SUMMER– 19 EXAMINATION

Subject Name: Advance communication system Model Answer Subject Code: 17656

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1	(A)	**Attempt any THREE of the following:**	**12- Total Marks**
	(a)	**State the advantages of waveguide over two wire transmission line.(any 4)**	**4M**
	Ans:	**Advantages of waveguide over two wire transmission line** 1. Increased bandwidth availability. 2. It can handle greater power and possess less resistance. 3. Lower signal attenuation at high frequencies than TL. 4. They are simple to manufacture 5. EM fields are confined in the space available within the walls of a waveguide. Hence EM fields are shielded from outside and hence they have good amount of immunity against any RF interference from outside. 6. It is easy to install waveguides in a microwave transmission systems due to its simple structure on both the ends	**any 4 advantages 4M**
	(b)	**Draw construction and explain working of Reflex Klystron.**	**4M**
	Ans:		

2M

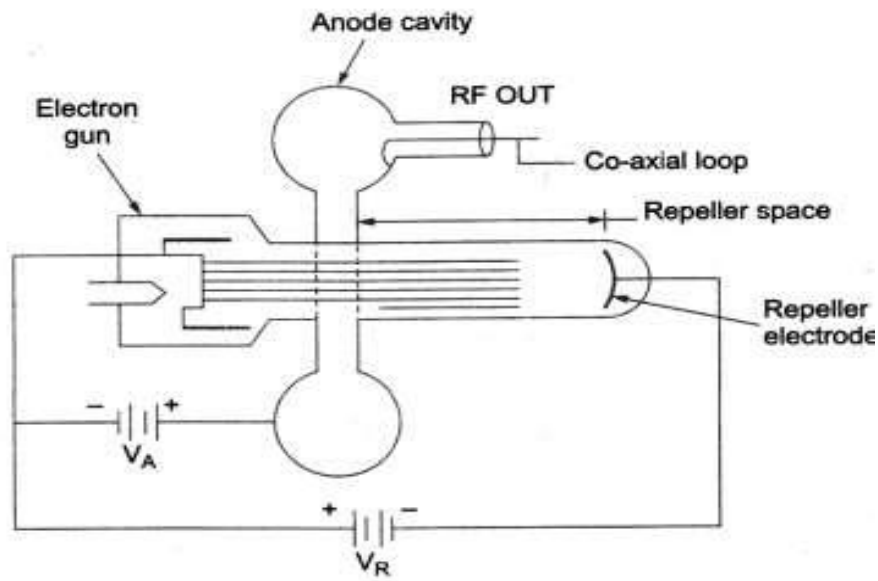
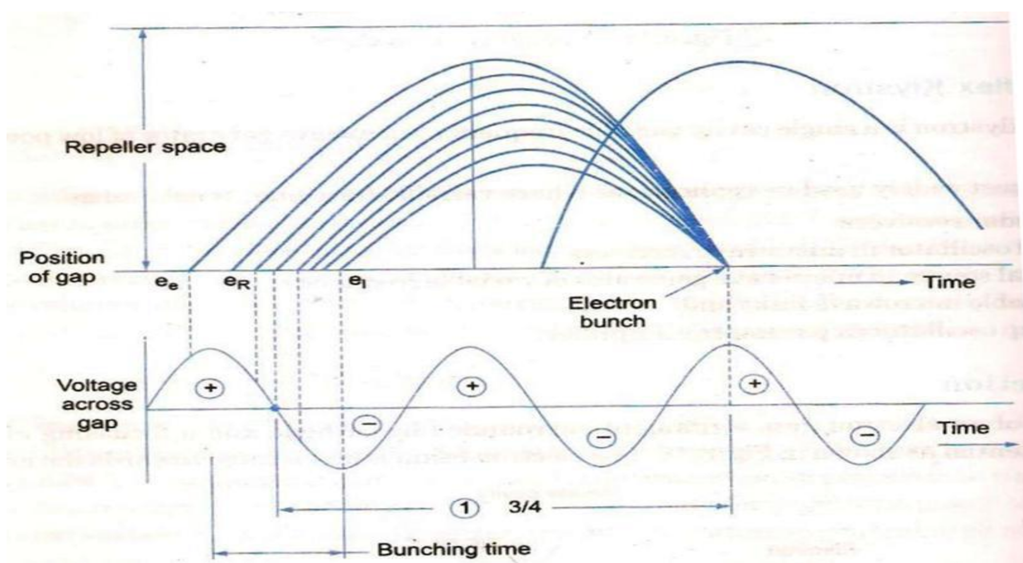


Fig. Constructional details of reflex klystron.

1M



1M

Working :

- The RF voltage that is produced across the gap by the cavity oscillations act on the electron beam to cause velocity modulation. e_R is the reference electron taken as the one that passes the gap on its way to the repeller at the time when the gap voltage is

SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

		zero and going negative. This electron is unaffected, overshoots the gap and is ultimately returned to it having penetrated some distance into the repeller space. • The early electron ee that passes the gap before the reference electron, experiences a positive voltage at the gap. This electron is accelerated and moves with greater velocity and penetrates deep into reseller space. This electron will take slightly greater time than the reference electron to return to the gap. • The late electron el that passes through the gap later than reference electron experiences negative voltage at the gap. This electron is retarded and shortens its stay in the repeller space and will return earlier to the gap as compared to the reference electron. So, the late electron will be able to catch up with ee and eR electrons forming the bunch. • Bunches occur once per cycle centered on the reference electron. These bunch transfer maximum energy to the gap to get sustained oscillations.	
	(c)	**Write RADAR range equation and state the factor affecting maximum range of RADAR.**	**4M**
	Ans:	The Radar range equation is given by	**1M for equation ,3M for factor**

$$R_{max} = \left(\frac{P_t A_0^2 S}{4\pi \lambda^2 P_{min}}\right)^{1/4}$$

where R_{max} = maximum range
A_0 = Capture area of Antenna
P_t = Transmitter power
S = effective surface area of target
λ = signal wavelength
P_{min} = minimum receivable power.

The factors influencing maximum range are as follows

- **Transmitted power (Pt):** if the radar range is to be doubled we have to increase a transmitted power by 16 times.
- **Frequency(f) :** increase in frequency increase the range
- **Target cross sectional area(S).** Radar cross sectional area of the target is not a controllable factor.
- **Minimum received signal (Pmin):** A decrease in minimum receivable power will have the same effect has raising the transmuting power.

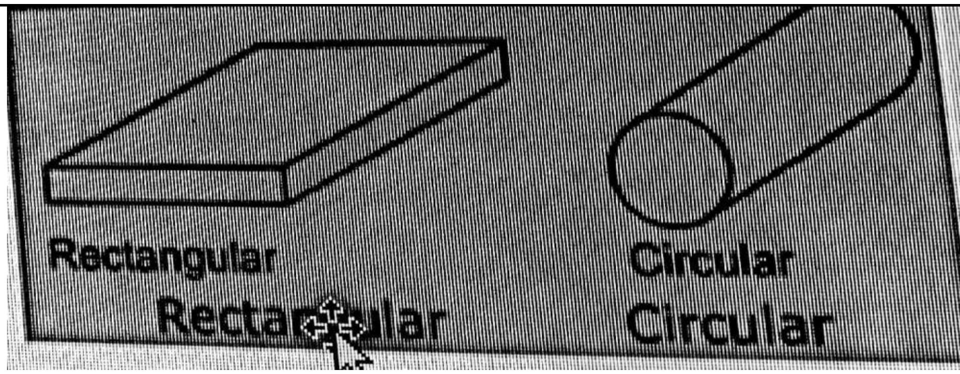
(d) **Define the following terms w.r.t.Satallite.** **4M**

(i) **Foot print**
(ii) **Station keeping**
(iii) **Azimuth angle**
(iv) **Elevation angle**

SUMMER– 19 EXAMINATION

Subject Name: Advance communication system Model Answer Subject Code: 17656

	Ans:	(i) **Foot print**: The geographical representation of a satellite antenna radiation pattern is called foot print. OR the **foot print** of a satellite is the earth area that the satellite can receive from and transmitted to. (ii) **Station keeping:** The process of the firing the rocket underground control to maintain or adjust the orbit is referred to as station keeping. **OR** **Station keeping** is the process of maintenance of satellite's orbit against different factors such gravitational force of sun, moon, solar radiation pressure etc that cause temporal drift. **(iii) Azimuth angle**:- It refers to the angle made from the true north to the sub-satellite point on the horizontal plan **(iv) Elevation angle**: Elevation angle is the vertical angle formed between the direction of travel of an electromagnetic wave radiated from an earth station antenna pointing directly towered a satellite and the horizontal plane. **OR** **Elevation angle** is the angle subtended between the line of sight joining the earth station antenna and the satellite and the horizontal plane.	**Each definition 1M**
	(B)	**Attempt any ONE of the following:**	**06- Total Marks**
	(a)	**Draw different types of waveguide. What is dominant mode? Explain wave propagation in rectangular waveguide.**	**6M**
	Ans:	**Different types of waveguide**	**2M**



2M

Dominant mode:

1. **It is the mode of the waveguide in which the signal has the lowest cut off frequency or largest cut off wavelength and can still can propagate in a given waveguide.**

. Cut of wavelength is given by

$$\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$$

$$\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$$

For $TE_{1,0}$.

$m = 1 \quad n = 0$

$\therefore \lambda_c = 2a$

For $TE_{0,1}$

$m = 0 \quad n = 1$

$\therefore \lambda_c = 2b$

For $TE_{1,1}$, $m = 1$; $n = 1$

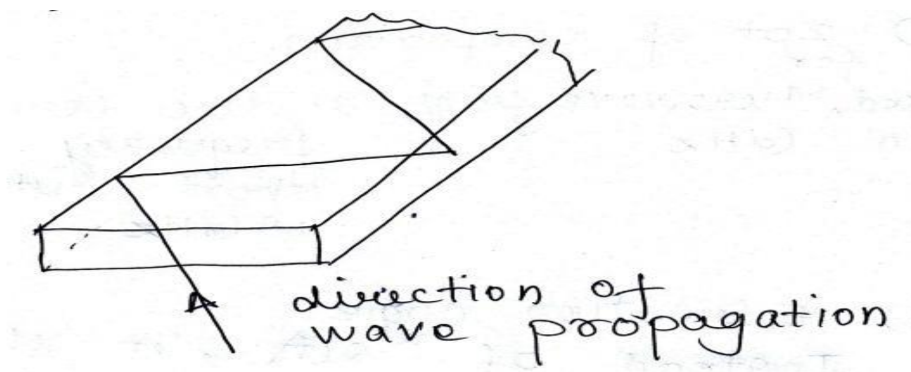
$$\lambda_c = \frac{2ab}{\sqrt{a^2 + b^2}}$$

2M

Form the above modes TE1,0 has highest cut off wave length since a>b. hence TE1,0 is the dominant mode.

