MODEL ANSWER

WINTER - 2017 EXAMINATION

Subject: Communication Technology **Subject Code: 17519**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model 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) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills).
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 judgement 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.	Answer	Marking Scheme
1.	**a) i) Ans.**	**Attempt any three:** **State advantages and disadvantages of analog communication.** **Advantages of analog communication:** 1. No quantization errors, 2. Requires less bandwidth, 3. Low cost 4. It can be easily constructed because of less pre-processing requirements. **Disadvantages analog communication:** 1. Quality often degraded due to noise 2. Requires high quality processing which in turn demands costly hardware 3. costly storage requirements due to more data 4. high power requirements	**4X3=12** **4M** ***Any 2 advantages and disadvantages of analog communication 1M each***
	ii) Ans.	**Explain the basic block diagram of communication system.**	**4M**

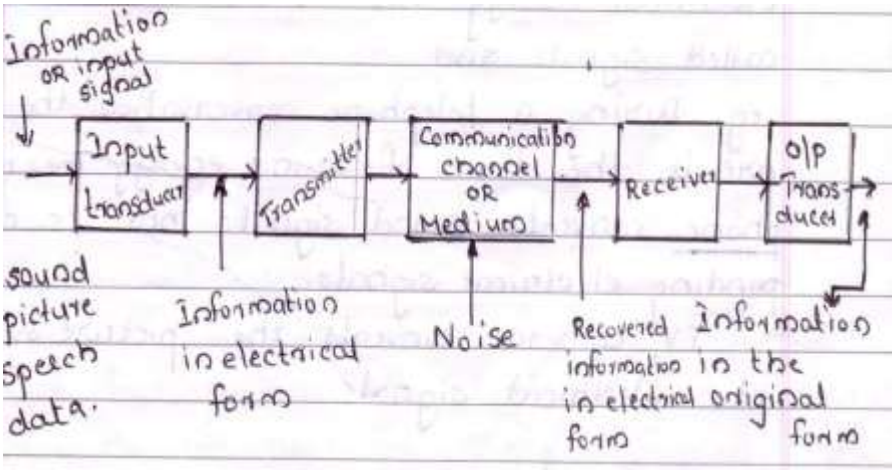


Fig: block diagram of communication system

2M block diagram

The main components of a basic communication system are:
1. Information or input signal
2. Input transducer
3. Transmitter
4. Communication channel or medium
5. Noise
6. Receiver
7. Output transducer

2M explanation

1. Information or input signal: The information can be in the form of a sound signal like speech or music or it can be in the form of pictures (T. V. signals) or it can be data information coming from a computer.

2. Input Transducer: The communication system transmits information in the form of electrical signals. The transducers convert the non-electrical energy into its electrical energy called signals.
E.g. During a telephone conversation the words are in the form of sound energy. The microphone converts sound signals into its corresponding electrical signals.
TV camera converts the picture signals into electrical signals.
E.g. Microphone, TV, Camera.

3. Transmitter: It is used to convert the information into a signal

		suitable for transmission over a given communication medium. It increases the power level of the signal. The power level is increased to cover a large range. The transmitter consists of electronic circuits such as amplifier, mixer oscillator and power amplifier. **4. Communication channel or medium:** The communication channel is the medium used for transmission of electrical signals from one place to other. The communication medium can be conducting wires cables optical fiber or free space. Depending on the type of communication medium two types of communication systems will exist. They are 1. Wire communication or line communication 2. Wireless communication or radio communication. **5. Noise:** Noise is random undesirable electric energy that enters the communication system through the communication medium and interferes with the transmitted signal. **6. Receiver:** The reception is exactly the opposite process of transmission. The received signal is amplified demodulated converted into a suitable form by the receiver. The receiver consists of electronic circuits like mixer, oscillator, detector amplifier etc. **7. Output Transducer:** The output transducer converts the electrical signal at the output of the receiver back to the original form is sound or TV pictures etc. E.g. Loud speaker: electrical signals sound Picture tubes: electrical signals visual data.	
	iii) **Ans.**	**Explain the concept of Handoff in mobile communication.** **Handoff:** Cellular system has the ability to transfer calls that are already in progress from one cell-site controller to another as the mobile unit moves from cell to cell within the cellular network. The transfer of a mobile unit from one base stations control to another base stations control is called a handoff.	**4M**

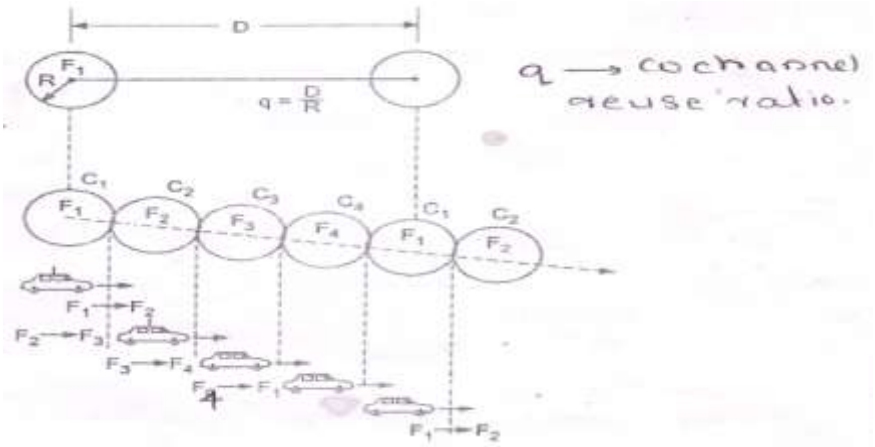


Diagram 2M

The process in which mobile station changes one cell to another, hence from one base station to another base station and mobile station remains connected to this called person is called "handoff" operation of a base station.

Explanation 2M

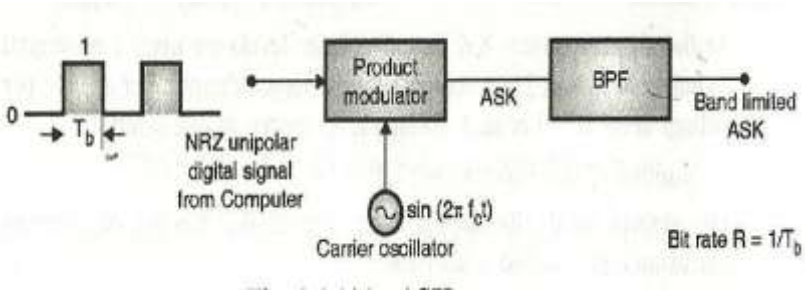
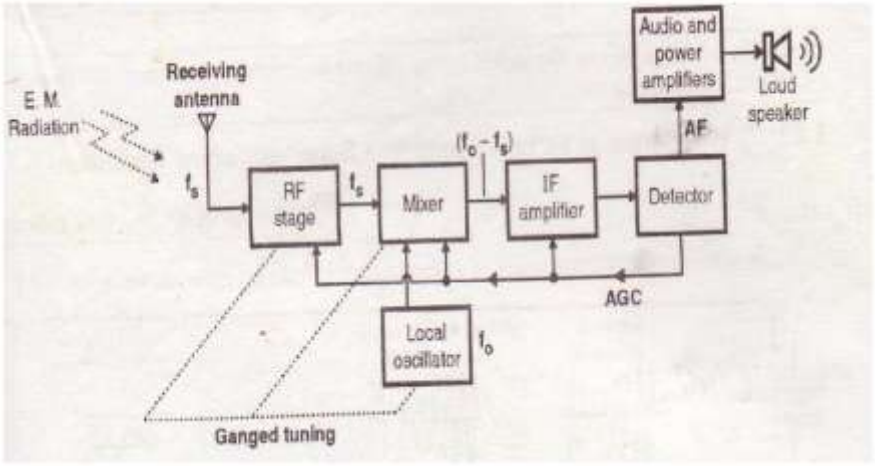
- As the vechicle containing the telephone passes through a cell it is served by the cell transceiver.
- The telephone call is routed through the MTSO and to the standard telephone system.
- As the vehicle moves the system automatically switches from one cell to the next.
- The receiver in each cell station continously monitors the signal strength of the mobile unit.
- When the signal strength drops below a desired level, it automatically seeks a cell where the signal ffrom the mobile ubit is stronger.
- The computer at the MTSO causes the transmission from the vechicle to be switched from the weaker cell to the stronger cell. It is called "Hand off" Mechanism.

Consider two co-channel cells using the frequencey F_1 seperated by a distance D. The radius R and the distance D are represented by q (co-channel reuse ratio) q =D/R. The other frequency channels such as F_2 F_3 and F_4 are selected between two co-channel cells to provide the communication system in whole area . The corressponding cells are C_2, C_3 and C_4. Suppose a mobile unit is starting a cell in cell C_1 and

		then moves to C_2. The call be dropped and reinitated in the frequencey channel from F_1 to F_2 while mobile unit moves from cell C_1 to C_2. The process of changing frequency can be done automatically by the system without users mediation. This process is called "Hand off". The process of reallocating a different voice channel to the mobile cellular phonw as the user moves between cells during a call is called Hand off.	
	iv) **Ans.**	**Define: Shanon's theorem for channel capacity and compare analog communication with digital communication.** **Shannon's Theorem** gives an upper bound to the capacity of a link, in bits per second (bps), as a function of the available bandwidth and the signal-to-noise ratio of the link.The Theorem can be stated as: $C = B * \log_2(1+ S/N)$ Where C is the achievable channel capacity, B is the bandwidth of the line, S is the average signal power and N is the average noise power. **Comparison between Analog and Digital communication:**	**4M** ***Definition 2M***

Sr. No.	Analog communication	Digital Communication
1	Original information converted into equivalent analog signal.	Original information converted into equivalent digital signal.
2.	Information may be in the form of human voice, picture, music etc.	Information in the form of data, binary coded numbers, alpha numeric codes etc.
3.	Poor noise immunity for AM but improved for FM and PM.	Excellent noise immunity.
4.	Coding is not possible.	Coding techniques used to detect and correct the errors.
5.	FDM is used for multiplexing	TDM is used for multiplexing
6.	Not suitable for secret transmission such as in	Due to coding techniques, suitable for police, military

