

SCHEME OF VALUATION

(Scoring Indicators)

Revision :2015		Course Title: Communication Systems		
Course Code: 6042				
QST No	Scoring Indicator	Split up Score	Sub Total	Total
I	PART A			
1	<ul style="list-style-type: none">• Microwaves are the waves that radiate electromagnetic energy with shorter wavelength.• Microwaves are not reflected by Ionosphere.• Microwaves travel in a straight line and are reflected by the conducting surfaces.• Microwaves are easily attenuated within shorter distances.• Microwaves don't require any medium to travel	Any 4 4*.5	2	2
2	Velocity modulation is defined as the variation in the velocity of a beam of electrons caused by the alternating speeding up and slowing down of electrons in the beam	2	2	2
3	<ul style="list-style-type: none">• In Radio broadcasting.• In TV broadcasting such as DTH.• In Internet applications such as providing Internet connection for data transfer, GPS applications, Internet surfing, etc.• For voice communications.• For research and development sector, in many areas.• In military applications and navigations.	Any 4 4*.5	2	2
4	Acceptance angle, defined as the maximum value of the angle of incidence at the entrance end of the fibre, at which the angle of incidence at the core – cladding surface is equal to the critical angle of the core medium	2	2	2
5	<ul style="list-style-type: none">• Freedom from wires• Global Coverage• Flexibility.• Stay Connected	Any 4 4*.5	2	2

<p>II 1</p>	<ul style="list-style-type: none"> • TRANSIT TIME is basically time taken for movement or transition of electron from one electrode to another is known transit time and the effect which is caused due to transit time is known as TRANSIT TIME EFFECT. • When the Transit time becomes comparable to the period of the signal then we have to incorporate the effect of the Transit time. • At High frequency: The time period of input voltage becomes small, so the transit time becomes comparable to T. So the transit time effects cannot be neglected. • At Low frequency: The time period of the input voltage becomes large and transit time is negligible compared to time period. Hence the transit time effects can be neglected. <p>To ignore the transit time effect input voltage time period must be greater than transit time.</p> <p style="text-align: center;">$T \gg t_r$ (Transit Time can be neglected)</p> <p style="text-align: center;">$T \gg L/v$ $1/f \gg L/v$ $v/f \gg L$ i.e $\lambda \gg L$</p> <p>Hence we see that to neglect the transit time effect the wavelength of the input voltage must be larger than length of the conducting wires</p>	<p>Exp: 6</p>	<p>6</p>	<p>6</p>			
<p>2</p>		<p>Fig : 6</p>	<p>6</p>	<p>6</p>			
<p>3</p>	<table border="1" style="width: 100%; height: 100%;"> <tr> <td style="text-align: center;">TDMA</td> <td style="text-align: center;">FDMA</td> <td style="text-align: center;">CDMA</td> </tr> </table>	TDMA	FDMA	CDMA	<p>Any 4 4*1.5</p>	<p>6</p>	<p>6</p>
TDMA	FDMA	CDMA					

Different slots for each user	Time for each	Different Frequencies for each user	Orthogonal codes for each user
All terminals active for a short period of time with same frequency		All terminals active for entire period of time with different frequency	All terminals active for entire period of time with same frequency
Synchronization in Time domain		Filtering in Frequency Domain	Codes plus special receivers
Flexible, established		Simple, robust	Flexible, less frequency planning required
Synchronization is difficult		Guard space required between frequencies	Complex receivers required