Wave propagation in rectangular waveguide.

- The walls of the waveguides can be considered as nearly perfect conductors.
- Therefore, the boundary conditions require that electric field be normal i.e.,

		perpendicular, to the waveguide walls. ▪ Rectangular waveguide is a hollow metallic tube with a rectangular cross section. ▪ TEM wave cannot exists in rectangular waveguide. ▪ The wave propagates down the wave guide in a zig – zag manner with the Electric field maximum at the center of the guide and zero at the walls.  ▪	
	(b)	**With neat sketch describe the operation of the GUNN Diode & list it's applications**	**6M**

Ans:

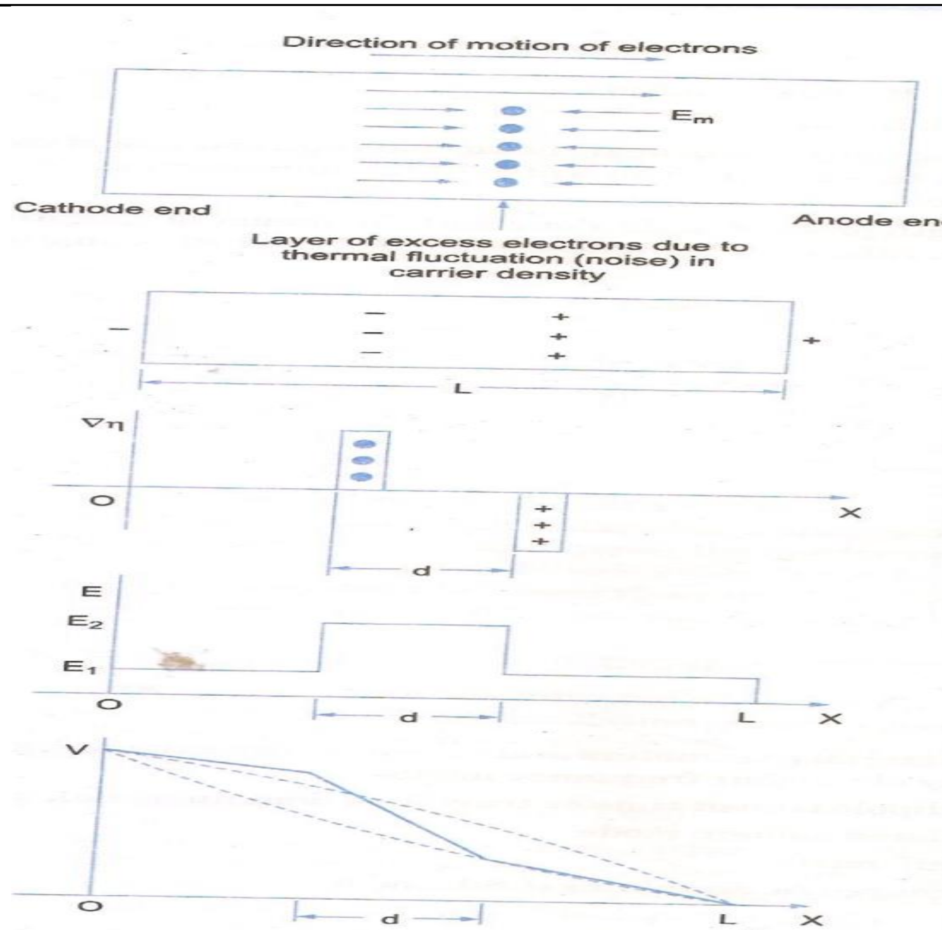


Fig. 9.44 Dipole domain formation.

2M

OPERATION:

2M

When a DC bias of value equal or more than threshold field (of about 3.3KV/cm) is applied to an n-type GaAs sample, the charge density and electric field within the sample become non-uniform creating domains that is electron in some region of the sample will be first to experience the inter-valley transfer than the rest of the electrons in the sample. The EF inside the dip[ole domain will be greater than the fields on either side of the dipole so the electrons in that region or domain will move to upper- valley and hence with less mobility. This creates a slight deficiency of *e*-1 s in the region immediately ahead. This region of excess and efficient *e*-1 s form a dipole layer.

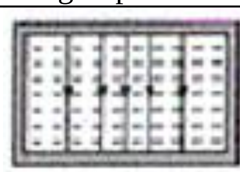
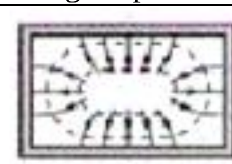
As the dipole drifts along more *e*-1 s in the vicinity will be transferred to the U-valley until the

		electric field outside the dipole region is depress below the threshold EF. This dipole continues towards the anode until it is collected upon collector, the EF in the sample jumps immediately to its original value and next domain formation begins as soon as the field values exceeds the threshold values and this process is repeated cyclically. **Applications of Gunn diode:** • Used as Gunn oscillators to generate frequencies ranging from 100mW 5GHz to 1W 35GHz outputs. These Gunn oscillators are used for radio communications, military and commercial radar sources. • Used as sensors for detecting trespassers, to avoid derailment of trains. • Used as efficient microwave generators with a frequency range of up to hundreds of GHz. • Used for remote vibration detectors and rotational speed measuring tachometers. • Used as a microwave current generator (Pulsed Gunn diode generator). • Used in microwave transmitters to generate microwave radio waves at very low powers.	**Any 2 applications 2M**

SUMMER– 19 EXAMINATION

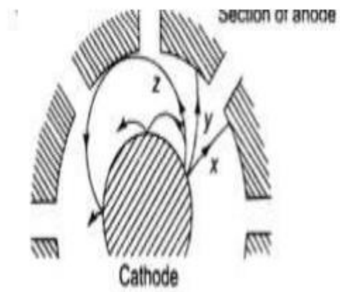
Subject Name: Advance communication system Model Answer Subject Code: 17656

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any FOUR of the following:**	**16- Total Marks**
	(a)	**Differentiate between TE and TM mode in rectangular waveguide.**	**4M**
	Ans:	**Note: Any other relevant diagram can be considered.**	**1M each point**

PARAMETER	**TE MODE**	**TM MODE**
Definition	In transverse electric mode, the magnetic field is along the direction of propagation whereas the electric field is perpendicular to the direction of propagation.	In transverse magnetic mode, the electric field is along the direction of propagation whereas the magnetic field is perpendicular to the direction of propagation.
Characteristic wave impedance	$Z_0 = \frac{377}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}}$ Characteristic wave impedance is always greater than 377Ω.	$Z_0 = 377\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}$ Characteristic wave impedance is always less than 377Ω.
Principle mode	$TE_{1,0}$	$TM_{1,1}$
Existence of 0,n and m,0 modes in rectangular waveguides	$TE_{1,0}$ and $TE_{0,1}$ modes can exist in rectangular waveguides.	$TM_{0,1}$ and $TM_{1,0}$ modes cannot exist in rectangular waveguides as magnetic field is closed loop form.
Method of excitation	Using Dipole antenna.	Using loop antenna.
Field pattern for principle mode (Front View)		

Q. No.	Sub Q. N.	Answers	Marking Scheme
	(b)	**Write the effect of magnetic and electric field in Magnetron.**	**4M**
	Ans:	**Note: diagram is not mandatory, however marks can be given if drawn properly**	**4m Explanation**

SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

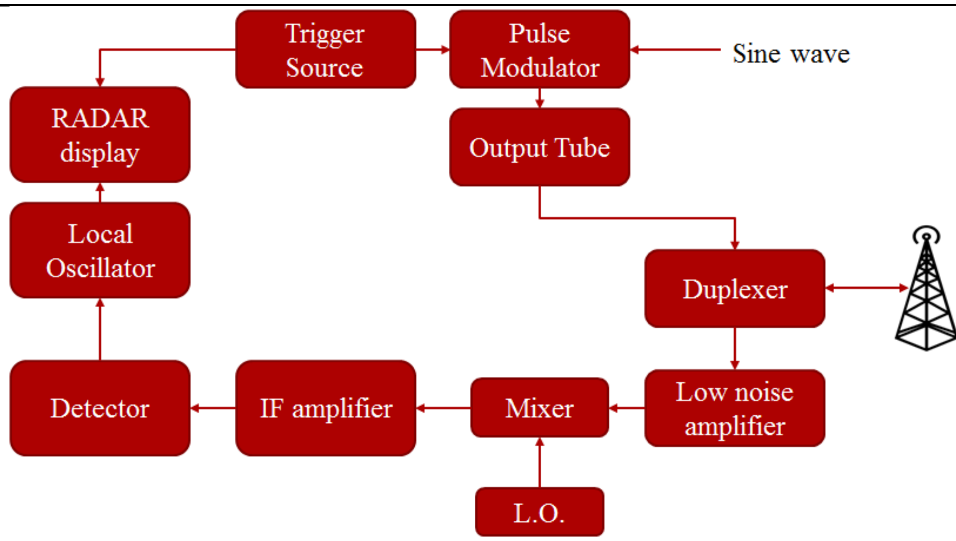


Electron paths in magnetron without oscillations, showing effect of increasing magnetic field.