Any 2 comparison 1M each

			military, police applications.	applications.	
		7.	Analog modulation systems are AM, FM, PM, PWM, PAM, PPM.	Digital modulation systems are PCM, DM, ADM, DPCM.	
1.	**b) i) Ans.**	**Attempt any one:** **Draw and explain ASK transmitter with block diagram.** **Block Diagram of ASK Generation:**  Carrier Oscillator – Generates carrier i.e. sinewave of frequency f_c Digital Signal – is the modulating or information signal. Product Modulator – It is multiplier which multiplies modulating and carrier signal. Due to multiplication ASK output will be present only when binary '1' is to be transmitted. BPF – Band pass filter allows only wanted frequency.	**6x1=6 6M** ***Diagram of ASK generation 3M*** ***Explanation 3M***
	ii) Ans.	**Explain superheterodyne AM receiver, state function of each block.**  	**6M** ***Diagram 3M***

		Function of block- The AM signal transmitted by the transmitter travels through the air and reaches the Receiving antenna. The signal is in the form of electromagnetic waves. It induces a very small voltage into the receiving antenna. **RF amplifier:** The RF amplifier is used to select the wanted signal and rejects the unwanted signals present at the antenna. It reduces the effect of noise. At the output of RF amplifier we get the desired signal at frequency f_s. **Mixer:** The mixer receives the signal from the RF amplifier at frequency (f_s) and from the local oscillator at frequency (f_0) such that $f_0 > f_s$. **Intermediate frequency (IF):** The mixer is a non-linear circuit. It will mix the signals having frequency and to produce signals having frequencies f_s, f_0 , f_0-f_s , $f_0+ f_s$. Out of these the difference of frequency component i.e. f_0-f_s is selected and all other are rejected. This frequency is called intermediate frequency (IF). **IF = f_0-f_s** **Ganged Tuning:** In order to maintain a constant difference between the local oscillator frequency and the incoming signal frequency ganged tuning is used, this is simultaneous tuning of RF amplifier mixer and local oscillator. This is obtained by using ganged tuning capacitors. **IF amplifier**: The IF signal is amplifier by one or more IF amplifier stage. **Detector**: The amplifier IF signal is detected by the detection to obtain the original modulating signal. Normally practical diode detectors are used as detector. **Audio and Power Amplifier**: The recovered modulating signal is amplified to the adequate power level by using the Audio and Power Amplifier and given to the Loudspeaker. Loudspeaker converts the electrical signals into sound signals. **AGC (Automatic Gain Control)**: This circuit controls the gain of RF and IF amplifiers to maintain a constant output voltage level even when the signal level at the receiver input is fluctuating. This is done by feeding a controlling D.C. voltage to the RF and IF amplifiers. The amplitude of this dc voltage is proportional to the detector output.	***Explanation 3M***

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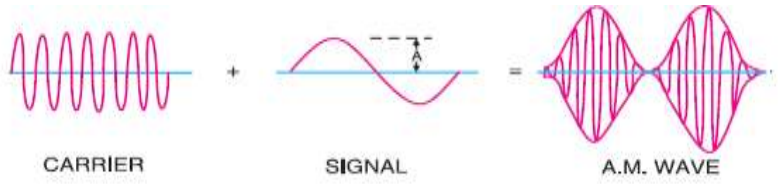
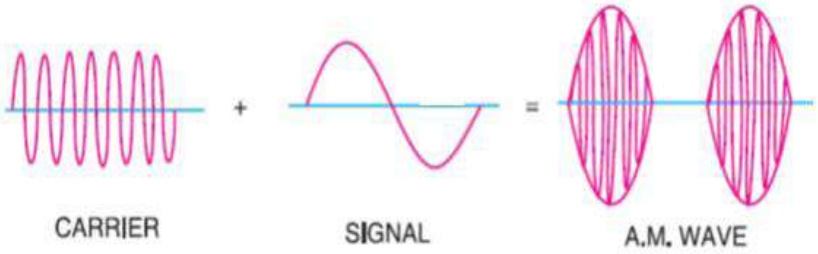
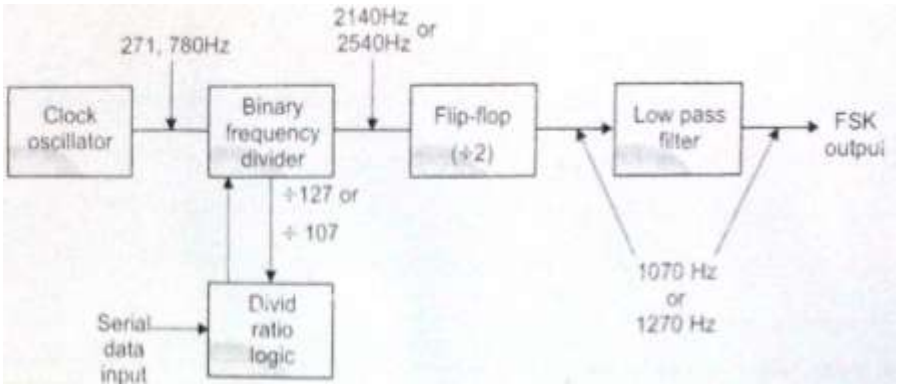
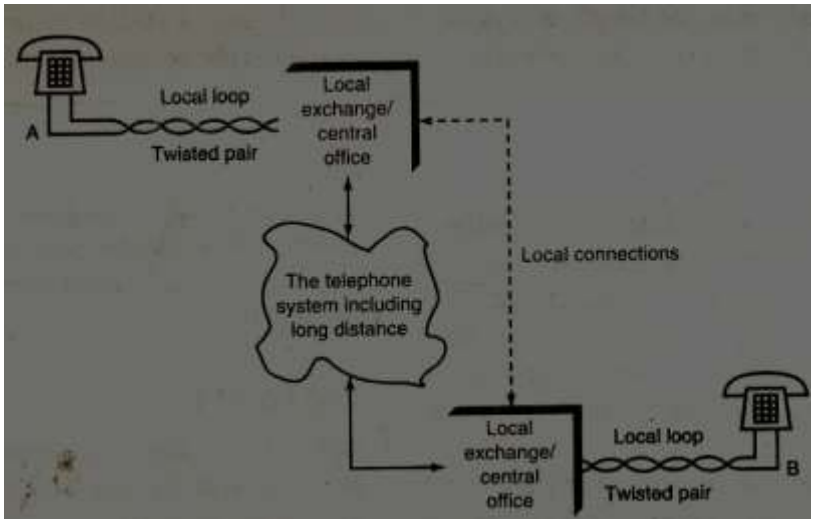
2.		**Attempt any four:**	**4x4=16**
	a)	**Draw the labelled AM wave in time domain for** **i) modulation index = 1** **ii) modulation index > 1**	**4M**
	Ans.	**i) modulation index = 1**  **ii) modulation index > 1**  	***Diagram of waveforms 2M each***
	b)	**State advantages and applications of PAM.**	**4M**
	Ans.	**Advantages of PAM:** 1. In PAM, amplitudes of regularly spaced pulses are varied in proportion to corresponding sample values of continuous message signal. Hence system is lowest in complexity to implement. 2. Generation and detection is easy. 3. PAM is used to carry information as well as to generate other pulse modulations. 4.Multiplexing of signals is possible	***2M for advantages***
		Applications of PAM: 1. Used in radio telemetry for remote monitoring and sensing. 2. Used as LED drivers.	***2M for applications***
	c)	**Explain FSK transmitter and state function of each block.** ***(Note: Any other relevant Block diagram with relevant explanation shall be consider)***	**4M**

	Ans.	**FSK:** Frequency shifting keying (FSK) is a digital modulation in which frequency of sinusoidal carrier is shifted between two discrete values of frequency where amplitude & phase remains constant. IN FSK, a binary information signal directly modulates the frequency of analog carrier.  Note that binary 1 corresponds to frequency 1270 Hz and binary 0 to frequency 1070 Hz As shown in block diagram, **Clock Oscillator**: Generates frequency of 271780Hz. **Divide ratio logic**: Produces frequency division by 127 **Frequency divider:** when data input is zero, the frequency divider output will be 1/127 of its input. Then output frequency will be 2140 Hz. **Flip Flop:** this divides the 2140 Hz frequency by 2, producing the desired 1070Hz output corresponding to binary "0" similarly, we get 1270 Hz frequency at binary "1" in which frequency divider will divide 107. **Low pass filter:** Removes higher frequency harmonics producing sine wave output.	***Explanation 2M*** ***Diagram 2M***
	d) Ans.	**Define: Bit rate and Baud rate and state importance of encoding.** **Bit rate:** • Bit rate is the number of bits transmitted per second. • Data rate is also known as bit rate. Bit rate = 1 /Bit interval • If the bit duration is Tb (known as bit interval), then bit rate will be 1/Tb • Bit rate should be as high as possible. • With increase in data rate the bandwidth of transmission medium	**4M** ***Definition of bit rate 1M***

		must be increased in order to transmit the signal without any distortion. **Baud rate:** • Baud rate is the number of signal units per second. • Baud is the unit of signaling speed or modulation rate or rate of symbol transmission. **Importance of encoding:** 1. The method of line encoding used determines the minimum bandwidth required for transmission. 2. Encoding also provides a measure of how easily a clock may be extracted from it, how easily it may be decoded, the average dc voltage level, and whether it offers a convenient means of detecting errors.	***Definition of baud rate 1M*** ***Importance 2M***
	e) **Ans.**	**State need of multiplexing. Write types of multiplexing techniques.** **Need of multiplexing:** In telephone systems, there are large numbers of users involved, It is not possible to connect separate wires from each subscriber to all other subscribers. It is very expensive and increases complexity Instead we can use a communication medium such as a coxial cable or optical fiber cable to carry many telephone signals from different sources together.This can be achieved by 'Multiplexing'. **Types of multiplexing:** 1. Space division multiplexing 2. Frequency division multiplexing 3. Time division multiplexing 4. Polarization division multiplexing 5. Code division multiplexing	**4M** ***Need 2M*** ***Any 4 types 2M***
	f) **Ans.**	**Describe working of telephone system with block diagram.** The original telephone system was designed for full-duplex analog communications of voice signals. The telephone system permits any telephone to connect with any other telephone in the world. This means that each telephone must have a unique identification code- the 10-digit telephone number assigned to each telephone. The telephone system provides a means	**4M** ***Description 2M***

		of reorganizing each individual number and switching systems that can connect any two telephones. Standard telephones are connected to the telephone system by way of a two-wire, twisted pair cable that terminates at the local exchange or central office. The connections from the central office go to the 'telephone system' by the large cloud. A call originating at telephone A will pass through the central office and then into the main system, where it is transmitted via one of many different routes to the central office connected to the desired location designated as B. The two-wire, twisted-pair connection between the telephone and the central office is referred to as the local loop or subscriber loop. The circuits in the telephone and at the central office from a complete electric circuit, or loop. This single circuit is analog in nature and carries both dc and ac signals. The dc power for operating the telephone is generated at the central office and supplied to each telephone over the local loop. The ac voice signals are transmitted along with the dc power. Despite the fact that only two wires are involved, full-duplex operation that is, simultaneous send and receive, is possible. All dialing and signaling operations are also carried on this single twisted pair.  	***Diagram 2M***
3.	**a)**	**Attempt any four:** **State and explain sampling theorem and Nyquist's rate of sampling.**	**4x4=16** **4M**

