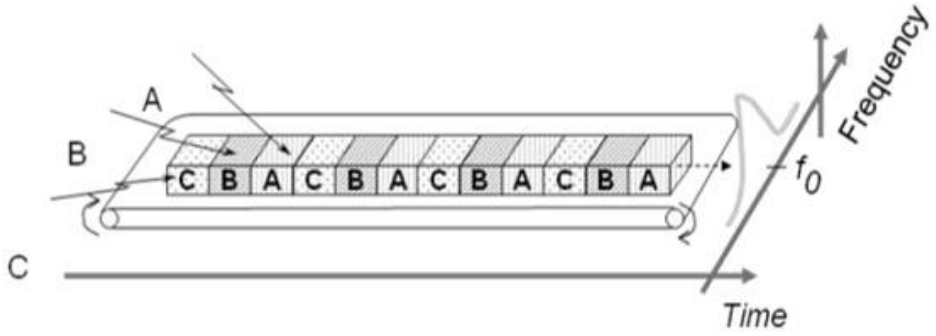


Q.DISCUSS THE TIME DIVISION MULTIPLE ACCESSING AND ITS AVANTAGE AND DISADVANTAGE?[2019s]

Time Division Multiple Access (TDMA) is a complex technology, because it requires an accurate synchronization between the transmitter and the receiver. TDMA is used in digital mobile radio systems. The individual mobile stations cyclically assign a frequency for the exclusive use of a time interval.

the entire system bandwidth for an interval of time is not assigned to a station. However, the frequency of the system is divided into sub-bands, and TDMA is used for the multiple access in each sub-band. Sub-bands are known as carrier frequencies. The mobile system that uses this technique is referred as the multi-carrier systems.

In the following example, the frequency band has been shared by three users. Each user is assigned definite timeslots to send and receive data. In this example, user 'B' sends after user 'A,' and user 'C' sends thereafter. In this way, the peak power becomes a problem and larger by the burst communication.



Advantages of TDMA

- Permits flexible rates (i.e. several slots can be assigned to a user, for example, each time interval translates 32Kbps, a user is assigned two 64 Kbps slots per frame).
- Can withstand gusty or variable bit rate traffic. Number of slots allocated to a user can be changed frame by frame (for example, two slots in the frame 1, three slots in the frame 2, one slot in the frame 3, frame 0 of the notches 4, etc.).
- No guard band required for the wideband system.
- No narrowband filter required for the wideband system.

Disadvantages of TDMA

The disadvantages of TDMA are as follow −

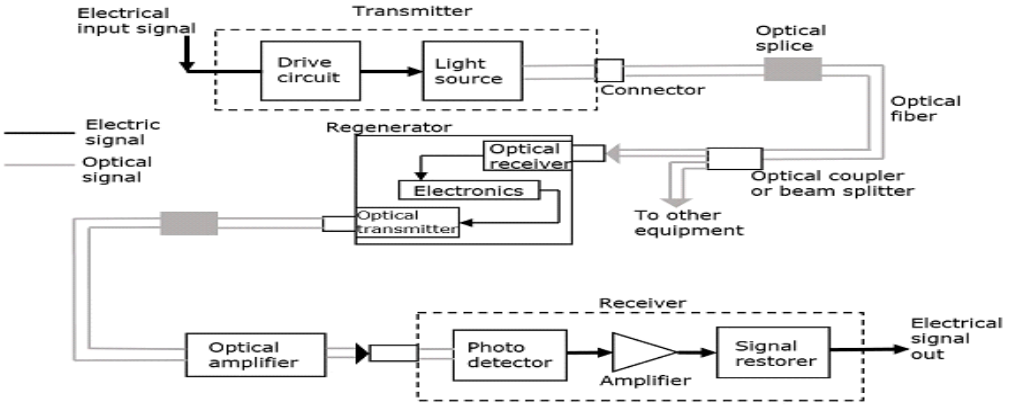
- High data rates of broadband systems require complex equalization.
- Due to the burst mode, a large number of additional bits are required for synchronization and supervision.
- Call time is needed in each slot to accommodate time to inaccuracies (due to clock instability).

- Electronics operating at high bit rates increase energy consumption.