- When magnetic & electric fields act simultaneously upon the electron, its path can have any of a number of shapes dictated by the resistive strengths of the mutually perpendicular electric & magnetic fields.
- Some of these electron paths are shown in figure in the absence of oscillations in a magnetron in which the electric field is constant and radial and the axial magnetic field can have any number of values.
- When the magnetic field is zero, the electron goes straight from the cathode to anode accelerating all the time under the force of the radial electric field.
- This is indicated by path x in figure.
- When the magnetic field has a small but definite strength ,it will exert a lateral force on the electron, bending its path to the left as shown in figure by path that the electrons motion is no longer rectilinear.
- As the electron approaches the anode its velocity continues to increase radially as it is accelerating.
- The effect of magnetic field upon it increases also.
- It is possible to make the magnetic field so strong the electrons will not reach the anode at all.
- The magnetic field required to return electrons to the cathode after they have just grazed the anode it is called the cut off field. The resulting path is z shown in figure.
- Knowing the value of the required magnetic field strength is important because this cut off field just reduces anode current to zero in the absence of oscillations.
- If the magnetic field is stronger still, the electron path as shown will be more curved still and the electrons will return to the cathode even sooner(only to be reemitted)

	(c)	**Write the operation of pulsed radar to detect the object.**	**4M**

SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

	Ans:	 The Block diagram of high power Pulsed RADAR set is shown in fig. Above. **Trigger Source:** It Provides pulses for the modulator. **Pulse Modulator:** This Modulator provides rectangular voltage pulses which act as the supply voltage to the output tube, thus switching ON & OFF as required. **Output tube:** It may be an oscillator tube such as a magnetron oscillator or an amplifier such as klystron, TWT or crossed field amplifier. If an amplifier is used, a source of microwave is also required. The pulse modulated sine wave carrier then travels via duplexer to the antenna where it is radiated into space. A single antenna is generally used for both transmission & reception. Usually parabolic reflectors with center feed arrangements is used. **Duplexer:** The duplexer channelize the returned echo signal to the receiver and not to the transmitter. The duplexer consists of gas-discharge tubes, one known as TR tube and other as ATR. The TR tube protects the receiver during transmission and the ATR helps in directing the received echo signals to the receiver. **Receiver:** The receiver is usually of super heterodyne type whose function is to detect the desired echo signals in the presence of noise, interference & Clutter. The receiver in Pulsed RADAR consists of the RF amplifier, mixer, local oscillator, IF amplifier, Detector, Video Amplifier & RADAR display. **Low Noise RF amplifier:** It is the first stage of the receiver. It is a low noise transmitter amplifier or parametric amplifier or TWT amplifier.	**2M diagram 2M explanation**

Mixer & Local Oscillator: These converts RF signal output from RF amplifier to comparatively lower frequency levels (IF). Thus, in a mixer stage, the Carrier frequency is reduced.

IF amplifier: This amplifier consists of a cascade of tuned amplifier & Provides the main receiver gain. It should be designed as a matched filter to get maximum peak signal to mean noise power ratio at the output.

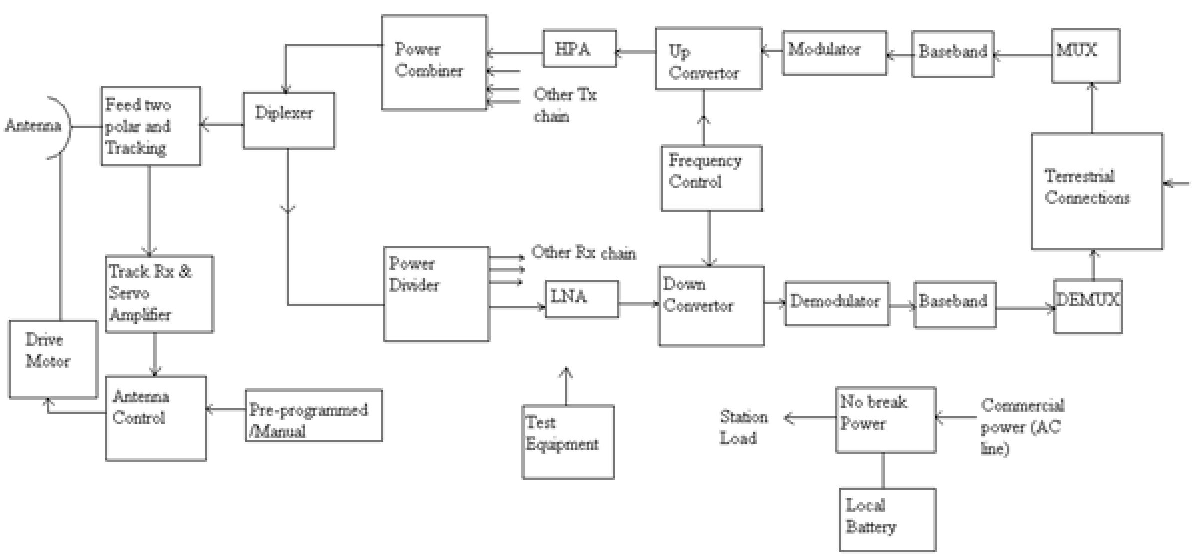
Detector: The Detector is often is a schottky-barrier diode which extracts the pulse modulation from the IF amplifier output. The detector output is the amplified by the video amplifier to a level where it can be properly displayed usually on CRT directly or via computer processing and enhancing. Sync pulses are applied by the trigger source to the display devices or the display indicator.

(d) **Draw block diagram of satellite earth station and explain function of each block.** **4M**

Ans: **Note: any other relevant diagram can be considered.**

2M Diagram 2M Explanation

The figure below shows the general block diagram of an earth station capable of transmission, reception and antenna tracking. The following are the major subsystems of the earth station –



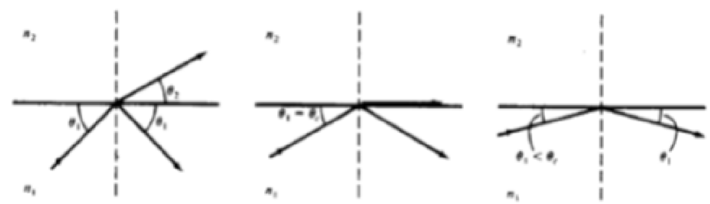
Transmitter:

- There may be one or many transmit chains depending on the number of separate carrier frequencies and satellites with which the station must operate simultaneously.
- It consists of MUX, modulators and filters, HPA. Microwave transmitters are expensive devices that employ costly HPA's such as TWTA and multi-cavity klystrons.

		Receiver: • There may be many receiver chains depending on the number of separate frequencies and satellites to be received and various operating conditions. The receiver subsystem consists of LNA and filters, down convertors, filters, demodulators and DEMUX equipment. **Antenna:** • Usually one antenna is used for both transmission and reception but not necessarily. Within the antenna subsystem are the antenna reflector and feed, separate feed systems to permit automatic tracking and a duplexer and MUX arrangement to permit simultaneous connection of many transmitters and receiver chains to the same antenna. **Tracking System:** • This comprises of control circuit and drive which are necessary to keep the antenna pointed at the satellite. Tracking system keeps antenna pointing in the direction of the satellite in spite of relative movement of the satellite and the station. **Terrestrial Interface:** • This is the interconnection with whatever terrestrial system if any is involved. In case of small receive only and transmit only stations, the user may be at the earth station itself. **Power Subsystem:** • This system includes the primary sources (the standard AC lines) for running the earth station. The subsystem operates power supplies which distribute a variety of dc voltages to the other equipment. • The power subsystem also consists of emergency power sources such as diesel generators, batteries and inverters to ensure continuous operation during power failures. It often includes provision for no break changeover from one source to another. **Test Equipment:** • This includes the equipment necessary for routine checking of the earth station and terrestrial interface, possible monitoring of satellite characteristics and occasionally for the measurement of special characteristics.	
	e)	**Define (1) Critical angle, (2) Snell's Law, (3) Numerical aperture, (4) Acceptance angle.**	**4M**

Ans:

Critical angle:



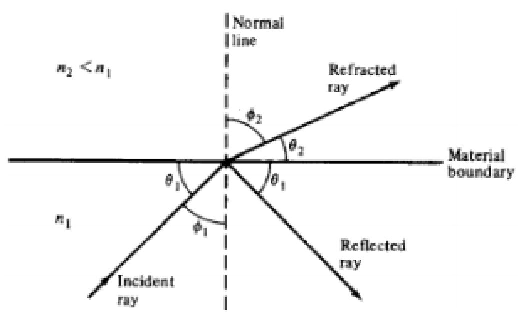
Above figure shows a glass surface in air. A light ray gets bent towards the glass surface as it leaves the glass in accordance to Snell's law.

- If the angle of incidence θ1 is decreased, a point is reached where the light ray in air is parallel to the glass surface. This angle is known as the critical angle of incidence θc.

Mathematically given by

$$\text{Sin}\, \emptyset_c = \frac{\eta_2}{\eta_1}$$

Snell's law:



At the interface of medium 1 and medium 2, the incident ray may be refracted toward the normal or away from it, depending on whether 1 is greater than or less than 2. Hence angle of refraction can be greater or smaller than the angle of incidence, depending on the refractive indices of the two materials.

The relationship at the interface is known as Snell's law and is given by

$\eta_1 \sin \emptyset_1 = \eta_2 \sin \emptyset_2$

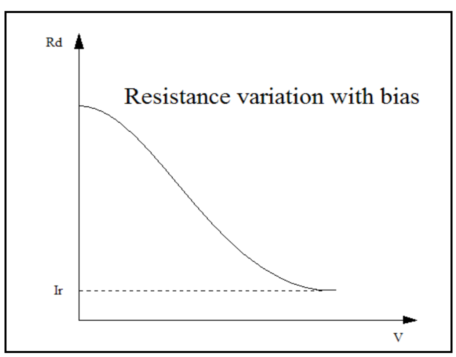
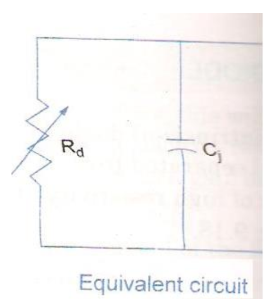
or equivalently, $\eta_1 \cos \theta_1 = \eta_2 \cos \theta_2$