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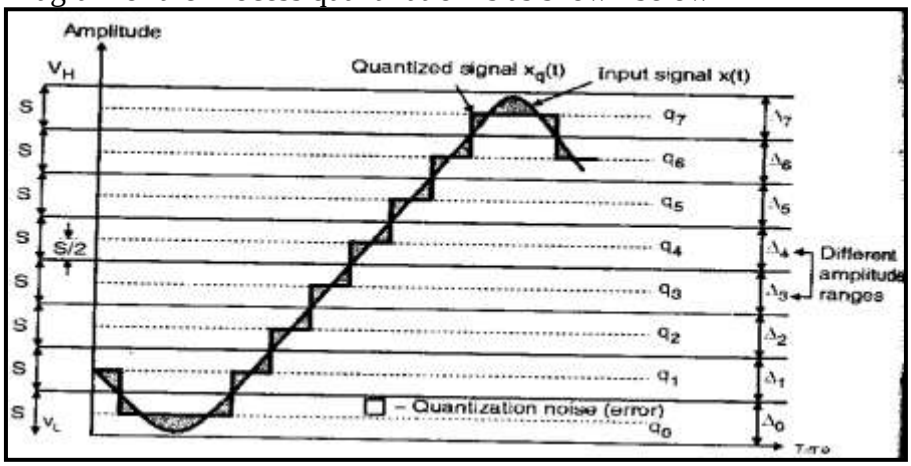
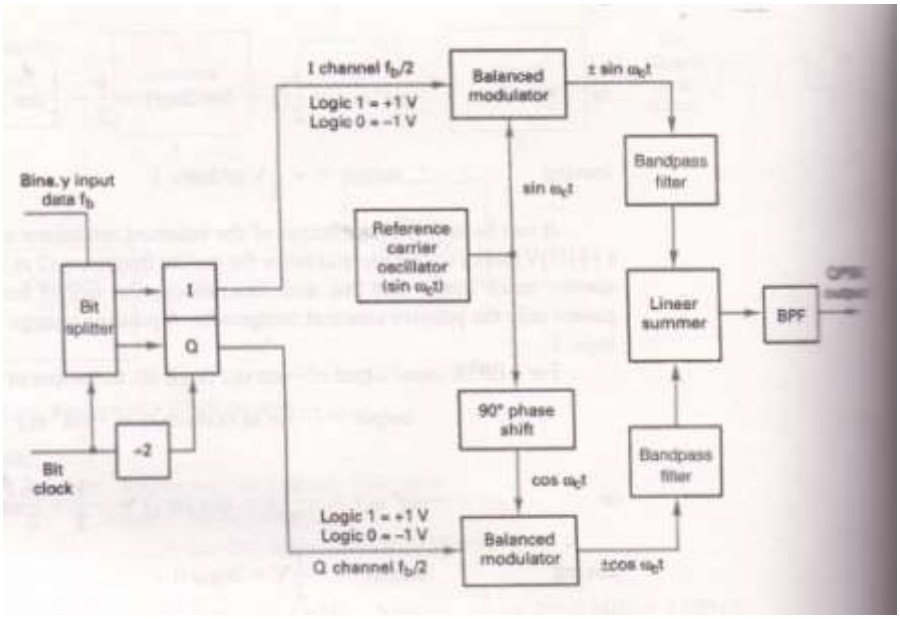
	Ans.	**Sampling theorem:** In any pulse modulation technique, the sampling frequency should be greater than or equal to twice the maximum frequency of the modulating signal to reconstruct the original information at the receiver with minimum distortion. $f_s \geq 2\ f_m$ **Nyquist rate:** Nyquist rate is the minimum sampling rate required to represent the continuous signal c(t) in its sampled form. According to sampling theorem, the Nyquist rate is, $f_s = 2f_m$	***Sampling theorem 2M*** ***Nyquist rate 2M***
	b) **Ans.**	**Explain quantization process in PCM and state what is quantization noise.** **Quantization process:** Quantization is the process of approximation or rounding off the sampled signal. The quantizer converts sampled signal into approximated rounded values consisting of only finite no. of pre decided voltage levels called as quantization levels. In the process of A to D conversion, after sampling, quantization is the next step. The input signal x(t) is assumed to have a peak swing of V_L to V_H volts. This entire voltage range has been divided into Q equal intervals each of size "s". s is called as step size and its value is given as $S = V_H - V_L / Q$ Diagram of the Process quantization is as shown below-  	**4M** ***Explanation 1M*** ***Diagram 2M***

		Quantization Noise or Error:-. The difference between the instantaneous values of the quantized signal and input signal is called as quantization noise or quantization error. **OR** The signal with discretized amplitude value is termed as quantized signal. The error between the original analog and its quantized version which is measured and is represented in terms of quantization noise or quantization error.	***Quantization noise definition 1M***
	c) Ans.	**Explain the block diagram of QPSK transmitter.** Quadrature Phase Shift Keying or Quaternary Phase shift Keying 1. QPSK is an example of multilevel phase modulation. 2. With QPSK four output phases are possible for a single carrier frequency. 3. Since four output phases are present, there e four different input conditions. 4. With two bits there are four possible conditions. 00, 01, 10, 11 are possible. 5. With QPSK the binary input data are combined into groups of two bits called dibits. 6. Each dibit code generates one of the four possible output phases ($+45^o$, $+135^o$, -45^o, -135^o) 	**4M** ***Explanation 2M*** ***Diagram 2M***

1. Two bits (a, dibit) are clocked into the bit splitter.
2. One bit is directed to the I channel and the other to Q channel.
3. The I bit modulates a carrier that is in phase reference oscillator (hence the name "I" for in phase channel).
4. The Q bit modulates a carrier that is 90^o out of phase OR in quadrature with the reference carrier (hence the name "Q" for "quadrature" channel.
5. A QPSK modulator is two BPSK modulators combined in parallel.
6. For a logic 1 = + 1V

Logic 0 = - 1V

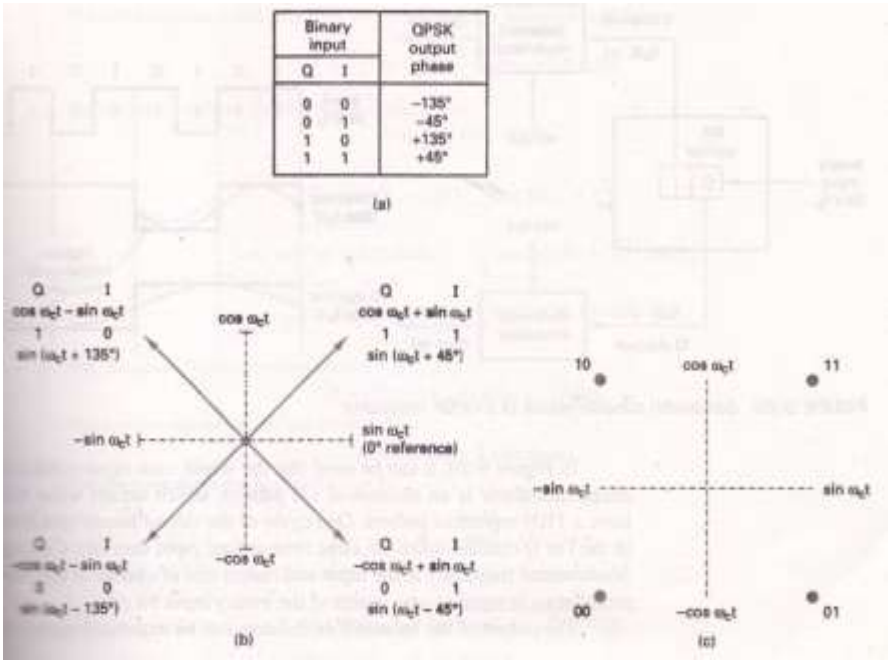
two phases are possible at the output of the I balanced modulator. (+Sin wc t, Sin wc t), and two phases are possible at the output of the Q balanced modulator (+Cos wc t, -Cos wc t). When the linear summer combines the two quadrature (90^o out of phase signals) there are four possible resultant phases given by these expressions:

+ Sin $w_c t$ + Cos $w_c t$

+ Sin $w_c t$ - Cos $w_c t$

- Sin $w_c t$ + Cos $w_c t$

+ Sin $w_c t$ - Cos $w_c t$



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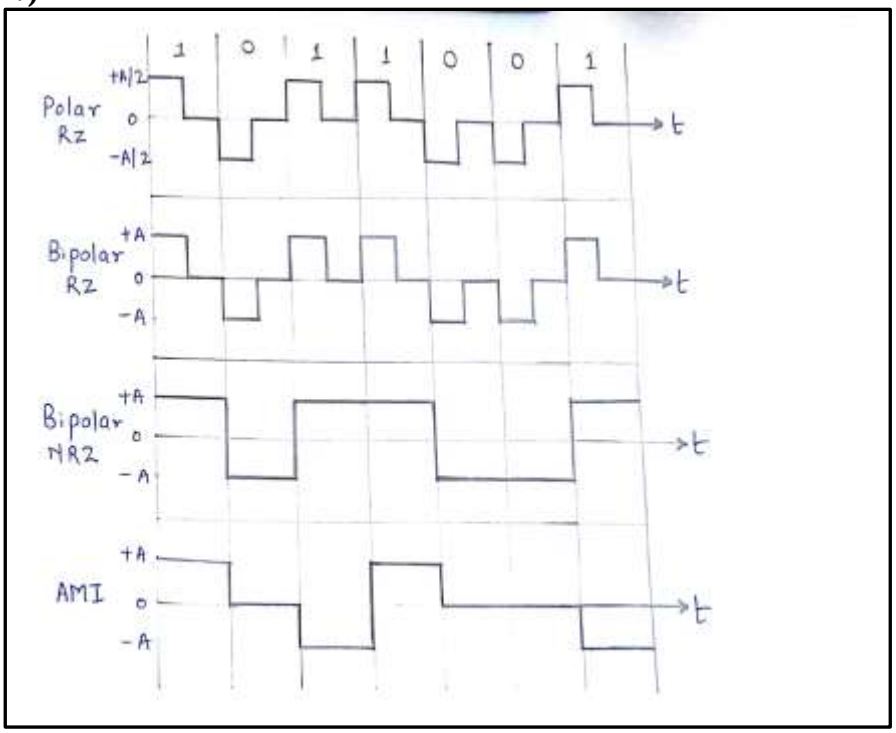
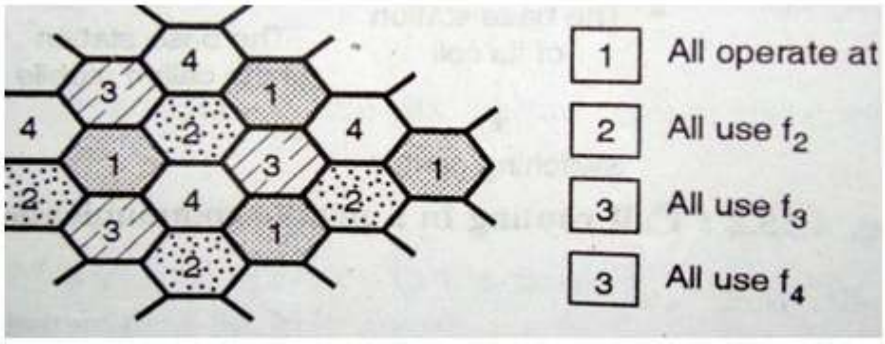
	d) **Ans.**	**Draw signals for data stream 1011001 using following encoding techniques:** **i) Polar RZ** **ii) Bipolar RZ** **iii) Bipolar NRZ** **iv) AMI**  	**4M** ***1M for each encoding techniques***
	e) **Ans.**	**Compare :TDMA with FDMA (4 pts).** **TDMA** | **FDMA** **Definition**: Entire bandwidth is shared among different subscribers at fixed predetermined or dynamically assigned time intervals/slots | Entire band of frequencies is divided into multiple RF channels/carriers. Each carrier is allocated to different users **Multiplexing Technique**: Time division multiplexin | Frequency division multiplexing	**4M** ***Any 4 points 1M each***

Power efficiency	More	Less		
Guard Band	Guard time band is required	Guard frequency band is required		
Synchronization	Required	Does not required		
Interference	Due to incorrect synchronization there can be interference between the adjacent time slots.	Due to nonlinearity of devices Intermodulation products are generated due to interference between adjacent channels.		
Bandwidth available	Time sharing of satellite transponder takes place	Overall bandwidth is shared among many stations.		
application	Advanced mobile phone, system(AMPS), Cordless telephone	GSM , PDC(pacific digital cellular), Radio, TV		

4. **a)** **Attempt any three:** **4x3=12**

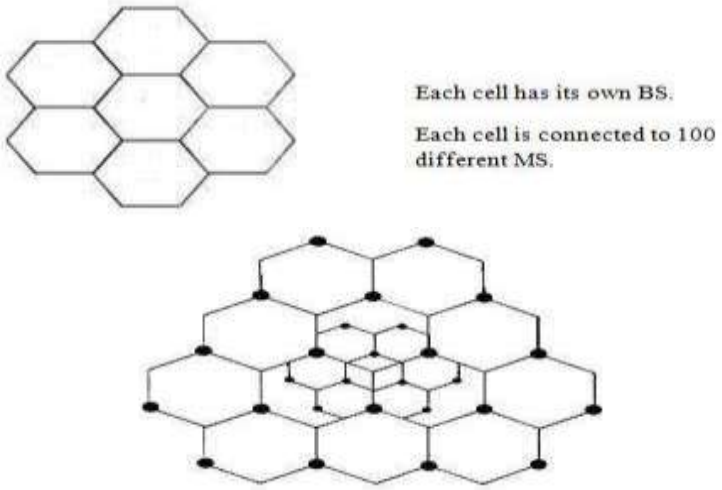
i) **Explain the concept of frequency reuse and cell splitting.** **4M**

Ans. **Frequency Reuse:**

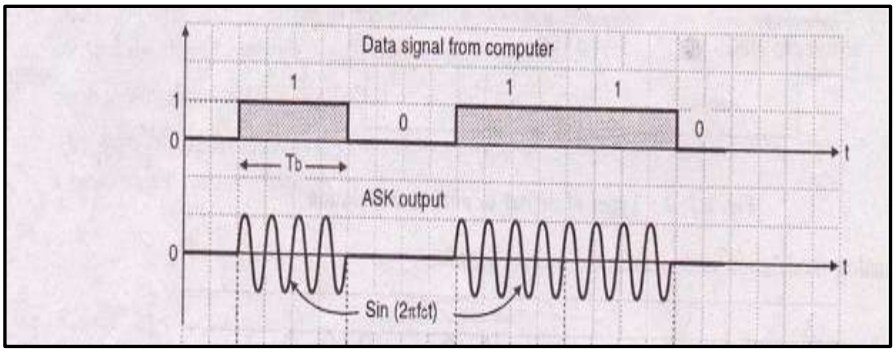
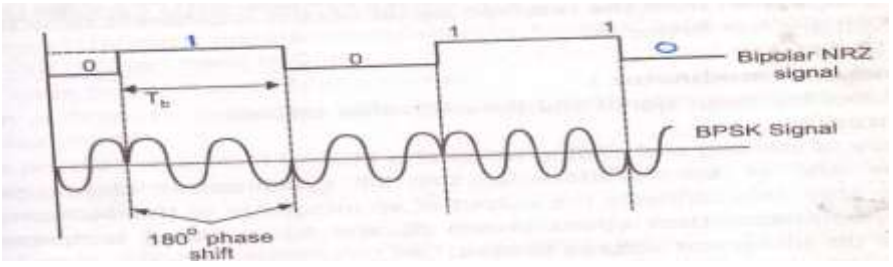


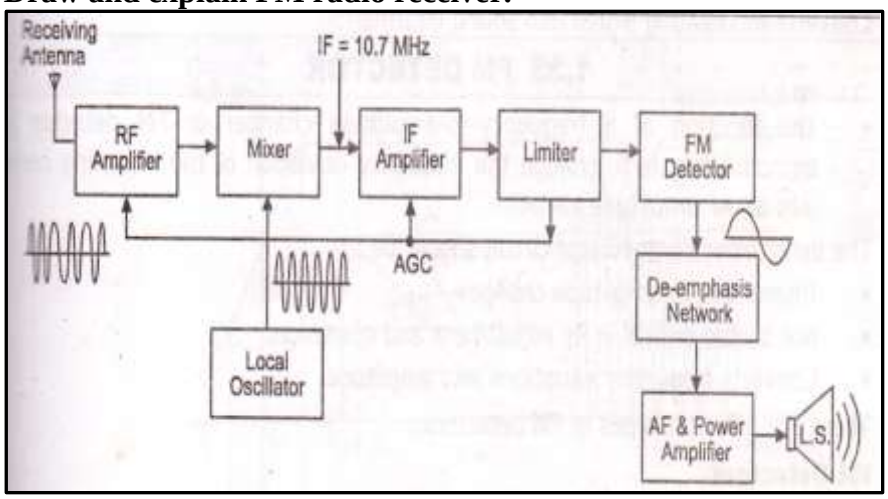
Concept of frequency reuse 2M

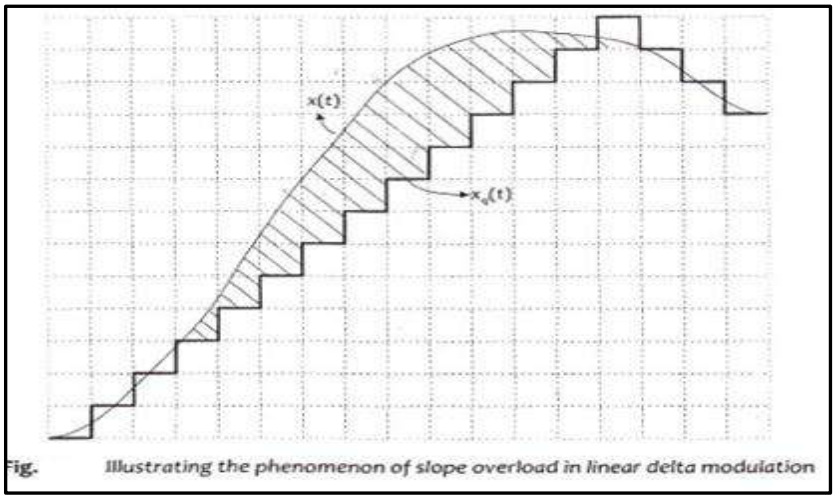
Frequency reuse is the process in which the same set of frequencies (channels) can be allocated to more than one cell. Provided the cells are separated by sufficient distance reducing each cells coverage area

		invites frequency reuse cells using the same set of radio channels can avoid mutual interference, provided they are properly separated. Each cell base station is allocated a group of channel frequencies that are different from those of neighboring cells & base station antennas are chosen to achieve a desired coverage pattern within its cell. However as long as a coverage area is limited to within a cells boundaries the same group of channel frequencies may be used in different cells without interfacing with each other provided the two cells are sufficient distance from one another. **Cell Splitting:** Cell splitting means to split up cells into smaller cells. The process of cell splitting is used to expand the capacity (number of channels) of a mobile communication system. As a network grows, a quite large number of mobile users in an area come into picture. Consider the following scenario. There are 100 people in a specific area. All of them owns a mobile phone (MS) and are quite comfortable to communicate with each other. So, a provision for all of them to mutually communicate must be made. As there are only 100 users, a single base station (BS) is built in the middle of the area and all these users' MS are connected to it. All these 100 users now come under the coverage area of a single base station. This coverage area is called a cell.  **Fig: Cell splitting** The concept of cell splitting can further be applied to the split cells as	***Concept of cell splitting 2M***

		well. That is, the split up cells can further be split into a number of smaller cells to improve the efficiency of the BS even more.	
	ii) Ans.	**State advantages and disadvantages of encoding techniques.** **Advantages of unipolar:** 1. Simple mechanism to generate signal **Disadvantages of unipolar:** **1. DC component.** The average amplitude of unipolar encoded signal is not zero. It has a DC component associated with it. This dc component affets the between of the processing circuit and also the power required to transmit the signal through the media. **2. Synchronization:** A series of same kind of bits can cause a problem while decoding. When signal is not varying, the receiver cannot determine the beginning & ending of each bit. Whenever there is no signal change to indicate the start of next bit, the receiver has to depend on time. The lack of synchronization between the transmitter & receiver clock distorts the signal. This disadvantage is overcome by using parallel lines which carry clock pulse and allows receiver to synchronize with transmitter. This increases the cost & hence not used. **Advantages of NR-I:** 1. DC component is reduced because two voltage levels are present. Since 1's are represented. As a transition, synchronization is achieved for consecutive 1's. **Disadvantages of NR-I:** 2. Synchronization for consecutive 0's is not achieved. **Advantages of Biphase:** 1. At least 1 transition in 2 bit period which can be used for synchronization. 2. The waveform doesn't have DC component because every bit is encoded as +ve polarity for half bit period and –ve polarity for half bit period. 3. Error detection is easier because there is at least 1 transition for each bit. **Disadvantages of Biphase:** 1. The frequency at which transitions are taking place is high, and	**4M** ***Give 2 advantages and disadvantages of any one of the encoding techniques 1M for each point***