4



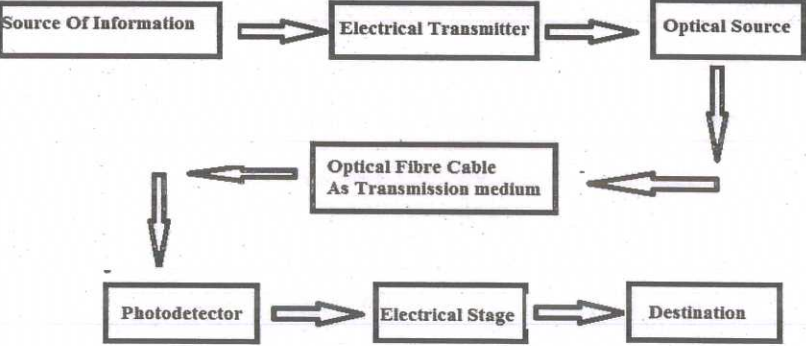
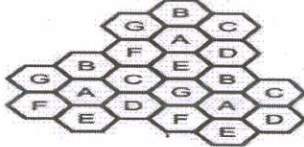
- ▶ The PIN diode is a photo detector, used to convert optical signal into an electrical signal.
- ▶ The PIN diode comprises of three regions, namely
 - P-region,
 - I-region
 - and N-region.
- ▶ P and N regions are heavily doped
- ▶ PIN diode is reverse biased
- ▶ An incident photon striking the diode gives an electron in the valence band sufficient energy to move to the conduction band, creating a free electron and a hole.
- ▶ The sensitive area of a photodiode is the depletion region.
- ▶ If the creation of these carriers occurs in a depleted region, the carriers will quickly separate and create a current
- ▶ By having a larger depletion region, the volume for light

Fig :2

6

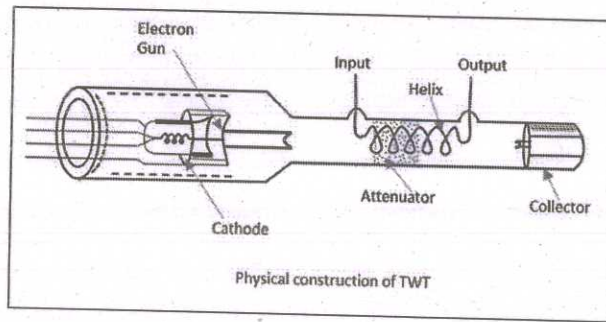
6

Exp :4

	<p>reception is increased. So electron hole pair generation is more and more current is produced</p> <p>This makes PIN diodes ideal for use as photodetectors</p>			
5	 <ul style="list-style-type: none"> ▶ The source provides information in the form of electrical signal to the transmitter. ▶ The electrical stage of the transmitter drives an optical source to produce modulated light wave carrier. ▶ The information carrying light wave then passes through the transmission medium i.e. optical fibre cables in this system. ▶ Signal reaches to the receiver stage where the optical detector demodulates the optical carrier and gives an electrical output signal to the electrical stage. ▶ Finally the electrical stage gets the real information back and gives it to the concerned destination. 	Fig :4 Exp:2	6	6
6	 <ul style="list-style-type: none"> • Each base station is given a group of radio channels to be used within a cell. • Base stations in neighbouring cells are assigned completely different set of channel frequencies. • Same set of channels may be used to cover different cells separated from one another by a distance large enough to keep interference level within tolerable limits • Cells with the same letter use the same set of frequencies, called reusing cells. • N cells which collectively use the available frequencies (S 	Fig :2 Exp:4	6	6

	<p>= k.N) is known as cluster.</p> <ul style="list-style-type: none"> • If a cluster is replicated M times within a system, then total number duplex channels (capacity) is $C = M.k.N = M.S$ • This process of selecting and allotting channel groups for cellular base stations is frequency reuse 																														
7	<table border="1"> <thead> <tr> <th>Basis for Comparison</th> <th>GSM</th> <th>CDMA</th> </tr> </thead> <tbody> <tr> <td>Basic</td> <td>GSM is SIM specific.</td> <td>CDMA is Handset specific</td> </tr> <tr> <td>Full Form</td> <td>Global System for Mobile communication</td> <td>Code Division Multiple Access</td> </tr> <tr> <td>Technology</td> <td>FDMA and TDMA</td> <td>CDMA</td> </tr> <tr> <td>Network</td> <td>Network Tower in each cell serves the mobile phone of that area.</td> <td>There are a physical channel and a dedicated code for each device in the network.</td> </tr> <tr> <td>Transmission</td> <td>Voice and data transmission at the same time</td> <td>Cannot do voice and data transmission simultaneously</td> </tr> <tr> <td>Roaming</td> <td>Worldwide</td> <td>Limited</td> </tr> <tr> <td>Data Rate</td> <td>Slower.</td> <td>Faster</td> </tr> <tr> <td></td> <td>GSM networks are encrypted, the data being stored in the SIM card makes it vulnerable to hacking or misuse.</td> <td>CDMA device has a unique code & there is an encryption standard embedded into the device. All the conversation is encrypted by the device and can be decrypted only with appropriate receiver device.</td> </tr> </tbody> </table>	Basis for Comparison	GSM	CDMA	Basic	GSM is SIM specific.	CDMA is Handset specific	Full Form	Global System for Mobile communication	Code Division Multiple Access	Technology	FDMA and TDMA	CDMA	Network	Network Tower in each cell serves the mobile phone of that area.	There are a physical channel and a dedicated code for each device in the network.	Transmission	Voice and data transmission at the same time	Cannot do voice and data transmission simultaneously	Roaming	Worldwide	Limited	Data Rate	Slower.	Faster		GSM networks are encrypted, the data being stored in the SIM card makes it vulnerable to hacking or misuse.	CDMA device has a unique code & there is an encryption standard embedded into the device. All the conversation is encrypted by the device and can be decrypted only with appropriate receiver device.	Any 4 4*1.5	6	6
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IIIa	Part C Traveling Wave Tube	Fig :5 Exp:4	9	9																											