Q.DISCUSS THE BLOCK DIAGRAM OF AN OPTICAL FIBER COMMUNICATION SYSTEM WITH THE HELP OF NEAT BLOCK DIAGRAM[2019s,2017w.]

Optical Fiber Communications

The communication system of fiber optics is well understood by studying the parts and sections of it. The major elements of an optical fiber communication system are shown in the following figure.



Any fibre optic data transmission system will comprise a number of different elements. There are three major elements (marked in bold), and a further one that is vital for practical systems:

Transmitter (light source)

Fibre optic cable

Optical repeater

Receiver (Detector)

The different elements of the system will vary according to the application. Systems used for lower capacity links, possibly for local area networks will employ somewhat different techniques and components to those used by network providers that provide extremely high data rates over long distances. Nevertheless the basic principles are the same whatever the system.

In the system the transmitter of light source generates a light stream modulated to enable it to carry the data. Conventionally a pulse of light indicates a "1" and the absence of light indicates "0". This light is transmitted down a very thin fibre of glass or other suitable material to be presented at the receiver or detector. The detector converts the pulses of light into equivalent electrical pulses. In this way the data can be transmitted as light over great distances.

The simplest transmitter device is the LED. Its main advantage is that it is cheap, and this makes it ideal

for low cost applications where only short runs are needed. However they have a number of drawbacks. The first is that they offer a very low level of efficiency. Only about 1% of the input power enters the

optical fibre, and this means that high power drivers would be needed to provide sufficient light to enable long distance transmission.

Fibre optic cable

The full details and description of fibre optic cabling are found in a separate article / tutorial on this area of the website. In essence a fibre optic cable consists of core, around which is another layer referred to as the cladding. Outside of this there is a protective outer coating.

The fibre optic cables operate because their cladding has a refractive index that is slightly lower than that of the core. This means that light passing down the core undergoes total internal reflection when it reaches the core / cladding boundary, and it is thereby contained within the core of the optical fibre.

Repeaters and amplifiers

There is a maximum distance over which signals may be transmitted over fibre optic cabling. This is limited not only by the attenuation of the cable, but also the distortion of the light signal along the cable. In order to overcome these effects and transmit the signals over longer distances, repeaters and amplifiers are used.

Opto-electric repeaters may be used. These devices convert the optical signal into an electrical format where it can be processed to ensure that the signal is not distorted and then converted back into the optical format. It may then be transmitted along the next state of the fibre optic cable.

Receivers

Light travelling along a fibre optic cable needs to be converted into an electrical signal so that it can be processed and the data that is carried can be extracted. The component that is at the heart of the receiver is a photo-detector. This is normally a semiconductor device and may be a p-n junction, a p-i-n photo-diode or an avalanche photo-diode. Photo-transistors are not used because they do not have sufficient speed.

Once the optical signal from the fibre optic cable has been applied to the photo-detector and converted into an electrical format it can be processed to recover the data which can then be passed to its final destination.

CHAPTER 4

2 MARKS QUESTION

Q.DEFINE UNIT OF POWER MEASUREMENT.[2017w]

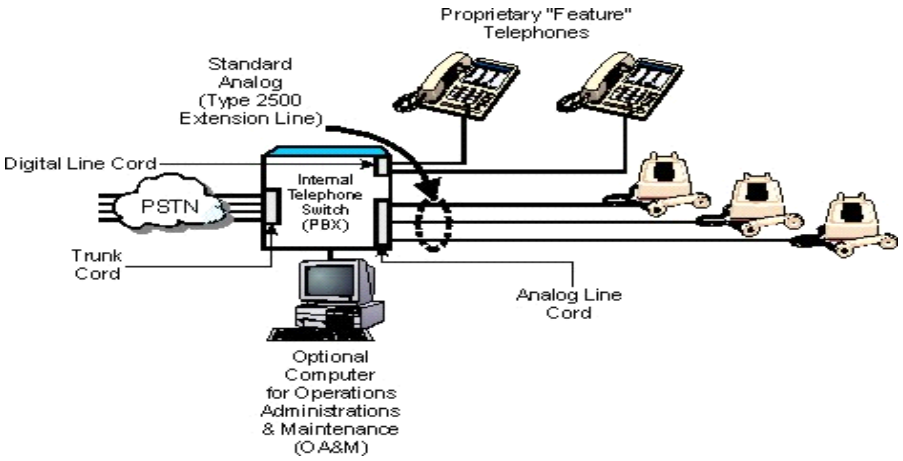
The dimension of power is energy divided by time. The SI unit of power is the watt (W), which is equal to one joule per second.