		hence higher bandwidth requirement. **Advantages of B8ZS:** 1. Good synchronization capability. 2. Since alternate polarity of signal is used, DC component is absent. 3. Error detection and correction is easy. **Disadvantages of B8ZS:** 1. Because alternating polarity are used, the transmission data rate increases does increasing the band width. **Advantages of HDB3:** 1. Scrambling techniques eliminate constant signal level. 2. Transitions are introduced for each 1 bit which provides synchronization. 3. DC component is almost absent. 4. Error detection is improved in a long sequence of 1s and 0s.	
	iii) **Ans.**	**Draw the waveforms of ASK and PSK with relevant examples.** ***(Note: Any other example shall be consider).*** **ASK Modulation:**  **PSK Modulation:**  	**4M** ***ASK Waveform 2M*** ***PSK Waveform 2M***

	iv) Ans.	**Draw and explain FM radio receiver.**  **Fig: FM radio receiver** **1. RF Amplifier:** Its function is To improve the signal to noise ratio. To march the receiver input impedance to antenna impedance. To reduce noise figure. **2. Mixer:** It is also known as frequency changer. Input signal frequency fsand local oscillator frequency f0 are mixed to down convert the received signal to intermediate frequency (IF). IF = f0 - fsIF = 10.7 MHz **3. IF Amplifiers:** It amplifies the IF of mixer output. Due to large bandwidth gain per stage is low. Therefore two or more stages of IF amplifiers are used. **4. Amplitude Limiter:** It removes the unwanted amplitude that added in original FM signal while travelling in free space. It is removed before demodulation, otherwise distortion appears at the output. **5. FM Detector:** It converts the FM signal into original modulating signal. **6. De-emphasis:** The artificially boosted high frequencies at transmitter are removed by de-emphasis. **7. AF and Power Amplifier:** First the modulating signal is voltage amplified and its power is increased to drive the loudspeaker. **8. AGC:** Automatic gain control is used to ensure that the signal fit to the limiter is within its limiting range and also prevents overloading	**4M** ***Diagram 2M*** ***Explanation 2M***

		of last IF amplifier. **9. Loudspeaker:** It converts modulating signal into sound information.	
4.	**b)** **i)** **Ans.**	**Attempt any one:** **Discuss the problems associated with Delta modulation in detail and explain working principle of ADM.** **SLOPE-OVERLOAD DISTORTION:** • If the slope of the analog signal x(t) is much higher (steep) than that of the approximated signal xq(t) over a long duration then xq(t) will not follow x(t) at all as shown in Figure • The difference between x(t) and xq(t) is called the **slope-overload distortion or the slope-overload error**. Thus, slope-overload error occurs when the slope of x(t) is much higher than xq(t).  Fig. Illustrating the phenomenon of slope overload in linear delta modulation **GRANULAR NOISE:** • When the input signal x(t) is relatively constant in amplitude, the approximated signal xq(t) will hunt above and below x(t) as shown in Figure. This leads to a noise called granular noise. • It increases with increase in step size δ. To reduce granular noise, the step size should be as small as possible. However, this will increase slope-overload distortion.	**6x1=6** **6M** ***Problem associated with Delta modulation 3M***

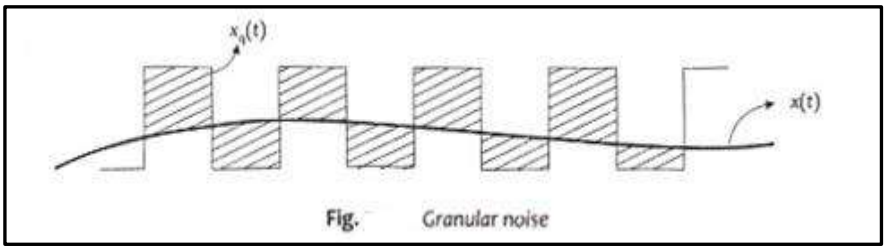
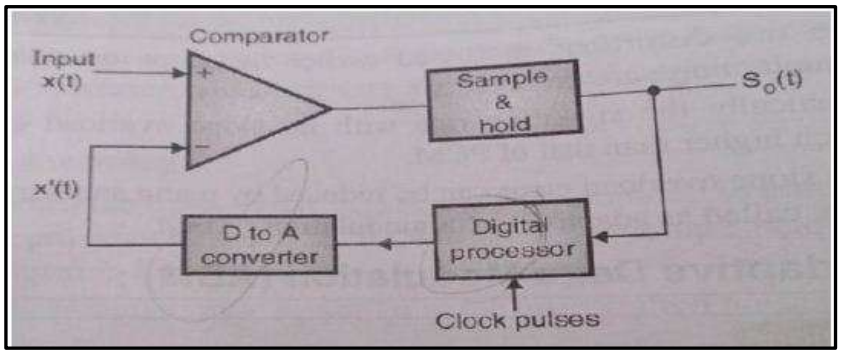
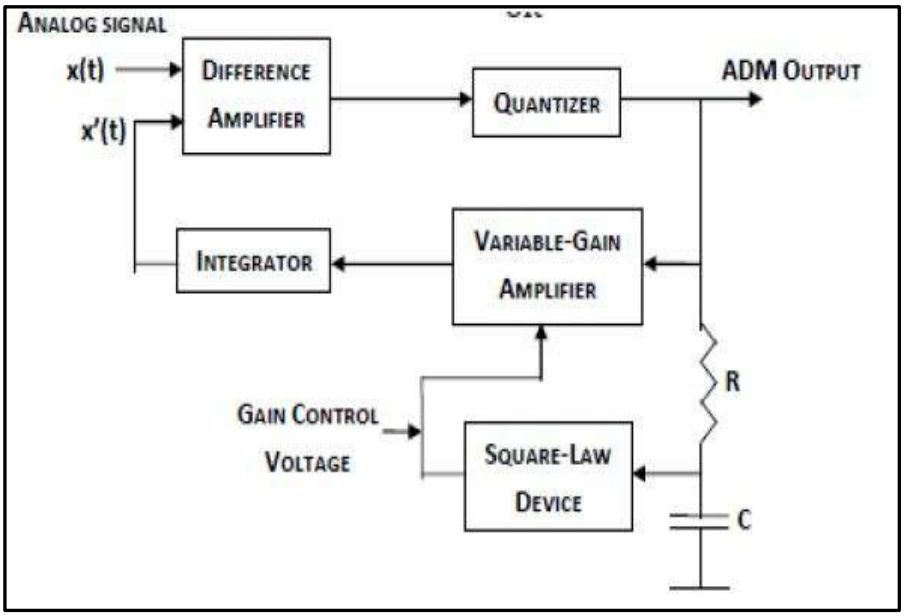


Fig. Granular noise

ADM:



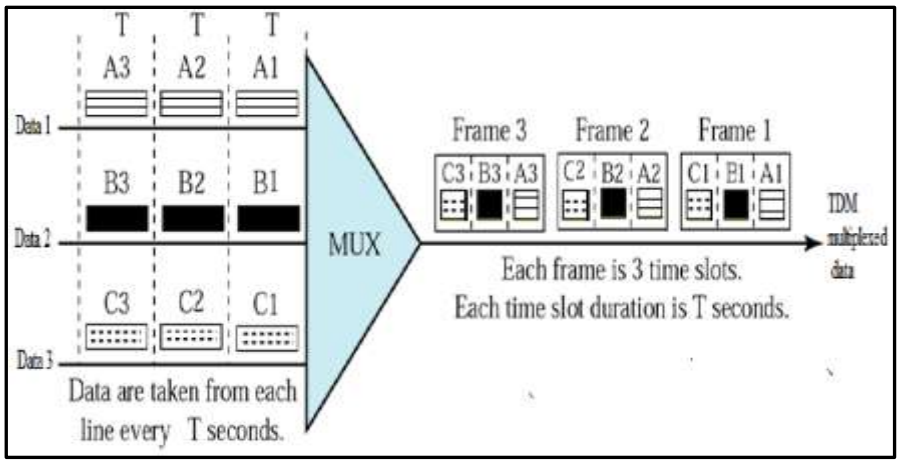
OR



Working Principle of ADM 3M

		Explanation: As shown, X (t) is the analog input signal & x' (t) is the quantized version of x(t). Both these signal are applied to comparator. Comparator output is goes high if x(t) >x'(t) & it goes low if x(t)<x'(t). Thus the comparator output is either 1 or 0.Sample & hold circuit will hold this level for entire clock cycle. In response to kthclock pulse trailing edge, a processor generates a step which is equal in magnitude to the step generated in response to the previous i.e. (k-1)th clock edge. If the direction of both the step is same then the processor will increase the magnitude of present step by delta. If the direction is opposite then the processor will decrease the magnitude of present step by delta.	
	ii) **Ans.**	**State the need of multiplexing and explain synchronous TDM with relevant sketch.** **Need of multiplexing:** In the application like telephony there are large numbers of users involved. It is not possible to lay a separate pair of wires from each subscriber to the other entire entire subscriber; this is very expensive and practically impossible. In the Process of multiplexing two or more individual signals are transmitted over a single communication channel. Here we used medium as a coaxial cable or an optical fiber cable because of multiplexing bandwidth utilization is possible. As the data and telecommunications usage increases, so does the traffic. We can accommodate this increase by continuing to add individual lines each time a new channel is needed, or we can install higher capacity links and use each to carry multiple signals. Today's technology includes high-bandwidth transmission media such as coaxial cable, optical fiber and terrestrial and satellite microwaves. Each of these has a carrying capacity (bandwidth) far in excess of that needed for the average transmission signal. If the bandwidth of the link is greater than the transmission needs of the devices connected to it, the excess capacity is wasted. An efficient system maximizes the utilization of all resources. Bandwidth is one of the most precious resources in data communications.	**6M** ***Need of multiplexing 3M***

TDMA:



OR

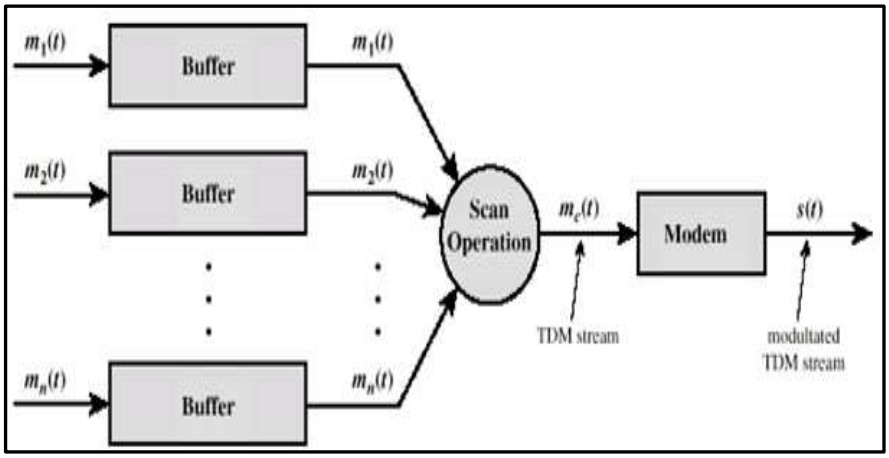
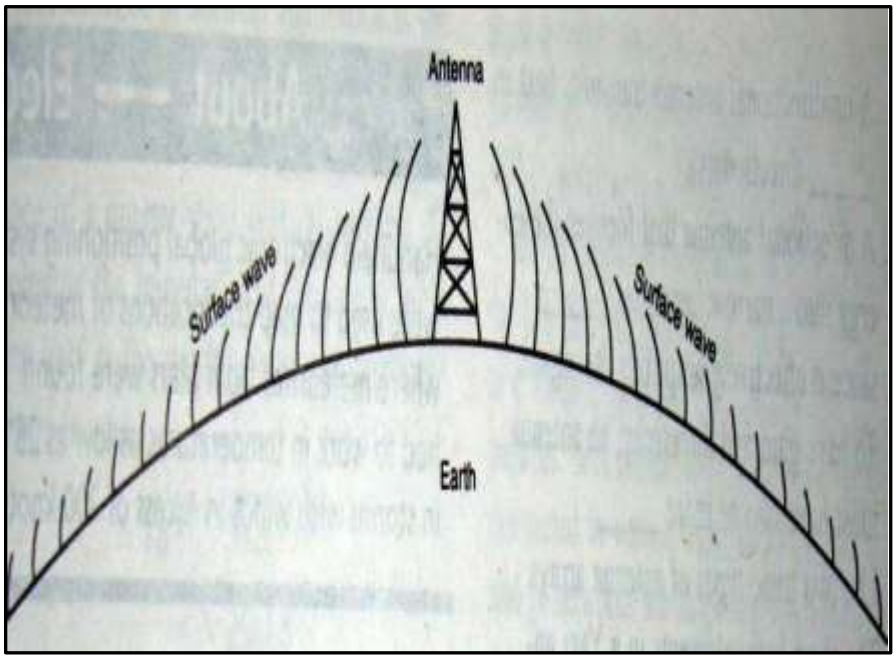


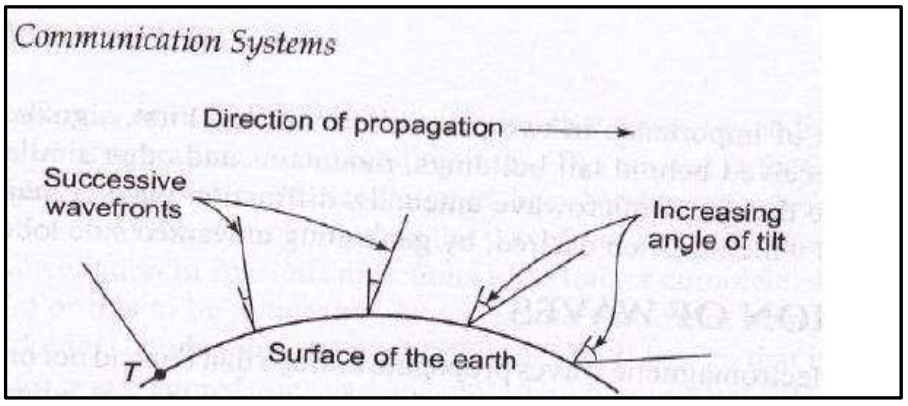
Fig: TDM Transmitter

Explanation:

- Process of combining digital signals from several sources whereby each connection occupies a portion of time in the link is called Time Division Multiplexing (TDM).
- Links are sectioned by time rather than frequency.
- Data flow of each connection is divided into units.
- In TDM data units from each input connection is collected in to a frame i.e link combines one unit of each connection to make a frame.
- If we have "n" connection a frame is divided in to "n" time slots

Synchronous TDM explanation 3M

		and one slot is allowed for each unit. i.e. *n* input connections □ *n* time slots. • One for each input line, if the duration of input is T, the duration of each slot is T/n and the duration of each frame is T. • Data rate of link must be *n* times the duration of a time slot to guarantee flow of data. • Time slots are grouped into frames; one complete cycle of time slots; each slot dedicated to one device. • A simple TDM process for three different data transmission is shown above. • Here, all three data are divided into equal timeslots also called as units. • And each data unit from all three data are combined / multiplexed together to form TDM frames comprising of small units of all three data which is further transmitted.	
5.	**a) Ans.**	**Attempt any four:** **With the help of neat sketch explain ground wave propagation.**  ***OR***	**4x4=16** **4M** ***Diagram 2M***

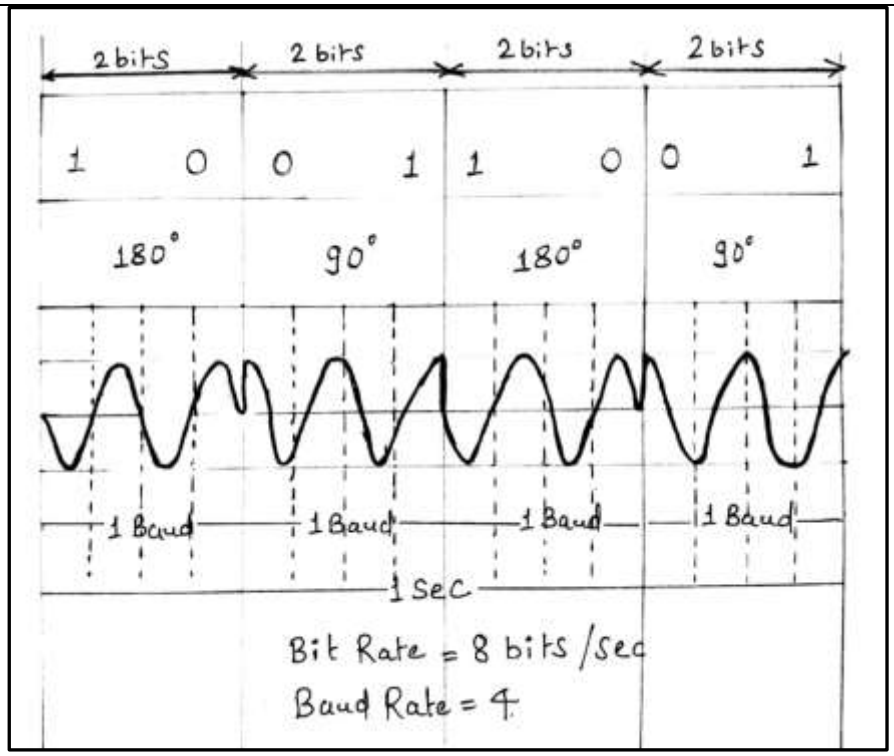
		 The ground or surface wave leaves the antenna & remains close to the earth. From above figure the ground wave will actually follow the curvature of the earth & can therefore travel of distances beyond the horizon. Ground wave propagation is strongest at the low & medium frequency ranges that are ground waves are the main signal path for the radio signals in the 30 KHz to 3 MHz range. The signals can propagate for hundreds & sometimes thousands of miles at these low frequencies. Amplitude modulation broadcast signals are propagated primarily by ground waves. At the higher frequencies beyond 3 MHz the earth begins to attenuate the radio signals. Objects on the earth & terrain features become the same order of magnitude in size as the wavelength of the signal ,will therefore absorb & otherwise affect the signal for this reason the ground wave propagation of signals above 3 MHz is insignificant except within several miles of the antenna.	***Explanation 2M***
	b) Ans.	**List advantages, disadvantages and applications of PCM.** **Advantages of PCM:** 1. PCM has very high noise immunity. 2. Repeaters can be used between the transmitter and the receiver which can further reduce the effect of noise. 3. It is possible to store the PCM signal due to its digital nature. 4. It is possible to use various coding techniques so that only the desired receiver (user) can decode the message. 5. Convenient for long distance communication. 6. High transmitter efficiency 7. Good signal to noise ratio (SNR)	**4M** ***Any 2 Advantages 2M***