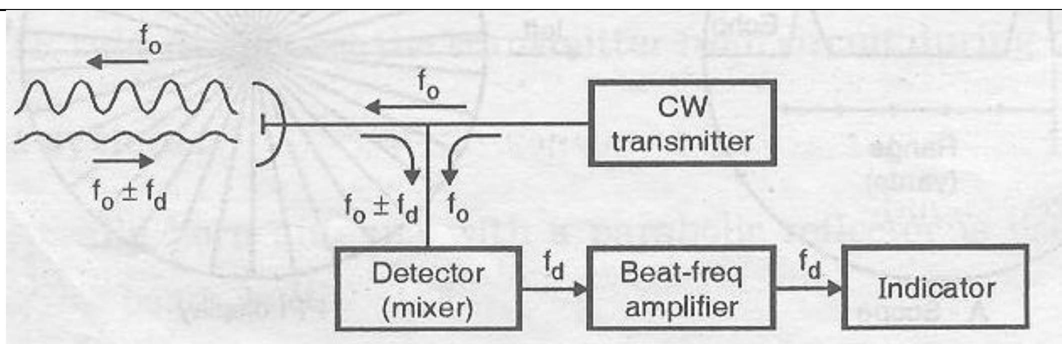
1M each definition

		The **Numerical Aperture (NA)** is defined as the light gathering ability of an optical fiber and is given by the sine of the maximum angle a ray entering the fiber can have with the axis of the fiber and still propagate by internal reflection. For step index; $= sin\theta_{in} = \sqrt{\eta_1^2 - \eta_2^2}$; ϑ_{in} = *acceptance cone half angle* For graded index; $= sin\theta_c$; ϑ_c = *critical angle*	
	f)	**Give classification of optical fiber.**	**4M**
	Ans:	Classification of fiber optic cable on the basis of modes: • Single mode. • Multimode. Classification of fiber optic cable on the basis of refractive index profile: • Step index. • Graded index OR Essentially there are three types of optical fibers: 1. **Single Mode Step Index Fiber:** 2. **Muti Mode Step Index Fiber** 3. **Muti Mode Graded Index Fiber**	**2M for each classification** **or** **4M**
Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any FOUR of the following:**	**16- Total Marks**
	a)	**State any two advantages and application of circular waveguide.**	**4M**

SUMMER– 19 EXAMINATION

Subject Name: Advance communication system Model Answer Subject Code: 17656

	Ans:	**Advantages: (any two)** • The circular waveguide are easier to manufacture than rectangular waveguides and are easier to join. • The TM01 modes are rotationally symmetrical and hence rotation of polarization can be overcome. • TE01 mode in circular for long distance waveguide transmission. • High power handling capacity. • Low attenuation loss **Applications: (any two)** • Rotating joints in radars to connect the horn antenna feeding a paraboloid reflector (which must rotate for tracking). • TE01 mode is suitable for long distance waveguide transmission above 10GHz. • Short and medium distance communication.(microwave link)	2M For advantages – each advantages -1M (any two) 2M For application – each application -1M (any two)
	b)	**With neat sketch describe the operation of PIN diode.**	**4M**
	Ans:	 **Zero bias:** • At zero bias the diffusion of the holes and electrons across the junction causes space charge region of thickness inversely proportional to the impurity concentration.	Any one constructional diagram 2 marks, For operation on -2 marks

		• An ideal 'i' layer has no depletion region i.e. p layer has a fixed negative charge and n layer has a fixed positive charge. **Reverse bias:** • As reverse bias is applied the space charge regions in the p and n layers will become thicker. • The reverse resistance will be very high and almost constant. **Forward bias:** • With forward bias carrier will be injected into the I layer and p and n space charge regions will become thinner. So the electrons and holes are injected into the i layer from p and n layers respectively. This increases the carrier concentration in the I layer above equilibrium. Thus resistivity decreases as increase in forward bias. Therefore low resistance is offered in the forward direction.	
	c)	**Draw neat labeled block diagram of CW Doppler Radar & explain its working.**	**4M**
	Ans:	 • Type of radar which employs a continuous transmission is continuous wave (CW) radar. CW radar transmits a constant- amplitude continuous microwave sine wave. And echo generated by sine wave is also of constant amplitude but with small amplitude.	Block Diagram —2 M ; working –2M

		• CW radar gives better understanding of nature and use of Doppler information contained in echo signal. It provides a measurement of relative velocity to distinguish moving target from stationary object. • When a moving air plane, ship, missile or automobile is detected by radar, the reflected signal gives a frequency change. • That frequency change is used to determine the speed of the target. • As shown in above Fig. CW transmitter generates a continuous wave of frequency fo that is radiated by antenna. Some part of energy is intercepted by target and scattered in the direction of radar. Receiving antenna collects it. • Then the received signal will be shifted in frequency from transmitted frequency fo if target is in motion by an amount + fd. If the distance between target and radar is decreasing then received signal frequency is greater than transmitted signal frequency i.e. (fo + fd). • If the distance between target and radar is increasing then received signal frequency is lesser than transmitted signal frequency .i.e. (fo - fd). • So the received echo signal frequency (fo + fd) enters that radar and the heterodyned with portion of transmitted signal fo , which produce a dopple beat of frequency fd. • Beat- frequency amplifier eliminates echo from stationary target and amplify the dopple echo signal at a level that can operate the indicator. Indicator may be pair of ear phones or frequency meter.	
	d)	**Define term orbit w.r.t. Satellite. List different types of orbits of Satellite.**	**4M**

SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

	Ans:	An orbit is a trajectory that is periodically repeated. While the path followed by the motion of an artificial satellite around Earth is an orbit. **Types of orbit satellite:** **Based on Orientation of the orbital plane –** 1. Equatorial Orbit 2. Polar Orbit 3. Inclined Orbit **Based on Distance of the orbit from the Earth's surface –** 1. Low Earth Orbit 2. Medium Earth Orbit 3. High Earth Orbit or GEO **Based on eccentricity of the orbit --1.** Circular orbit **2.** Elliptical orbit	2 M for Define & 2M For types of orbits
	e)	**State and explain advantages of fiber optic communication.(any 4)**	**4M**
	Ans:	**Advantages: (any four)** **1. Extremely wide system bandwidth:** Fiber systems have greater capacity due to the inherently larger BWs available with optical frequencies. Metallic cables exhibit capacitance between and inductance along their conductors. These properties cause them to act as low pass filters which limit their transmission frequencies and hence bandwidths. **2. Immunity to electromagnetic interference:** Fiber cables are immune to static interference caused by lightning, electric motors, fluorescent light and other external electrical noise sources. This immunity is due to the fact that optical fibers are non-conductors of electricity. Also fiber cables do not radiate RF energy and therefore cannot cause interference with other communication system. **3. Virtual elimination of crosstalk:** The light on one glass fiber does not interfere with light on an adjacent fiber. Fiber systems are immune to cross talk between cables caused by magnetic induction. Glass or plastic fibers are non-conductors of electricity and therefore do not have a magnetic field associated with them. In metallic cables, the primary cause of cross talk is magnetic induction between conductors located near each other.	**Any four- each applicati on -1M**

4. Lower signal attenuation than other propagation systems:

Typically attenuation figure of a 1GHz BW signal for optical fibers are 0.03dB per 100 feet compared to 4dB for both coax and an X band waveguide. So, fewer repeater stations are needed as a result of glass fiber.

5. Substantially lighter weight and smaller size:

Fibers are smaller and much lighter in weight than their metallic counterparts. Fiber cables require less storage space and are cheaper to transport.

6. More resistive to environmental extremes and non-corrosiveness: Fiber cables operate over a larger temperature variation than their metallic counterparts and fiber cable are affected less by corrosive liquids and gases. Fibers are used around volatile liquids and gases without worrying about their causing explosions.

7. Lower cost:

The long term cost of fiber optics system is projected to be less than that of its metallic counterpart as the cost of copper is increasing.

8. Conservation of the earth's resources:

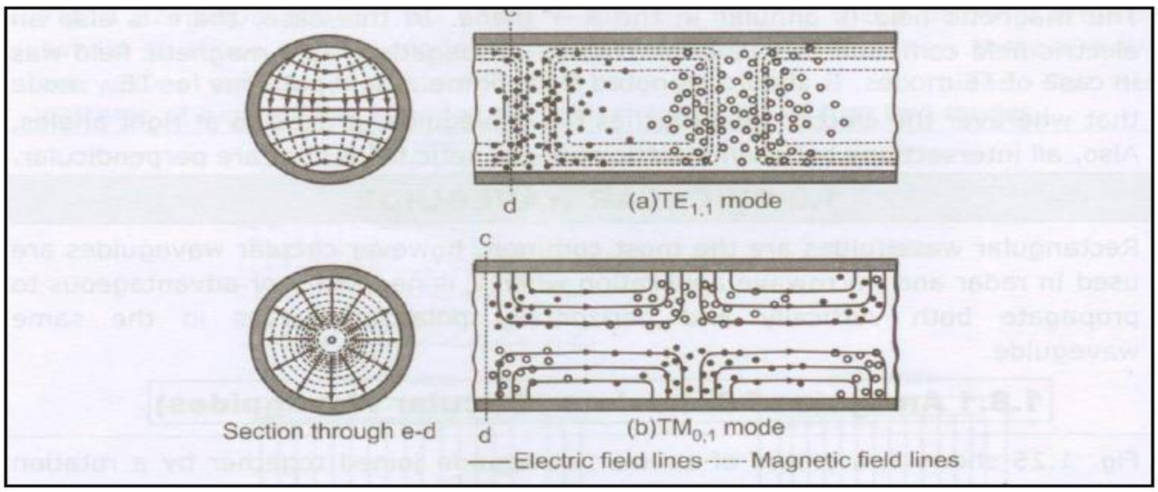
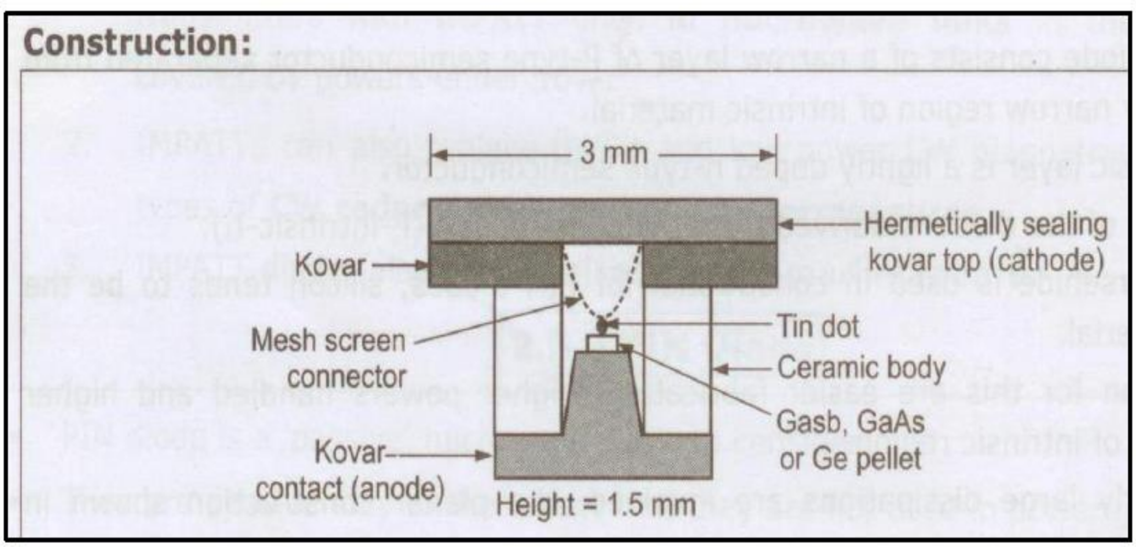
The supply of copper and other good electrical conductors is limited whereas the principal ingredient of glass is sand and it is cheap and in unlimited supply