5 marks question

Q.DESCRIBE THE OPRATION OF EPABX WITH A NEAT BLOCK DIGRAM.[2017W,2019s]

EPABX stands for Electronic Private Automatic Branch Exchange which is a private telephone network used by the organizations and the companies for various types of communication, either between the employees or outside the clients

EPABX stands for Electronic Private Automatic Branch Exchange which is a private telephone network used by the organizations and the companies for various types of communication, either between the employees or outside the clients. PBX which is Private Brand Exchange is a telephone exchange which is used by a particular office or business, opposite to the one that a common carrier or telephone company operates for many companies and businesses for the general public. Private Branch Exchange (PBX) is also known as (PABX) Private Automatic Branch Exchange and (EPABX) Electronic Private Automatic Branch Exchange.



EPABX is essential equipment that has made daily working in the offices and organizations much smoother and simpler, especially the area of communication. This system is a switching system which has enabled both internal and external stitching functions for any organization. To select an appropriate EPABX one need to have proper knowledge about the traffic pattern inside the office. With the right utilization of the EPABX, all the internal and external requirements of the organization are adequately served. With the advancement in the field of computers along with the advent of microprocessors, the EPABX incorporates a lot of helpful features. The boss can establish a hotline with his or her immediate subordinates.

The call transferring and forwarding feature has enabled the mobility of the users. Automatic redialing of numbers and auto conferencing has initiated engagement which is also one of the advancements in the characteristics of the EPABX. A proper survey of the organization should be done before the selection of an EPABX for the particular company. The exchange should incorporate a supporting system such as voice DISA-n-auto attendant. This feature is of great help to attendants and receptionist. The further specifications of this system should ensure inbuilt paging, auto fax homing, hot outward dialing, remote dialing; auto shut dynamic shot, as well as remote servicing.

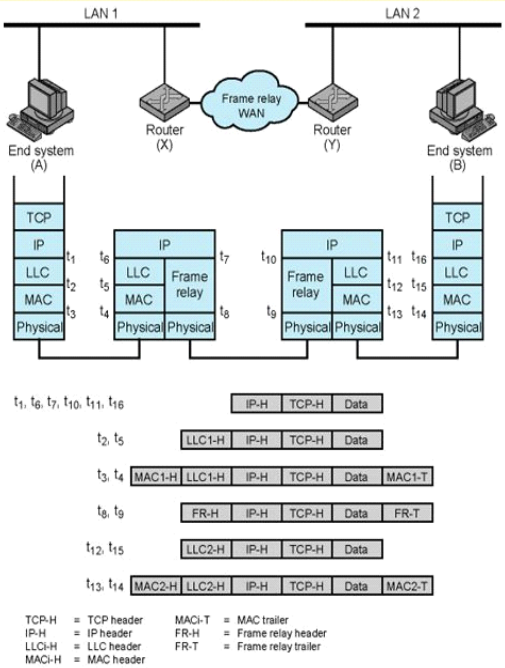
This telephone system helps businesses to cut cost by using a private branch exchange. With the help of this system, businesses aren't required to run a line from every phone in the building to the telephone company's central office.

The PBX Setup: Initially during the 20th century, PBX used to run on analog technology, but today it has gone digital. The typical private branch exchanges incorporate several phone lines from outside the building which terminates at the company exchange. It also includes several internal lines that lead to the exchange for the inside phones. A computer is used that manages the calls and switches them to one line to another based on the number dialed. This digital PBX doesn't require a human operator.