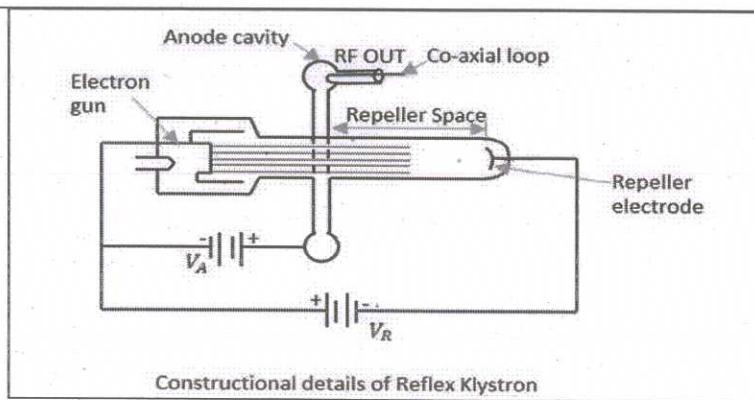
➤ Traveling Wave Tube (TWT) is microwave RF power amplifiers.



- The basic structure of a TWT consists of a cathode and filament heater plus an anode that is biased positively to accelerate the electron beam forward and to focus it into a narrow beam.
- The electrons are attracted by a positive plate called the collector, which has given a high dc voltage.
- Surrounding the tube are either permanent magnets or electromagnets that keep the electrons tightly focused into a narrow beam.
- The unique feature of the TWT is a helix or coil that surrounds the length of the tube and the electron beam passes through the centre or axis of the helix.
- The microwave signal to be amplified is applied to the end of the helix near the cathode and the output is taken from the end of the helix near the collector.
- The purpose of the helix is to provide path for RF signal.
- The propagation of the RF signal along the helix is equal to the velocity of the electron beam from the cathode to the collector
- The passage of the microwave signal down the helix produces electric and magnetic fields that will interact with the electron beam.
- The electromagnetic field produced by the helix causes the electrons to be speeded up and slowed down, this produces velocity modulation of the beam which produces density modulation.
- Density modulation causes bunches of electrons to group together.