9. Security:

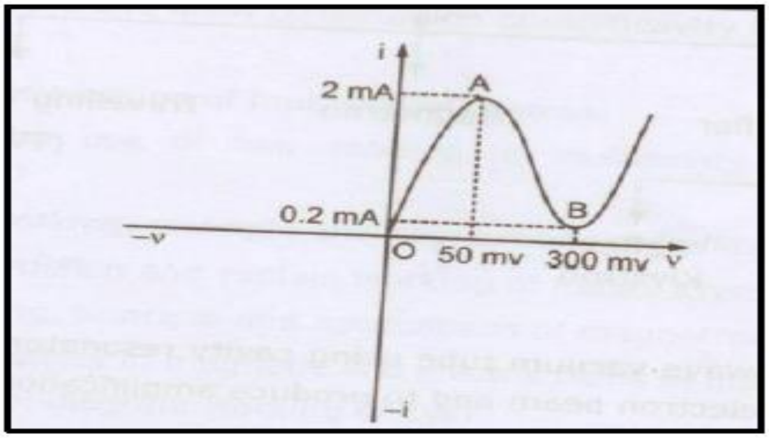
Fiber cables are more secure than their metallic counterparts. It is virtually impossible to tap into a fiber cable without the user knowing about it.

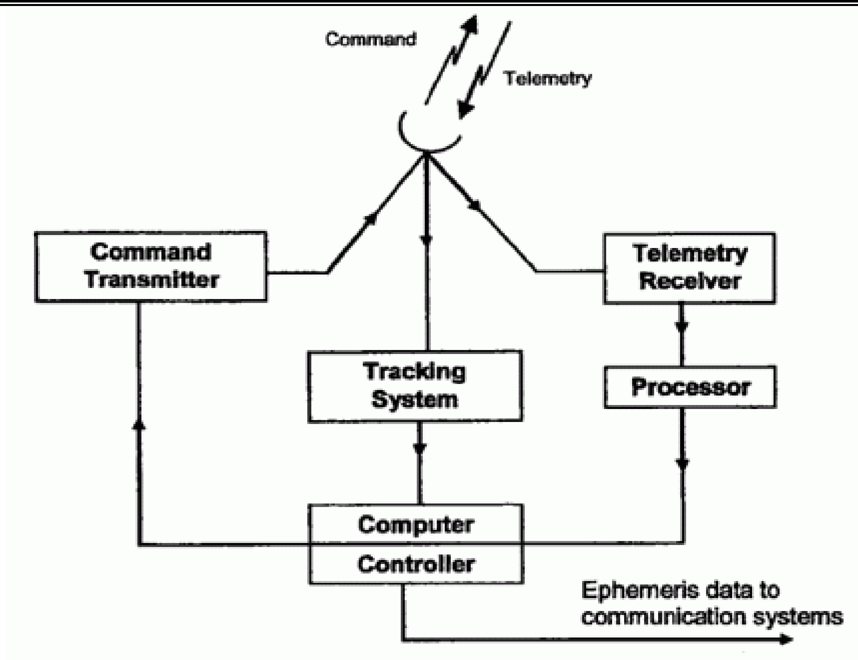
10. Safety:

In many wired systems, the potential hazard of short circuits requires precautionary designs. Additionally, the dielectric nature of optical fiber eliminates the spark hazard.

Q. No.	Sub Q. N.	Answers	Marking Scheme
4	**(A)**	**Attempt any THREE of the following:**	**12- Total Marks**
	(a)	**Draw field pattern of circular waveguide.**	**4M**
	Ans:		(correct Field pattern for any one mode- 4 M)
	(b)	**Draw construction of Tunnel diode and describe its working principle.**	**4M**
	Ans:	 **Tunnel diode** **Working:**	(2marks for diagram, 2 marks for working)

		• Tunnel diode is a thin junction diode which under low forward bias conditions exhibits negative resistance useful for oscillation or amplification. • The junction capacitance of the tunnel diode is highly dependent on the bias voltage and temperature. A very small tin dot about 50µm in diameter is soldered or alloyed to a heavily doped pellet of n- type Ge, GaSb or GaAs. • The pellet is then soldered to a kovar pedestal, used for heat dissipation, which forms the anode contact. The cathode contact is also kovar being connected to the tin dot via a mesh screen used to reduce inductance. The diode has a ceramic body and hermetically sealing lid on top. • In tunnel diode semiconductor material are very heavily doped, as much as 1000 times more than in ordinary diodes. This heavy doping result in a junction which has a depletion layer that is so thin (0.01µm) as to prevent tunneling to occur. • In addition, the thinness of the junction allows microwave operation of the diode because it considerably shortens the time taken by the carriers to cross the junction. • A current-voltage characteristics for a typical Germanium tunnel diode is shown in figure. Forward current rises sharply as voltage is applied. At point A, peak voltage occurs. • As forward bias is increased past this point, the forward current drops and continues to drop until point B is reached, this is the valley voltage. • At point B current starts to increase once again and does so very rapidly as bias is increases further. Diode exhibits dynamic negative resistance between A and B therefore, useful for oscillator applications.	

			
	(c)	**Define antenna scanning and its type used in radar.**	**4M**
	Ans:	**Antenna scanning** refers to way in which the antenna keeps moving in azimuth and elevation for covering an area, which has desired target. Tracking means tracking the path of target by means of radar. Antenna scans given area of surroundings pace but actual scanning pattern depending on application. Types of antenna scanning: 1.Horizontal Scanning. 2. Nodding Scanning. 3.Helical Scanning. 4.Spiral Scanning.	Define-2M,Type of scanning -2M
	(d)	**Write working of Telemetry and tracking control sub-system in Satellite communication.**	**4M**
	Ans:		2M For diagram 2 M for working



Telemetry, Tracking and Command (TT&C) Subsystem These systems are partly on the satellite and partly at the control earth station. They support the functions of the spacecraft management. The main functions of a TTC system are

- To monitor the performance of all satellite subsystems and transmit the monitored data to the
- satellite control center via a separate Telemetry link.

To receive commands from the control center for performing various functions of the satellite.

Typical functions include:

- To correct the position and attitude of the satellite.
- To control the antenna pointing and communication system configuration to suit current traffic • requirements.

To operate switches on the spacecraft.

TELEMETRY:

- It collects data from all sensors on the satellite and send to the controlling earth station.
- The sighting device is used to maintain space craft altitudes are also monitored by

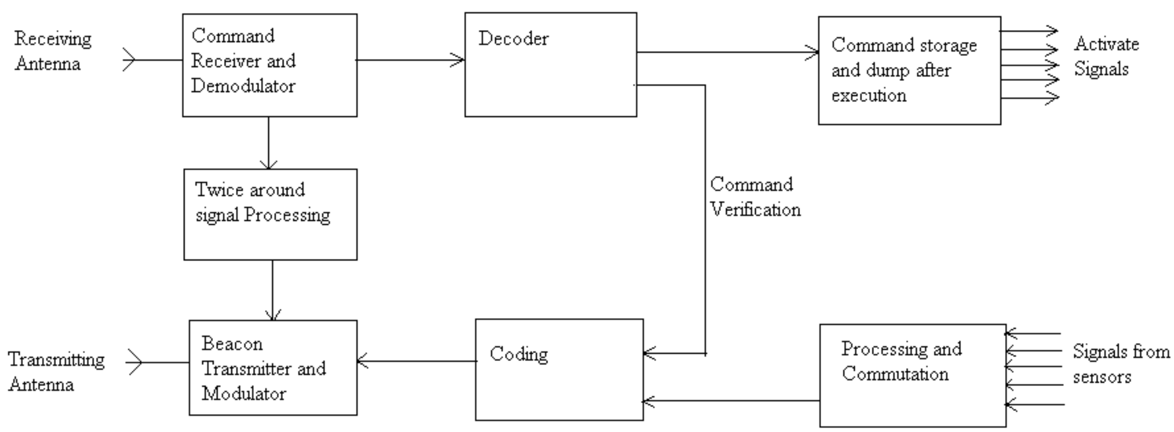
telemetry. • At a controlling earth station using computer telemetry data can be monitored and decode.

- And status of any system on satellite can be determined and can be controlled from earth station

TRACKING:

- By using velocity and acceleration sensors, on spacecraft the orbital position of satellite can be detect from earth station

OR



Telemetry System:

1. **The telemetry system is used to transmit information like temperature, pressure, voltage, etc. or data regarding the status of the on board subsystems to the ground station at all times.** The telemetry system consists of various electronic sensors for the measurement of quantities as voltage, current, temperature, pressure, radiation level, power supply, status of switches and solenoids.
2. The telemetry measurements can run into hundreds thus necessitating time division multiplexing to combine different data into a single stream for downlink transmission. In all modern satellites, pulse code modulation is used. After modulation, the transmitter sends the telemetry data back to the earth station where the processing equipment in the TT&C earth station recovers this telemetry information and monitors it.
3. With this information the ground station is then able to determine the operational status of the satellite at all times.