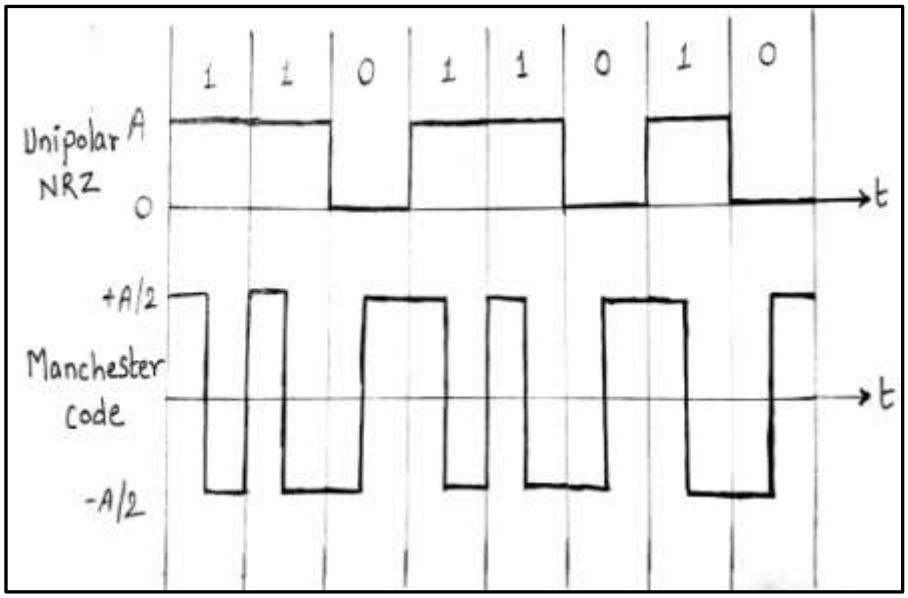
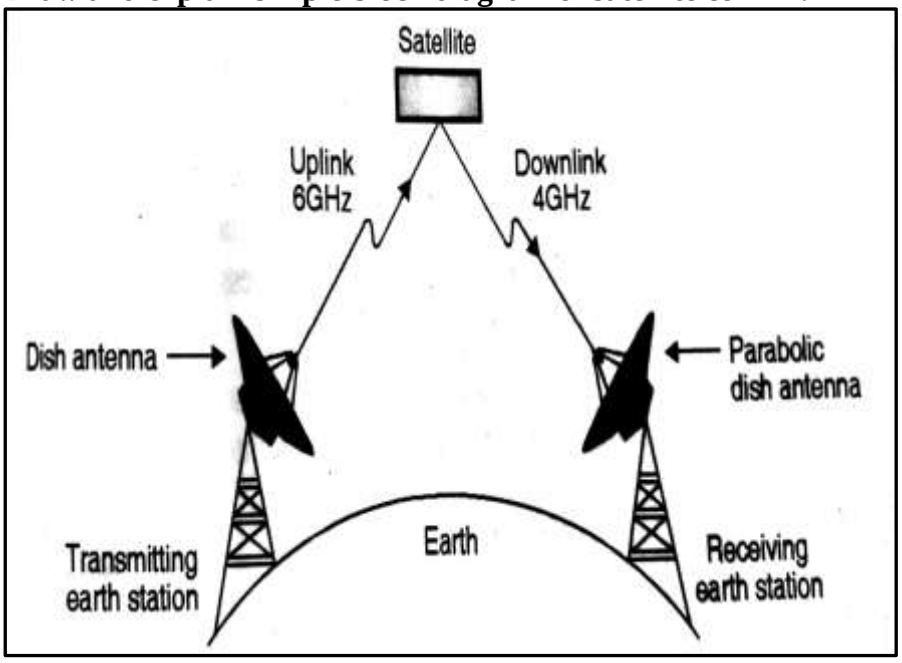
<table>
<tr>
<td></td>
<td></td>
<td>Disadvantages of PCM:
1. The encoding, decoding& quantizing circuitry of PCM is complex.
2. PCM requires a large bandwidth as compared to other systems.

Applications of PCM:
1. In space communication
2. In telephony
3. In satellite transmission system
4. The compact disc (CD) is recent application of PCM</td>
<td>Any 2 Disadvantages 1M

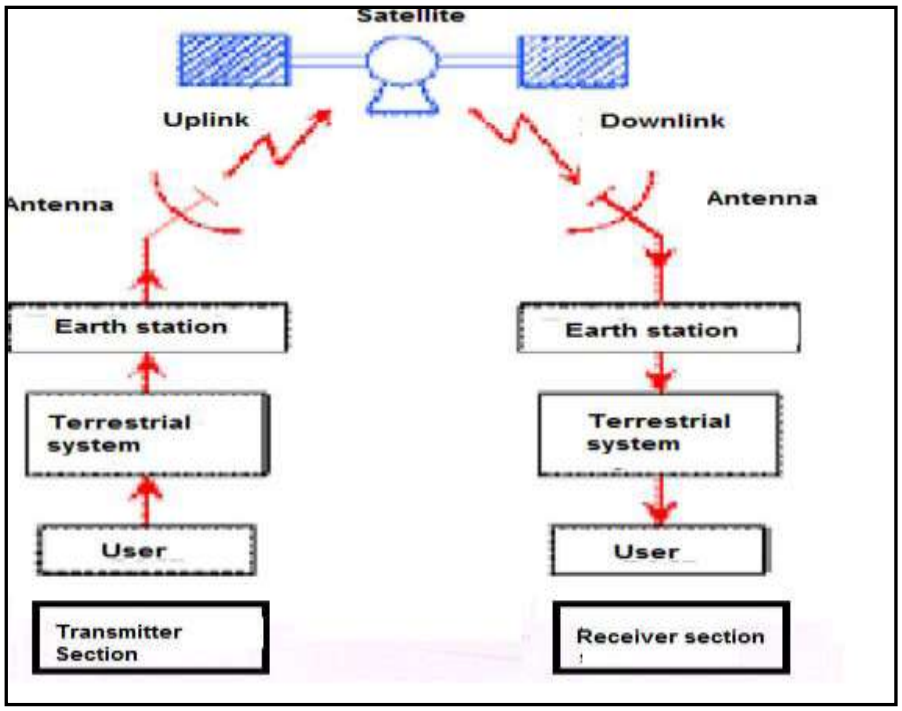
Any 2 Applications 1M</td>
</tr>
<tr>
<td></td>
<td>c) Ans.</td>
<td>Compare: Baseband transmission with passband transmission.
<table>
<tr><th>Sr No</th><th>Baseband transmission</th><th>Passband transmission</th></tr>
<tr><td>1</td><td>If the baseband signal is transmitted directly then it is called baseband transmission</td><td>If the modulated signal is transmitted over the channel it is called bandpass transmission.</td></tr>
<tr><td>2</td><td>Baseband transmission sends the information signal as it is without modulation (without frequency shifting)</td><td>Passband transmission shifts the signal to be transmitted in frequency to a higher frequency and then transmits.</td></tr>
<tr><td>3</td><td>Baseband transmission is a Bi-directional transmission</td><td>Passband transmission is a Unidirectional transmission</td></tr>
<tr><td>4</td><td>Baseband transmission is preferred for low frequencies</td><td>Passband transmission is preferred for high frequencies</td></tr>
<tr><td>5</td><td>Baseband transmission can travel short distances</td><td>Passband transmission can travel long distances.</td></tr>
<tr><td>6</td><td>Baseband transmission usually used when communicating over wires such as computer data or computer networks</td><td>Passband transmission usually used when communicating over the air transmission such as microwave or satellite link</td></tr>
</table></td>
<td>4M

Any 4 comparison points 1M Each</td>
</tr>
<tr>
<td></td>
<td>d) Ans.</td>
<td>Draw QPSK signal for data: 10011001. State advantages of QPSK.</td>
<td>4M</td>
</tr>
</table>

		 **Advantages of QPSK:** 1. The bandwidth reduction to half as compared to BPSK 2. Due to reduction in bandwidth, information transmission rate is higher 3. Carrier power almost remains constant. 4. Very good noise immunity 5. Low error Probability 6. Baud rate is half the bit rate therefore more effective utilization of the available bandwidth of transmission channel.	***Draw QPSK signal 2M*** ***Any 2 Advantages 1M each***
	e) **Ans.**	**Encode the data stream 11011010 using following encoding techniques.** **i) Unipolar NRZ** **ii) Manchester Code.**	**4M**

			***Correct Encoding for Unipolar NRZ 2M*** ***Manchester Code 2M***
	f) Ans.	**Draw and explain simple block diagram of satellite comm^{n}.**  **Fig: Basic operation of satellite communication system**	**4M** ***Block Diagram 2M***

OR



A satellite is any natural or artificial object located in space, capable of receiving and retransmitting electromagnetic waves.

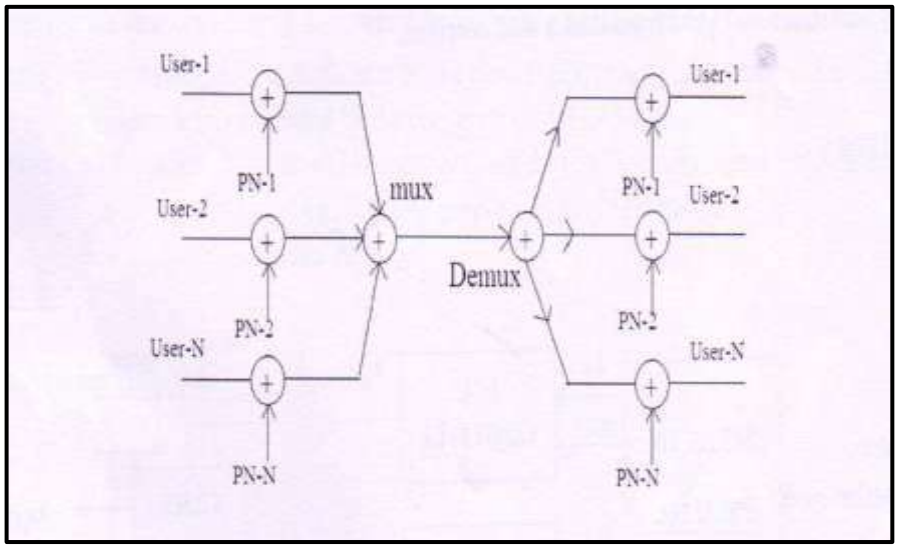
Transmitter

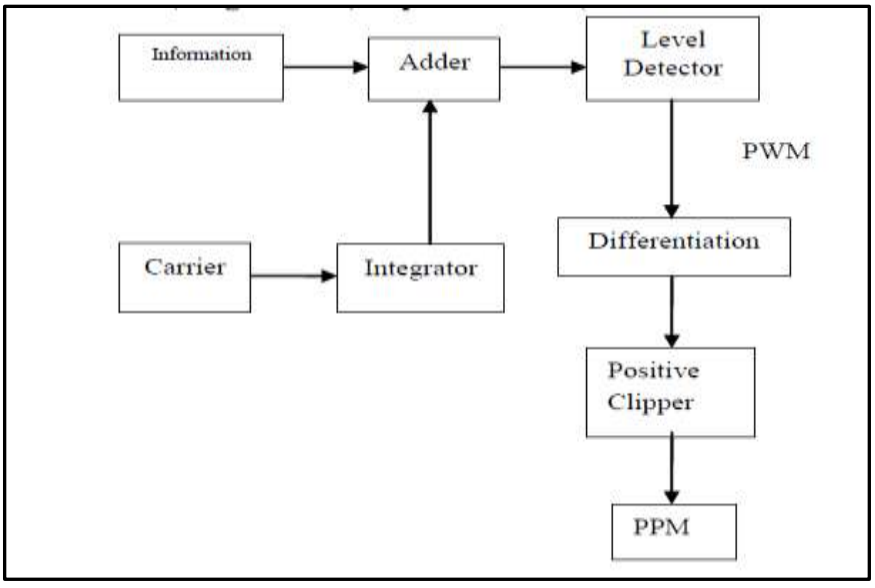
The satellite communication system consists of a satellite that links many earth stations on the ground. When the user is connected to earth station through a terrestrial network (telephone or leased line) the user generates baseband signal, processes & transmits to the satellite at the earth station.