The electron bunches induce voltages into the helix which

	reinforce the voltage already present there. Due to that the strength of the electromagnetic field on the helix increases as the wave travels down the tube towards the collector.																											
b	<p>Frequency Bands</p> <p>Frequencies in the microwave range are often referred as S, C, X, K_u, K, or K_a band,</p> <table border="1"> <thead> <tr> <th>Designation</th> <th>Frequency range</th> <th>Typical uses</th> </tr> </thead> <tbody> <tr> <td><u>L band</u></td> <td>1 to 2 GHz</td> <td>military telemetry, GPS, mobile phones (GSM)</td> </tr> <tr> <td><u>S band</u></td> <td>2 to 4 GHz</td> <td>weather radar, surface ship radar, and communications satellites</td> </tr> <tr> <td><u>C band</u></td> <td>4 to 8 GHz</td> <td>long-distance radio telecommunications</td> </tr> <tr> <td><u>X band</u></td> <td>8 to 12 GHz</td> <td>satellite communications, radar, space communications</td> </tr> <tr> <td><u>K_u band</u></td> <td>12 to 18 GHz</td> <td>satellite communications</td> </tr> <tr> <td><u>K band</u></td> <td>18 to 26.5 GHz</td> <td>radar, satellite communications</td> </tr> <tr> <td><u>K_a band</u></td> <td>26.5 to 40 GHz</td> <td>satellite communications</td> </tr> </tbody> </table>	Designation	Frequency range	Typical uses	<u>L band</u>	1 to 2 GHz	military telemetry, GPS, mobile phones (GSM)	<u>S band</u>	2 to 4 GHz	weather radar, surface ship radar, and communications satellites	<u>C band</u>	4 to 8 GHz	long-distance radio telecommunications	<u>X band</u>	8 to 12 GHz	satellite communications, radar, space communications	<u>K_u band</u>	12 to 18 GHz	satellite communications	<u>K band</u>	18 to 26.5 GHz	radar, satellite communications	<u>K_a band</u>	26.5 to 40 GHz	satellite communications	6	6	6
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IV a	<p>Reflex Klystron :</p> <ul style="list-style-type: none"> • Reflex Klystron is one of the most commonly used microwave (low power) generators. • It converts D.C. power into microwave power. • Reflex Klystron consists of an electron gun, a cathode , an anode cavity, and an electrode at the cathode potential(repeller). • It provides low power and has low efficiency. 	Fig 5 Exp:4	9	9																								

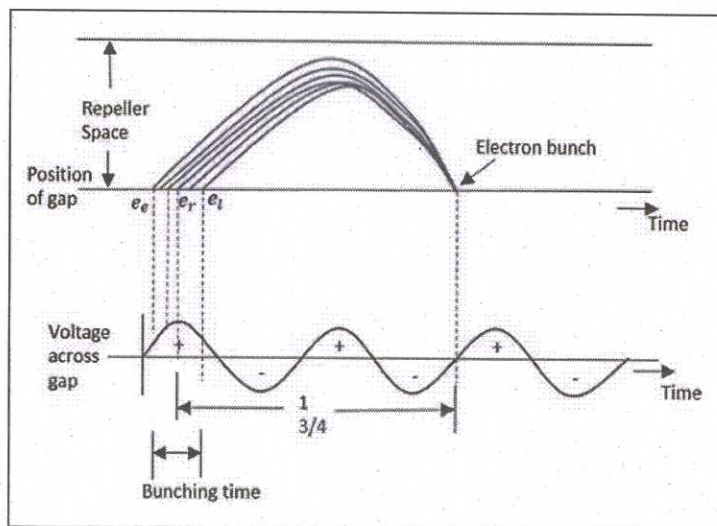


The electron gun emits the electron beam, which passes through the gap in the anode cavity. These electrons travel towards the Repeller electrode, which is at high negative potential. Due to the high negative field, the electrons repel back to the anode cavity. Due to dc voltage in the cavity circuit, RF voltage is generated in the cavity. The electrons passing through the cavity gap experience this RF field and are velocity modulated. The electrons while passing through the anode cavity, gain some velocity.

Consider a reference electron e_r crosses the anode cavity but has no extra velocity and it repels back after reaching the Repeller electrode, with the same velocity. Another electron, let's say e_e which has started earlier than this reference electron, reaches the Repeller first, but returns slowly, reaching at the same time as the reference electron.

The late electron e_l , which starts later than both e_r and e_e , however, it moves with greater velocity while returning back, reaching at the same time as e_r and e_e .

Three electrons, namely e_r , e_e and e_l reach the gap at the same time, forming an **electron bunch**. This process is known as **velocity modulation**.



<p>b</p>	<p>Transmitter</p> <p>Receiver</p>	<p>Fig: (2+2) Exp:2</p>	<p>6</p>	<p>6</p>
<p>V a</p>	<p>An earth station comprises</p>	<p>Fig:5 Exp:4</p>	<p>9</p>	<p>9</p>