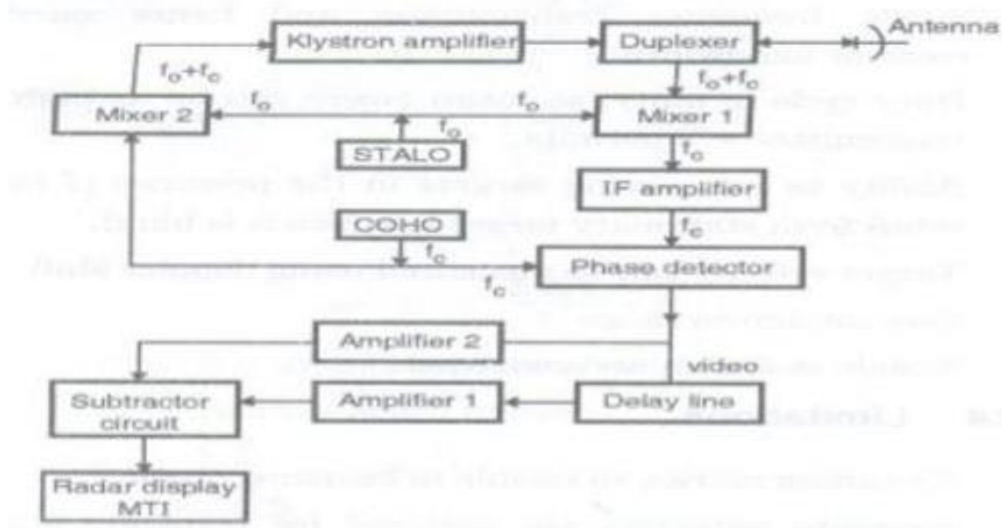
Tracking:

1. Another important function of the TT&C system is measurement of satellite position.
2. Beacon transmitters are usually provided on the spacecraft for tracking during the launch and operation. This transmitter can also carry telemetry signals and range signal, turn around and command verifications.
3. Angular measurements are done by conventional terrestrial methods using large antennas and mono pulse or conical scanning system is used.
4. Ranging is done by sending uplink frequency which is modulated by a tone frequency by the earth station to the satellite. The received uplink frequency is demodulated in the command receiver, the tone re-modulated and transmitted back to the earth station on the telemetry carrier (downlink frequency). The precise range is obtained by measuring at TT&C station the time delay between the transmitted and received pulses.
5. In this way the orbital parameters are obtained by tracking the communication satellite from the ground and measuring angular position and range of the satellite.

Command:

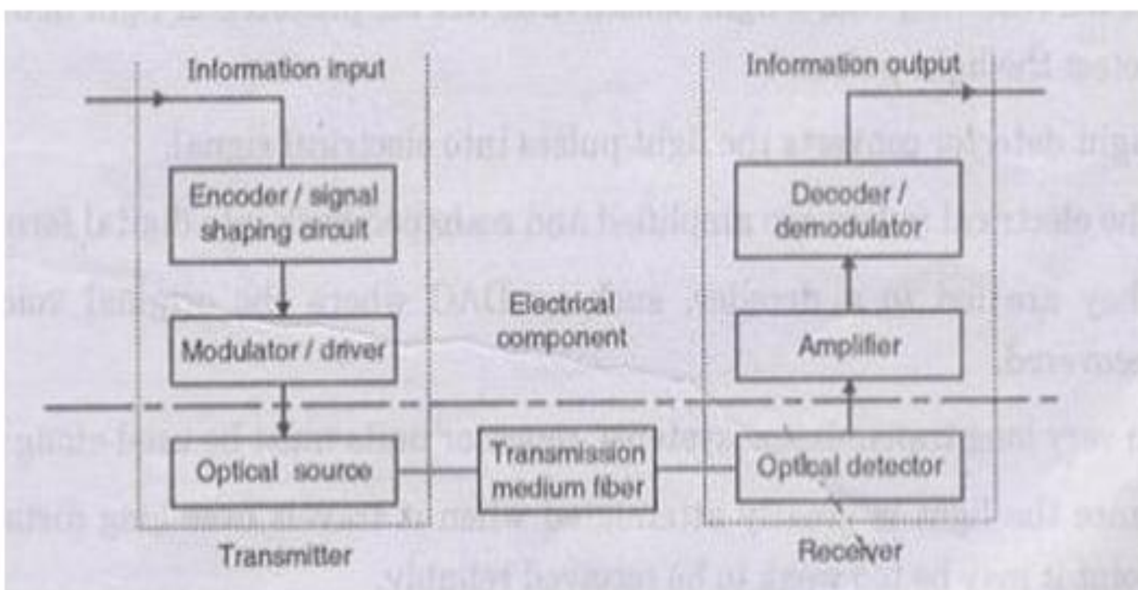
1. The computers on the ground station generate the command signals which are sent to the satellite on the command uplink. The TT&C receiver accepts the commands and decodes these signals and sends verification signal back to the earth station.
2. On reception of the verification signal, the ground station sends back an execute pulse to the satellite. Then the satellite executes these commands.

	(B)	**Attempt any ONE of the following:**	**06- Total Marks**
	(a)	**With neat sketch draw block diagram of MTI radar system and explain working.**	**6M**
			(Block diagram 3M, working 3M)

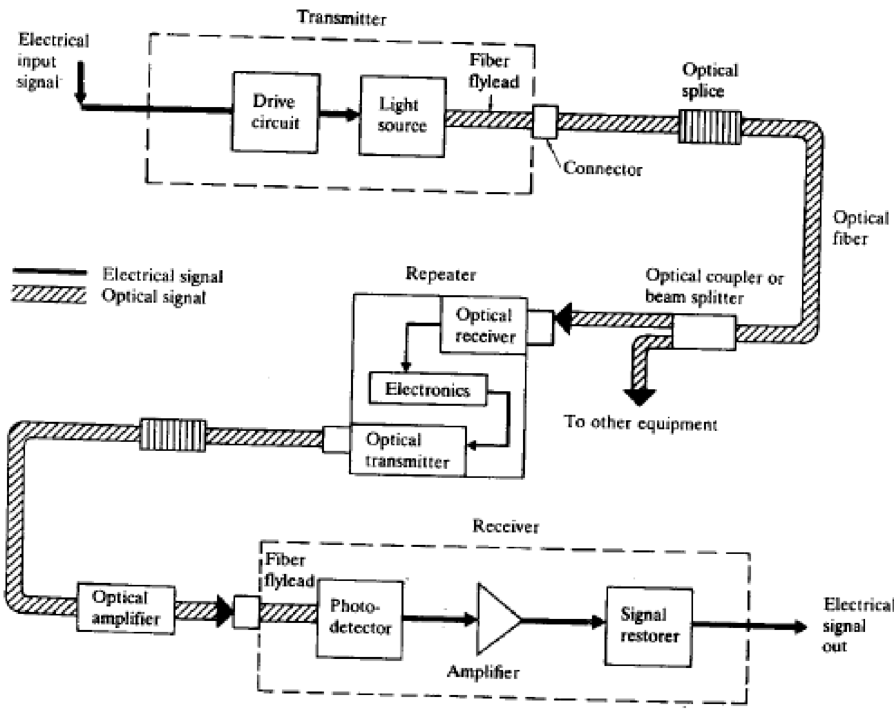


Working :

- The echo pulse from the target is received by MTI radar antenna. If echo is due to moving target, the echo pulse under goes a Doppler frequency. The received echo pulses than pass through mixer 1 of the receiver.
- Mixer 1 heterodynes the received signal of frequency (Fo+Fc) with the output of the stalo at Fo. Mixer 1 produces a difference frequency Fc at its output.
- This difference frequency signal is amplified by an IF amplifier. Amplifies output is given to phase detector.
- The detector compares to IF amplifier with reference signal from the COHO oscillator. The frequency produced by COHO is same as IF frequency so called coherent frequency.
- The detector provides an output which depends upon the phase difference between the two signals. Since all received signal pulses will have a phase difference compared with the transmitted pulse.

		• The phase detector gives output for both fixed and also moving targets. Phase difference is constant for all fixed targets but varies for moving targets. • Doppler frequency shift causes this variation in the phase difference. A change of half cycle in Doppler shift would cause an output of opposite polarity in the phase detector output. The output of phase detector will have an output different in magnitude and polarity from successive pulse in case of moving targets.	
	(b)	**Draw block diagram of fiber optic communication system & list out optical sources and detectors suitable for fiber optic communication.**	**6M**
	Ans:	 OR	(Diagram -4M, Source and detector -2M)

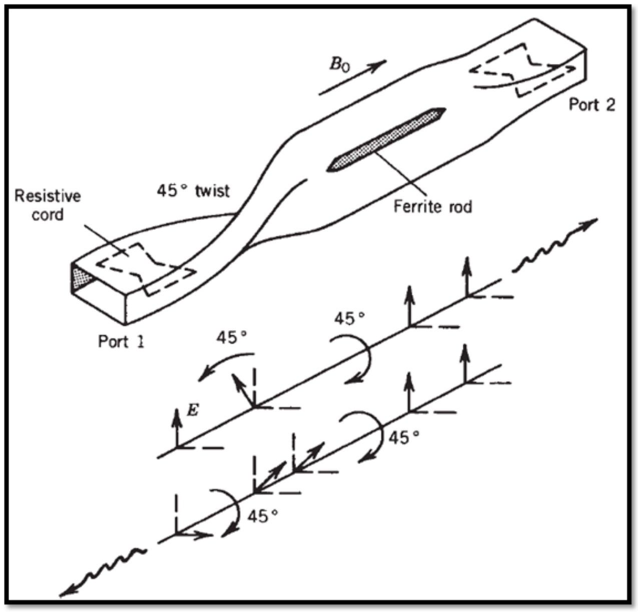
SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

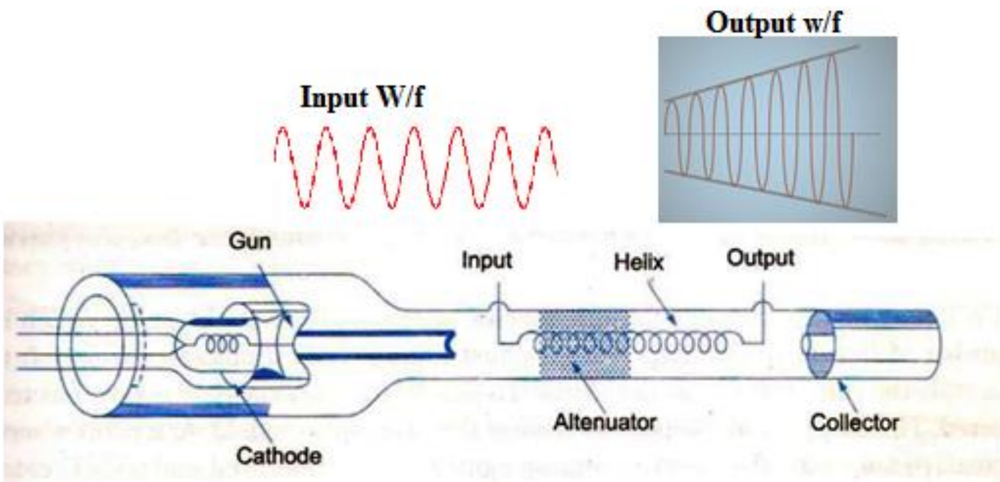


Optical source: Light source at the transmitter end which converts electrical current into optical signal. Light sources which are used are LED and LASER.