Q.DECRIBE OPERATION OF INTERNET PROTOCOL TELEPHONE.[2017W]

The Internet works by using a protocol called TCP/IP, or Transmission Control Protocol/Internet Protocol. ... In base terms, TCP/IP allows one computer to talk to another computer via the Internet through compiling packets of data and sending them to right location

Example Internet Protocol Operation

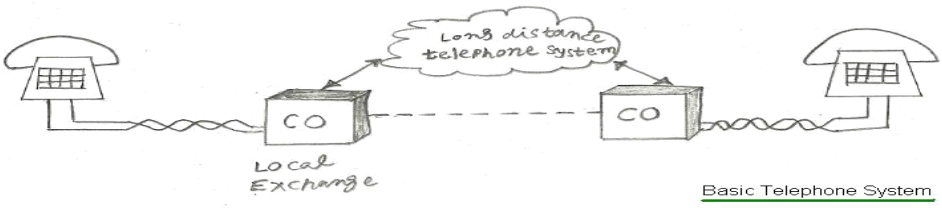


The Internet Protocol is responsible for addressing host interfaces, encapsulating data into datagrams (including fragmentation and reassembly) and routing datagrams from a source host interface to a destination host interface across one or more IP networks.[1] For these purposes, the Internet Protocol defines the format of packets and provides an addressing system.

Each datagram has two components: a header and a payload. The IP header includes source IP address, destination IP address, and other metadata needed to route and deliver the datagram. The payload is the data that is transported. This method of nesting the data payload in a packet with a header is called encapsulation.

IP addressing entails the assignment of IP addresses and associated parameters to host interfaces. The address space is divided into subnetworks, involving the designation of network prefixes. IP routing is performed by all hosts, as well as routers, whose main function is to transport packets across network boundaries. Routers communicate with one another via specially designed routing protocols, either interior gateway protocols or exterior gateway protocols, as needed for the topology of the network.

Q.**DISCUSS THE OPERATION OF ELECTRONIC TELEPHONE SYSTEM**.[2016W,2019S]



Electronic Telephone

Usually any telephone set will have following basic functions in the transmit and receive direction:

In the transmit mode,

- Indication to the user that call can or can not be made by way of dial tones and busy tones respectively.
- means to send the number to be dialled to the telephone CO or local exchange.

In the receive mode,

- It should have ringer so that it rings the bell indicating call is received.
- Signal to the exchange(telephone system) that the call has been answered
- Device to convert voice to the electrical signal and vice versa, such device is called as transducer.

In a telephone system all the telephones connected to the central offices are provided with group of basic electronic circuits referred as SLIC(Subscriber Line Interface Circuits). This SLIC has following basic functions referred as BORSCHT.

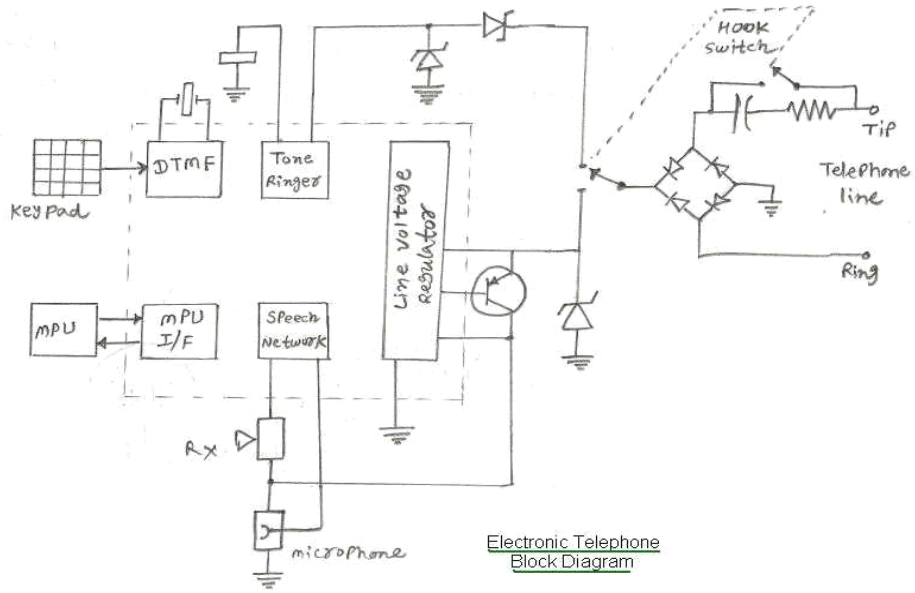
- Provision of Battery feed
- Provision of Over voltage protection mechanism

• Provision of Ringing circuit

• Provision of Codec functionalities

• Provision of Hybrid and signal conditioning, which takes care of 2 wire to 4 wire conversion and vice versa.

• Provision of Testing the telephone system



Electronic Telephone Block Diagram