	<ul style="list-style-type: none"> ▫ an antenna ▫ tracking system ▫ receiver ▫ transmitter, ▫ multiplexer (combiner ▫ Terrestrial links via a modem (or codec). <ul style="list-style-type: none"> ▫ The antenna is used for transmitting and receiving: Hence called a TRANSCIVER. ▫ Tracking system ensures precise pointing of the antenna at the satellite ▫ Antenna tracking system can be programmed to point to pre-assigned direction(s) automatically and can also be directed manually ▫ If a satellite operates digitally, then analog signals must be converted to digital format before transmission. The conversion is done with a circuit called a codec (coder and decoder) ▫ Receiver passes the RF received signals through a low-noise wideband RF front end, followed by a translator to IF. ▫ Those signals which are not specifically destined to the earth station are retransmitted, thereby acting like a transponder. ▫ The demodulated baseband signals may then be demultiplexed, if necessary, and thereby transferred to the users. 			
b	<p>A satellite dish is a dish-shaped type of parabolic antenna designed to receive or transmit information by radio waves to or from a communication satellite.</p> <ul style="list-style-type: none"> • Used by consumers to receive direct-broadcast satellite television from a direct broadcast satellite in geostationary orbit. <div data-bbox="391 1500 1045 1803" data-label="Diagram"> <p>The diagram consists of two parts. On the left is a 3D perspective view of a satellite dish antenna. A label 'feed horn' points to the central receiver at the focal point of the dish. On the right is a 2D cross-sectional diagram of a parabolic reflector. A label 'Parabolic Reflector' is placed above it, and a label 'Feed Antenna' is placed above the feed horn symbol located at the focal point of the parabola.</p> </div> <p>Principle Of Operation</p> <ul style="list-style-type: none"> • The parabolic shape of a dish reflects the signal to the dish's focal point where a feed horn is placed 	Fig 3 Exp: 3	6	6

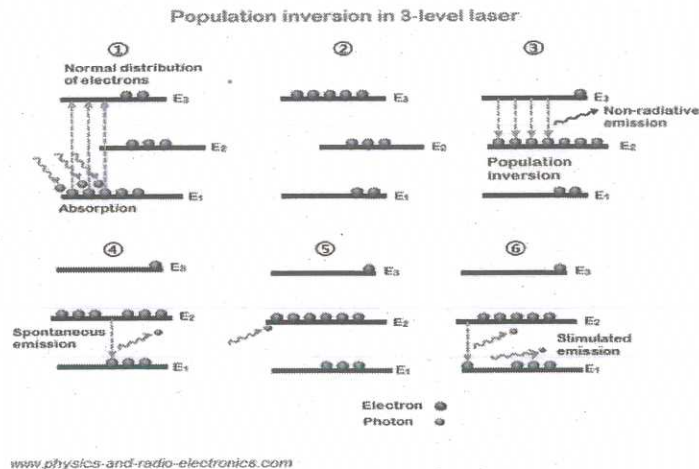
	<ul style="list-style-type: none"> • This feed horn gathers the signals and conducts them to a low-noise block down converter or LNB. • The LNB converts the signals from electromagnetic or radio waves to electrical signals • Dish antenna mainly used as interface between satellite and TV set. • All the signals which comes to the dish directed to the LNB and inturn gets connected to the TV set via set top box. 			
VI a	<p>Direct To Home (DTH)</p> <ul style="list-style-type: none"> • Goal of DTH is to bring hundreds of channels to the customers television directly • The provider selects programs and broadcasts them to subscribers as a set package. • There are five major components involved in a direct to home (DTH) satellite system: <ul style="list-style-type: none"> • the programming source, • the broadcast center, • the satellite, • the satellite dish • the receiver. <p>Programming source,</p> <ul style="list-style-type: none"> • Programming sources are simply the channels that provide programming for broadcast. • The DTH provider pays other companies (HBO, or ESPN or STAR TV or Sahara etc.) for the right to broadcast their content via satellite. • i.e the provider is a broker between the viewer and the actual programming sources. <p>Broadcast centre</p> <ul style="list-style-type: none"> • The broadcast center is the central hub of the system. • At the broadcast center the television provider <ul style="list-style-type: none"> ▫ Receives signals from various programming sources, ▫ Compresses it using digital compression, 	9	9	9