Detector: light detector at the receiver end which converts optical energy electrical signal. The light detectors which are used as PIN photodiode and avalanche photo diode.

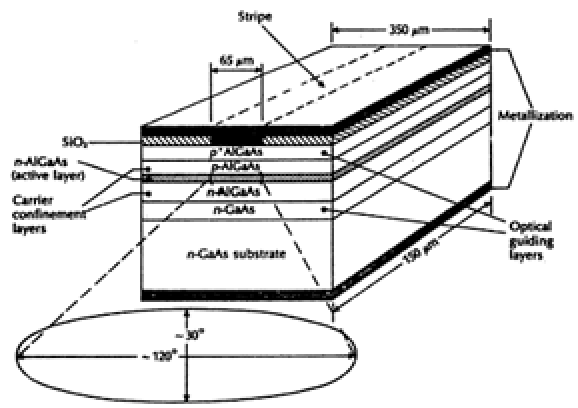
Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any FOUR of the following:**	**16- Total Marks**
	a)	**Draw constructional diagram of isolator and explain its working .**	**4M**
	Ans:	• An isolator is a 2 port device which provides very small amount of attenuation for transmission from port 1 to port 2 but provides maximum attenuation for transmission from port 2 to port 1.	**2M Diagram**

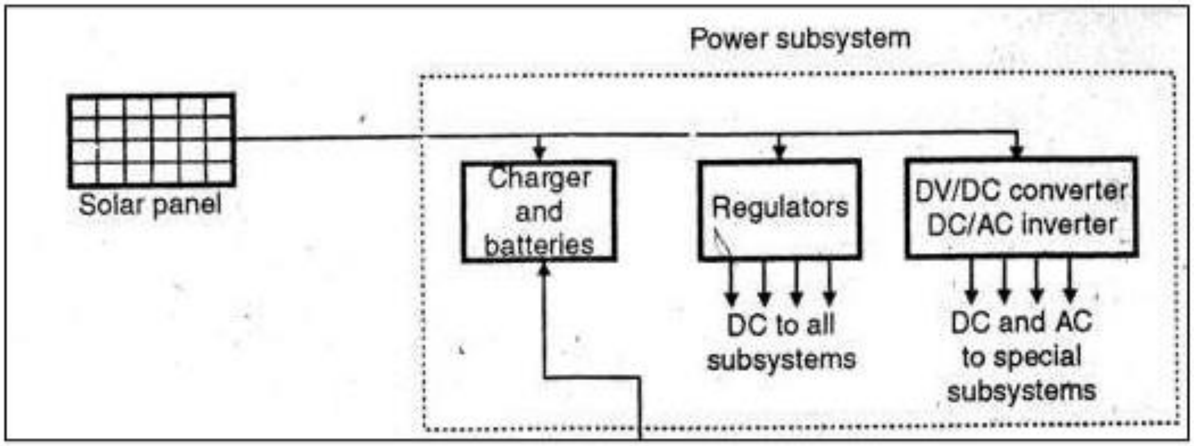
		• This is very desirable when we want to match a source with a variable load. • When an isolator is inserted between the microwave generator and the load, generator is coupled to the load with zero attenuation and reflections if any from the load side are completely absorbed by the isolator without affecting generator output.  *Figure: Isolator* **Operation:** A TE1,0 wave passing from port 1 through the resistive card is not attenuated. After coming out of the card, wave gets shifted by 45° because of the twist in anticlockwise direction and then by another 45° in clockwise direction because of ferrite rod and hence comes out of port 2 with same polarization as at port 1 without getting attenuated. But a TE1,0 wave fed from port 2 passes through the resistive card without any attenuation. The wave then gets rotated by 45° in clockwise direction due to Faraday rotation. It gets further rotated by 45° in clockwise direction due to the twist. Now plane of polarization of the wave will be parallel with that of the resistive card and hence will be completely absorbed by the card and output at port 1 will be 0.	**2M working**

		This power will be dissipated in the card as heat.	
	b)	**Describe with waveform , how signal grow in TWT.**	**4M**
	Ans:	**Working principle:**  • When the applied RF signal propagates around the turn of helix it produces electric field at the centre of helix. The RF field propagates with velocity of light. • The axial electric field due to the RF signal travels with velocity of light multiplied by the ratio of helix pitch to helix circumference. • When the velocity of electron beams, travelling through the helix approximates the rate of advance of axial field. The interaction takes place between them in such a way that on average the electron beam delivers energy to the RF field in helix. • So the signal wave grows and amplified output is obtained at output of TWT. At a point where axial field is zero electron velocity is unaffected. • A point where the axial field is positive, the electron coming against it is accelerated and tries to catch up with later electrons which encounter the RF axial field. A point where axial field is negative the electrons get velocity modulated. • And the energy transfer from electron to RF field at axial and second wave is induced on helix. This produces an axial electric field that lags behind original electric field by λ/4. Bunching continues to take place.	**2M diagram 2M Explanation**

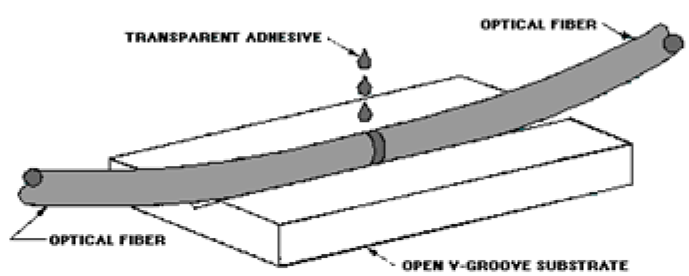
SUMMER– 19 EXAMINATION

Subject Name: Advance communication system Model Answer Subject Code: 17656

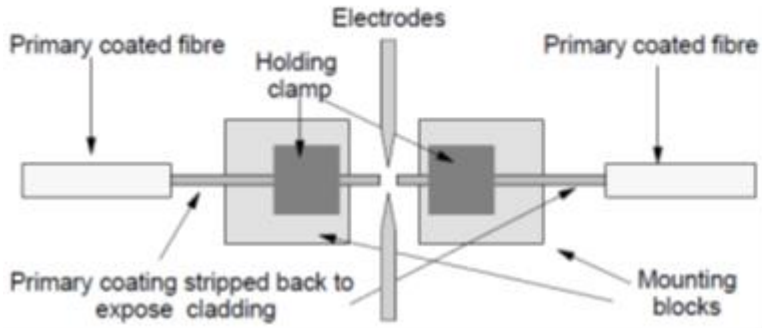
		• The electron in bunch encounter retarding field and deliver energy to way on helix. The output becomes larger than the input and then amplification results.	
	c)	**Draw constructional diagram of Edge Light emitter diode and explain it's working.**	**4M**
	Ans:	 • The edge emitting LED's emit a more functional light pattern than the surface emitting LED's. The edge emitter consists of an active junction region which is the source of the incoherent light and two guiding layers. • The guiding layers both have a refractive index which is lower than that of the active region but higher than the index of the surrounding material. • This structure forms a waveguide channel that directs the optical radiation toward the fiber core. The emitting surface is a stripe rather than confined circular area (as in surface emitter). • The light is emitted from an active stripe and forms an elliptical beam to match the typical fiber core diameters (50 to 100µm), the contact stripe for the edge emitter are 50-70µm wide. The length of the active region is 100 to 150µm. • Surface emitting LED's are more commonly used than edge emitters because they emit more light. However coupling losses with surface emitters are greater and have narrow bandwidths.	**2M Diagram 2M working**
	d)	**Draw block diagram of Satellite power sub-system.**	**4M**
	Ans:	**Note: any other relevant diagram can be considered.**	**4m diagram**

			
	e)	**A silica optical fiber with core diameter large enough to be considered by ray theory analysis has core refractive index of 1.50 & cladding refractive index of 1.47. Calculate (1) Critical angle, (2) NA of fiber, (3) Acceptance angle.**	**4M**
	Ans:	**Given:** $n_1 = 1.50$, $n_2 = 1.47$ To find: $\theta_c = ?$, $NA = ?$, $\theta_A = ?$ **) Critical angle:** $\theta_c = \sin^{-1}\frac{n_2}{n_1}$ $= \sin^{-1}\frac{1.47}{1.50}$ $= 78.52°$ $\therefore$ $\boxed{\theta_c = 78.52°}$ **i) Numerical aperature:** $NA = \sqrt{n_1^2 - n_2^2}$ $= \sqrt{(1.50)^2 - (1.47)^2}$ $= \sqrt{2.25 - 2.16}$ $= 0.30$ $\therefore$ $\boxed{NA = 0.30}$ **iii) Acceptance angle:** $\theta_A = \sin^{-1} NA$ $= \sin^{-1}(0.30)$ $= 17.45°$ $\boxed{\theta_A = 17.45°}$	**1M Critical Angle** **1M NA** **2M Acceptance angle**
	f)	**State the need of splicing & list different techniques used for optical fiber. Explain any one in detail.**	**4M**

SUMMER– 19 EXAMINATION
Subject Name: Advance communication system Model Answer Subject Code: 17656

	Ans:	**Need:** • A fiber splicing is the permanent connection of two pieces of optical fiber. These are typically used to create long optical links or in situations where frequent connections and disconnections are not needed. • In making and evaluating such splices, one must take into account the geometrical differences in the two fibers, fiber misalignments at the joints and the mechanical strength of the splice. Three types of techniques are used – Mechanical, Fusion and Elastic Tube. **Different types of splicing are:** 1. Fusion splicing or welding 2. Mechanical splicing 3. Elastic tube splicing **MECHANICAL SPLICES:** **V-Grooved Splices:** • Mechanical splices may also use either a grooved substrate or positioning rods to form suitable V-grooves for mechanical splicing. • The basic V-grooved device relies on an open grooved substrate to perform fiber alignment. When inserting the fibers into the grooved substrate, the V-groove aligns the cladding surface of each fiber end. • A transparent adhesive makes the splice permanent by securing the fiber ends to the grooved substrate. Figure below illustrates this type of open V-grooved splice.  **OR** **FUSION SPLICING:** • A fiber join is a type of weld. The fiber ends are cut, polished, butted up to one another and fused by heat. In practice, a light loss of only 0.1 dB is the current budget for power loss in a single-mode fiber join.	**1M Need** **1M List** **2M Explanation**

- But it should be realized that 0.1 dB is quite a lot in that it represents the total loss of one half of a kilometer of cable. A device setup for fusion splicing is illustrated in Figure below.

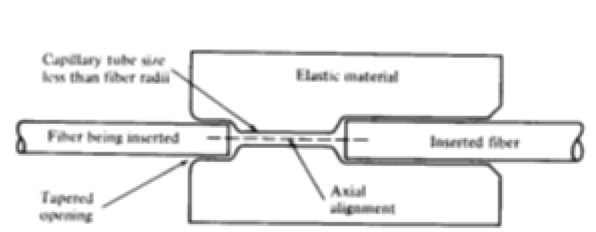


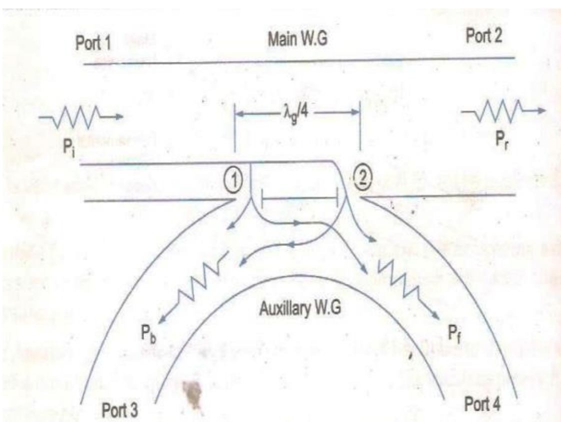
- Each fiber is stripped of its primary coating and the end cleaved such that it is square.
- The fiber ends are positioned a few mm from one another and clamped to positioning blocks. There is often a groove provided in the mounting block to aid in correct alignment.
- The fiber ends are then aligned with one another and brought closer together.
- When alignment is satisfactory an electric arc is started between the two electrodes and the fibers brought into contact. Heat from the arc melts the glass and the join is made.
- This technique can produce very low splice losses (no reflection loss and minimal insertion loss). However care must be taken in this technique since surface damage due to handling, surface defect growth created during heating and residual stresses induced near the joint as a result of changes in chemical composition arising from the material melting can produce a weak splice.

OR

ELASTIC TUBE SPLICE:

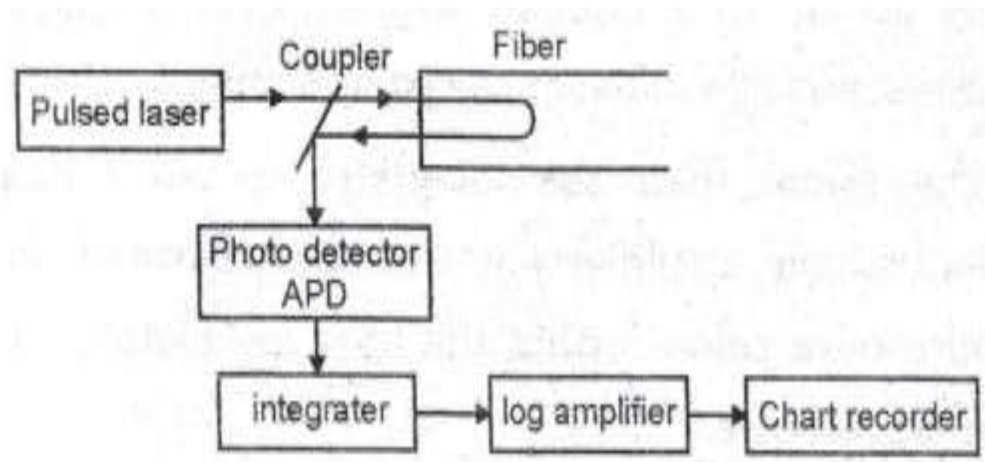
- The elastic tube splice shown cross sectionally in the figure below is a unique device that automatically performs lateral, longitudinal and angular alignment.
- It splices multimode fibers with losses in the same range as commercial fusion splices, but much less equipment and skill are needed.
- The splice mechanism is basically a tube made of elastic material. The central hole diameter is slightly smaller than that of the fiber to be spliced and is tapered on each end for easy fiber insertion.

		• When the fiber is inserted, it expands the hole diameter so that the elastic material exerts a symmetrical force on the fiber. • This symmetry feature allows an accurate and automatic alignment of the axes of the two joined fibers. • A wide range of diameters can be inserted into the elastic tube. Thus the fibers to be spliced do not have to be equal in diameter, since each fiber moves into position independently relative to the tube axis. 	
Q. No.	Sub Q. N.	Answers	Marking Scheme
6.		**Attempt any FOUR of the following:**	**16- Total Marks**
	a)	**Draw constructional diagram of two hole directional coupler & explain it's working.**	**4M**
	Ans:	**Working two hole directional coupler** • Directional couplers are devices that will pass signal across one path • while passing a much smaller signal along another path. • One of the most common uses of the directional coupler is to sample a RF power signal either for controlling transmitter output power level or for measurement. • The principle of operation of a two-hole directional coupler is shown in figure below. It consists of two guides; the main and the auxiliary with two tiny holes common between them as shown.	**working, 2M**

		• The two holes are at a distance of $\frac{\lambda g}{4}$ where λg is the guide wavelength. • The two leakages out of holes 1 and 2 both in phase at position of 2nd hole and hence they add up contributing to *Pf*. But the two leakages are out of phase by 180° at the position of the 1st hole and therefore they cancel each other making *Pb* = 0(ideally). • The magnitude of power coming out of the two holes depends on the dimension of the holes. Although a high degree of directivity can be achieved at a fixed frequency, it is quite difficult over a band of frequencies. The frequency determines the separation of the two holes as a fraction of the wavelength.  Fig. 6.19 Two hole directional coupler.	construc tional diagram 2M
	b)	**Describe absorption and dispersion losses in optical fiber.**	**4M**
	Ans:	**Absorption loss:-** • Absorption loss in optical fiber is analogous to power dissipation in copper cables. Impurities in the fiber absorb light and convert it to heat. Absorption losses in optical fibers are due to three different mechanisms – • i. Absorption by atomic defects in the glass composition. • ii. Extrinsic absorption by impurities in the glass material. • iii. Intrinsic absorption by the basic constituent atoms of the fiber material **Dispersion loss:**	**2M**

SUMMER– 19 EXAMINATION

Subject Name: Advance communication system Model Answer Subject Code: 17656

		Dispersion is a measure of the temporal spreading that occurs when a light pulse propagates through an optical fiber. Dispersion is sometimes referred to as delay distortion in the sense that the propagation time delay causes the pulse to broaden.	2M
	c)	**Draw block diagram of OTDR and explain its working principle.**	4M
	Ans:	**Block diagram of OTDR**  **Working principle of OTDR** • A light pulse is launched into the fiber in the forward direction from an injection laser using either a directional coupler or a beam splitter. • Beam splitter or coupler makes possible to couple the optical power impulse into the tested fiber and simultaneously to deviate the backscattered power to the optical receiver. • The backscattered light is detected using avalanche photodiode receiver. Output of photodiode receiver drivers an integrator.	**block diagram 2M** 2M
	d)	**Differentiate satellite communication and fiber optic communication w.r.t.** **(i) Frequency range** **(ii) Electro Magnetic Interference** **(iii) Application**	4M

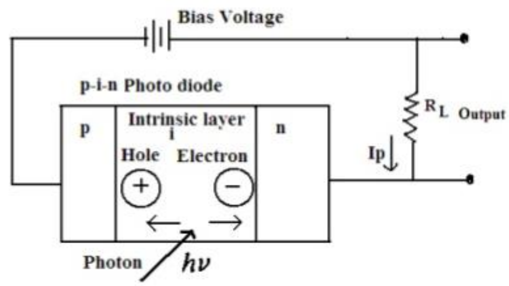
(iv) Limitation

Ans: (4M)

Sr. no.	Parameter	Satellite communication	Optical fiber communication
1	Frequency range	1GHz to 100GHz	10^{14}Hz to 10^{15}Hz
2	Electromagnetic interference	Not Immune to EM interference	Immune to EM interference
3	Application	i) It provide information regarding weather, make forecast about rains and cyclones. ii) It provides communication, remote sensing etc. iii) Used in mobile communication.	i) TV studio to transmitter interconnection illuminating microwave radio link ii) Secure communication system at military basis. iii)Data acquisition of control signal communication in industrial presses control system
4	Limitation	i) Launching and positioning of satellite is costlier, elaborated and need high technology. ii) Repel is nearly impossible after launching the satellite.	i) Difficulty in termination of fiber optics cable. ii) Fragility

e) **Draw the constructional diagram of PIN photo diode and explain its working.** **4M**

Ans: (Diagram -2M, working-2M



1. Light entering through the window of a PIN diode is absorbed by the intrinsic material and adds enough energy (an energy greater than or equal to the band gap energy of the semiconductor material) to cause the electrons to move from the valence band to the conduction band.
2. This process generates free electron hole pairs which are known as photo-carriers since they are photon-generated charge carriers.
3. The photodetector is designed so that these carriers are generated mainly in the depletion region where most of the incident light is absorbed.
4. The high electric field present in the depletion region causes the carriers to separate and be collected across the reverse biased junction. This gives rise to current flow in the external circuit.
5. This current flow is known as photocurrent and is proportional to the light power absorbed by the diode.