	<ul style="list-style-type: none"> ▫ Scrambles(Encrypt) the signal ▫ And beams a broadcast signal to the satellite being used by it. <p>Satellite</p> <ul style="list-style-type: none"> ▫ picks up the signal, ▫ amplifies it ▫ and beams it back to Earth, where viewers can pick it up <p>Satellite Dish</p> <ul style="list-style-type: none"> ▫Dish antenna picks up the signal from the satellite (or multiple satellites in the same part of the sky) and passes it on to the receiver. <p>Receiver</p> <ul style="list-style-type: none"> ▫The end component in the satellite TV system is the receiver. ▫Receiver uncompress & de-scrambles the encrypted signal 			
b	<p>Geo-stationary Earth Orbit</p> <ul style="list-style-type: none"> • If geo-synchronous orbit is circular and in the plane of equator, it is called as geo-stationary orbit. • These Satellites are placed at 35,900kms (same as geosynchronous) above the Earth's Equator • They keep on rotating with respect to earth's direction (west to east). • These satellites are considered stationary with respect to earth and hence the name implies. <p>Geo-Stationary Earth Orbit Satellites are used for weather forecasting, satellite TV, satellite radio and other types of global communications.</p>	6	6	6
VII a	<ul style="list-style-type: none"> ▶ Light Amplification by Stimulated Emission of Radiation ▶ A laser is a device that emits light based on the stimulated emission of electromagnetic radiation ▶ The principle of a laser is based on three separate features: <p>a) Stimulated emission</p>	Fig:3 Exp:6	9	9

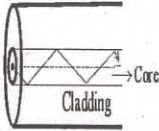
b) Population inversion of electrons

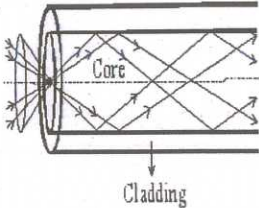
c) Optical resonator.

Population inversion



- ▶ If the higher energy state has a greater population than the lower energy state, it is called **Population inversion**.
- ▶ Three energy levels ($E_1 < E_2 < E_3$) with energy population N_1 , N_2 and N_3 is considered.
- ▶ Initially, the system is at thermal equilibrium, and the majority of electrons stay in the ground state.
- ▶ Then external energy is provided to excite them to level 3, referred as **pumping**.
- ▶ To get population inversion, the population of E_2 should be greater than the population of E_1 .
- ▶ The lifetime of electrons in E_3 is very small as compared to the lifetime of electrons in E_2 .
- ▶ Therefore, after a short period electrons in E_3 quickly fall to the Meta stable state or energy state E_2 and will have longer lifetime.
- ▶ As result, a large number of electrons accumulate in Meta stable state E_2 and the population of metal stable state will become greater than the population of energy states E_3 and E_1 . i.e $N_2 > N_1 > N_3$.
- ▶ Electrons in the E_2 fall back to the lower energy state E_1 by releasing energy in the form of photons and is called spontaneous emission.
- ▶ When this emitted photon interacts with the electron in the

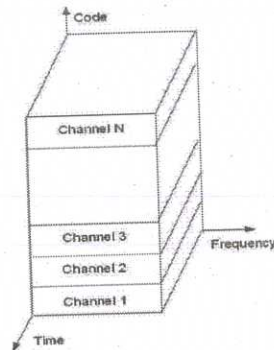
	<p>Meta stable state E_2, it forces that electron to fall back to the ground state.</p> <p>▶ As a result, two photons are emitted. This process of emission of photons is called stimulated emission.</p>			
b	<ul style="list-style-type: none"> • Large bandwidth to utilize • Very low transmission loss • Flexibility • Immunity to interference and crosstalk 	Any 4 4*1.5	6	6
VIII a	<p>▶ The avalanche photodiode possesses a similar structure to that of the PIN or PN photodiode</p> <p>▶ It operates under a high reverse bias condition to enable avalanche multiplication of the holes and electrons created by the initial hole electron pairs created by the photon / light impact.</p> <p>▶ An APD internally amplifies the photocurrent by an avalanche process when a large reverse-bias voltage is applied across the active region.</p> <p>➤ An incident photon striking the diode gives an electron in the valence band sufficient energy to move to the conduction band, creating a free electron and a hole</p> <p>➤ Under high reverse bias these free electron hole pairs will have sufficient energy to collide with other atoms and give rise to more electron hole pair.</p> <p>➤ This is known as avalanche multiplication</p> <p>➤ The gain of the APD can be changed by changing the reverse-bias voltage</p>	Exp:7	7	7
b	<p>Single Mode Fibre</p>  <p>▶ In a fiber, if only one mode is transmitted through it, then it is said to be a single mode fiber.</p> <p>▶ Only one path is available.</p> <p>▶ Core diameter is small</p> <p>▶ No dispersion</p> <p>▶ Higher band width (1000 MHz)</p>	Any 4 (4*2)	8	8

	<ul style="list-style-type: none"> ▶ Used for long haul communication ▶ Fabrication is difficult and costly <p>Multimode Fibre</p> <ul style="list-style-type: none"> ▶ If more than one mode is transmitted through optical fiber, then it is said to be a multimode fiber. ▶ The larger core radii of multimode fibers make it easier to launch optical power into the fiber ▶ More than one path is available ▶ Core diameter is higher ▶ Higher dispersion ▶ Lower bandwidth (50MHz) ▶ Used for short distance communication ▶ Fabrication is less difficult and not costly 			
IX a	<p>CODE DIVISION MULTIPLE ACCESS</p> <ul style="list-style-type: none"> • Code Division Multiple Access (CDMA) is a digital cellular technology used for mobile communication • A unique code has been assigned to each channel to distinguish from each other. • In CDMA, every channel uses the full available spectrum. • Individual conversations are encoded with a pseudo-random digital sequence and then transmitted using a wide frequency range. • All terminals active for entire period of time with same frequency • Codes plus special receivers for individual users • Flexible, less frequency planning required • Complex receivers required 	9	9	9

- In CDMA process,

$$\text{Encoded signal} = \text{Original data} \times \text{chipping sequence} \\ (\text{pseudo-random code})$$

- Decoding is done by the inner product of the encoded signal and chipping sequence.



b

3G vs 4G

Technology	3G	4G
Data Transfer Rate	3.1MB /sec	100MB/sec
Internet services	Broadband	Ultra Broadband
Mobile -TV Resolution	Low	High
Bandwidth	5 - 20 MHz	100+ MHz
Frequency	1.6 - 2 GHZ	2 - 8 GHz
Network Architecture	Wide Area Network	Hybrid Network
Signal Quality	Good	Best
Communication Type	Circuit Switching	Packet Switching

Any 4

6

6

(4*1.5)

X a

Hand Off:

- When a Mobile Station (MS) moves out of a cell, the base station notices the MS's signal fading away and requests all the neighbouring Base stations (BS) to report the strength they are receiving.
- The BS then transfers the call to the cell getting the strongest signal and the MSC changes the channel carrying the call. This process is called **handoff**.
- **Hard Handoff**.
- As a MS moves from cell A to cell B, the communication

(2*4)
Exp :8

8

8

between the MS and base station of cell A is first broken before communication is started between the MS and the base station of B.

- As a consequence, the transition is not smooth.
- Connection to source is broken before it is made to the target—known as **break-before-make**.

Soft Handoff

- For smooth transition from one cell (say A) to another (say B), an MS continues to talk to both A and B.
- In a soft handoff, source channel is retained and used in parallel with target channel in the target cell.
- The connection to the target is established before the connection to the source is broken—known as **make-before-break**

X b	<p>Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves from 2.4 to 2.485 GHz)</p> <p>The IEEE standardized Bluetooth as IEEE 802.15.1</p> <p>Bluetooth is a packet-based protocol with a master/slave architecture. One master may communicate with up to seven slaves. All devices share the master's clock.</p> <p>At any given time, data can be transferred between the master and one other device. The master chooses which slave device to address. Since it is the master that chooses which slave to address, whereas a slave is supposed to listen in each receive slot.</p> <p>Every device has a unique 48-bit address. However, friendly Bluetooth names are used, which can be set by the user. This name appears when another user scans for devices and in lists of paired devices.</p> <p>Setting up connections :Any Bluetooth device in <i>discoverable mode</i> transmits the following information on demand:</p> <ul style="list-style-type: none"> • Device name • Device class • List of services • Technical information (for example: device features, manufacturer, Bluetooth specification used, clock offset) <p>Any device may perform an inquiry to find other devices to connect to. If the device trying to connect knows the address of the device, it always responds to direct connection requests and transmits the information. Some devices can be connected to only one device at a time, and connecting to them prevents them from connecting to other devices until they disconnect from the other device.</p> <p>Every device has a unique 48-bit address but Bluetooth names are used, which can be set by the user. This name appears when another user scans for devices and in lists of paired devices.</p>	7	7	7
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