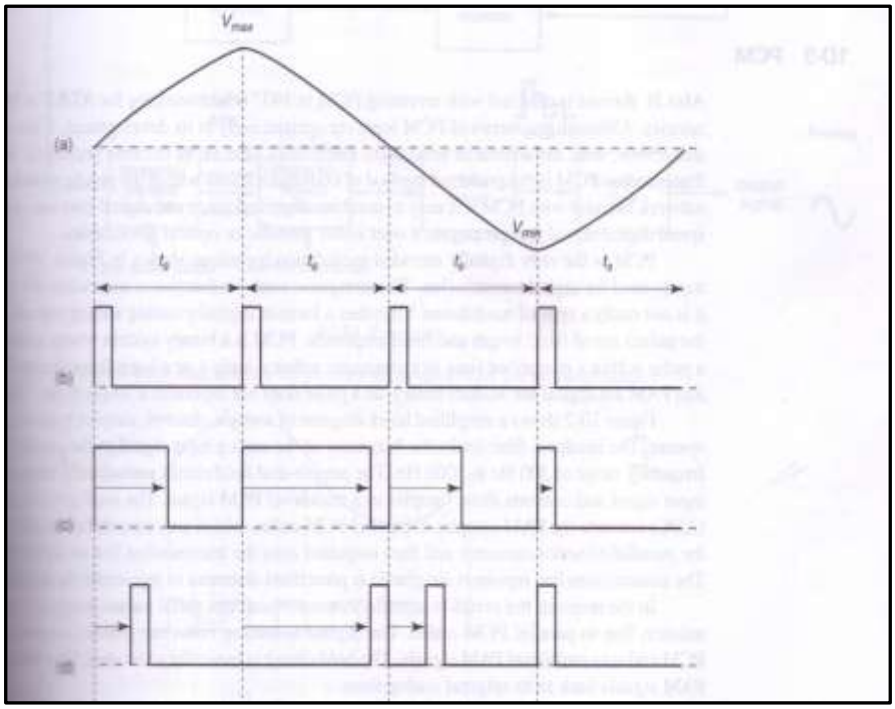
Explanation 2M

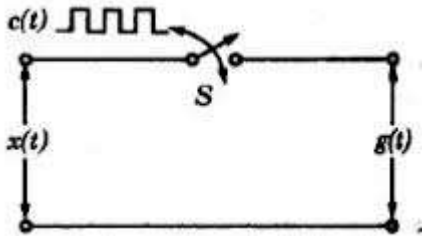
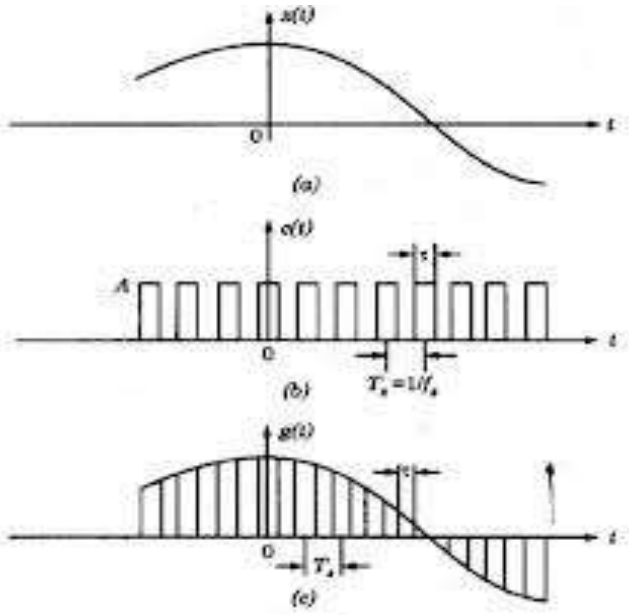
Satellite

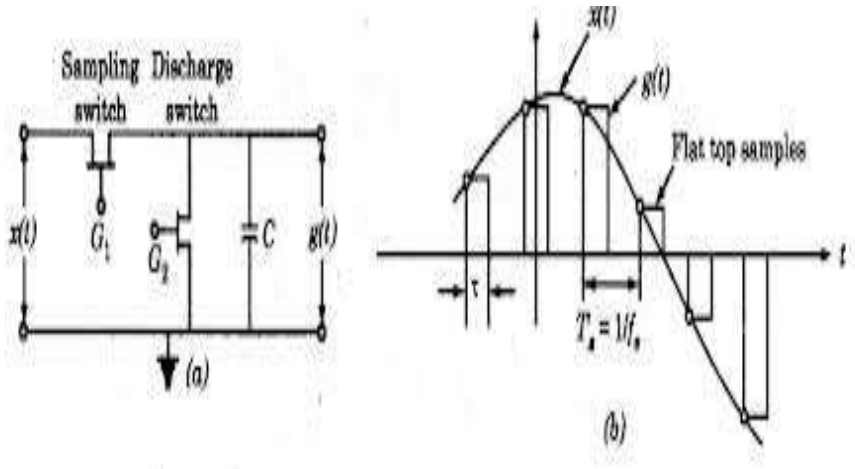
It is a large repeater in space. It receives the modulated RF carrier in uplink frequency spectrum from all the earth station in the network. The frequency used for transmission from earth station to space (satellite) is called uplink frequency. The satellite amplifies this carrier & retransmits them to the earth in the down link frequency spectrum. The frequency used for transmission from space to earth (satellite to earth station) is called down link frequency. The uplink &

		downlink frequency are made different in order to avoid interference of these signal is space. **Receiver** The earth station receives signal from satellite this signal is processed to get the original baseband signal which is then send to the user through terrestrial network	
6.		**Attempt any four:**	**4x4=16**
	a)	**Define uplink and downlink with respect to satellite communication system.** ***(Note: Uplink & Downlike block diagram may also be drawn)***	**4M**
	Ans.	**Uplink:** The signal is transmitted "up" towards the satellite. It is the range of frequencies transmitted from a ground station up to satellite is called up link frequency. The uplink frequency corresponding higher than downlink frequency. **Downlink:** The satellite receives signal coming from the earth station, amplifiesit, and changes its frequency and radiates back to the earth. It is the range of frequencies transmitted from a satellite down to one or more ground station/receivers.	***Each Definition 2M***
	b)	**Explain working principle of CDMA and list its applications.**	**4M**
	Ans.	 • CDMA system uses same frequency band and transmit simultaneously. They can use the whole available bandwidth for all	***Working Principle 2M***

		the time. The transmitted signal is recovered by co-relating the received signal with the PN code used by the transmitter. • CDMA allows all the users to occupy all channels at the same time. Transmitted signal is spread over the whole band and each voice or data call is assigned a unique code to differentiate it from other calls carried over the space spectrum. • All the users in CDMA use same carrier and may transmit simultaneously. Each user has its own pseudorandom code word which is unique for each channel. For detection of message signal the receiver needs to know the code word use by transmitter. Each user operates independently with no knowledge of other users. **Applications:** 1. It is used in military and some commercial application. 2. It is used in mobile communication. 3. It is used in radar and navigation systems. 4. It is widely used in defense communication system.	***Applications 2M***
	c) Ans.	**Describe generation of PPM from PWM with diagram.**  **Pulse position modulation (PPM)** It is the process of modulation in which the position of the carrier is	**4M** ***Diagram 2M***

		varied in accordance to the instantaneous voltage of the modulating signal keeping the carrier width and amplitude constant. PPM Signal is obtained from PWM signal. In PWM, the Positive or the leading edge appears after fixed interval of time. But the negative edge of the trailing edge does not appear after a fixed interval of time. It appears after time propagation to the width of the pulse. The width of the pulse is proportional to the modulating signal at that instance. Thus the position of the trailing edge is proportional to the instantaneous voltage of the modulating signal. **To obtained PPM from PWM** The trains of PWM pulses are given to the differential whose output is proportional to differential input which produces positive and negative spikes. The positive spikes are equidistant and negative spikes are position modulated. The positive spikes are removed by a positive chipper and the negative spikes represent the PPM signal. 	***Description 2M***
	d)	**Explain natural sampling and flat top sampling with relevant waveforms.**	**4M**

	Ans.	**1. Natural Sampling or Chopper Sampling** Natural Sampling is a practical method of sampling in which pulse have finite width equal to T. Sampling is done in accordance with the carrier signal which is digital in nature.  With the help of functional diagram of a Natural sampler, a sampled signal g(t) is obtained by multiplication of sampling function c(t) and the input signal x(t). Spectrum of Natural Sampled Signal is given by: $G(f) = A\tau / T_s .[\Sigma \sin c(n f_s.\tau) X(f-n f_s)]$  **Natural Sampled Waveform**	***Natural Sampling explanation& Waveform 2M***

		2. Flat Top Sampling or Rectangular Pulse Sampling Flat top sampling is like natural sampling i.e; practical in nature. In comparison to natural sampling flat top sampling can be easily obtained. In this sampling techniques, the top of the samples remains constant and is equal to the instantaneous value of the message signal x(t) at the start of sampling process. Sample and hold circuit is used in this type of sampling.  Figure (a) shows functional diagram of a sample hold circuit which is used to generate fat top samples. Figure (b) shows the general waveform of the flat top samples. It can be observed that only starting edge of the pulse represent the instantaneous value of the message signal x(t) **Spectrum of Flat top Sampled Signal is given by:** $G(f) = f_s .[\Sigma X(f-n f_s). H(f)]$	***Flat top sampling explanation & Waveform 2M***
	e) **Ans.**	**An AM transmitter produces 10KW power with the modulation percentage of 75. Calaculate carrier power and power in side bands.** **Formula** Total Power (Pt) = $Pc[1+m^2/2]$ Power in Sideband= $P_{USB}=P_{LSB}= (m^2/4) Pc$ Given data	**4M** ***Formula 1M***

		Pt = 10KW m = $\frac{100}{75}$ = 0.75 pt = pc $\left[1 + \frac{m^2}{2}\right]$ 10 X 10^3 = pc $\left[1 + \frac{(0.75)^2}{2}\right]$ 10 X 10^3 = pc $\left[1 + \frac{0.5625}{2}\right]$ 10 X 10^3 = pc [1 + 0.28125] 10 X 10^3 = pc [1.28125] pc = $\frac{10 \text{ X } 10^3}{1.28125}$ pc = 7804.87W = 7.804KW pc = 7.804KW power in sideband $P_{USB} = P_{LSB} = \frac{m^2}{4}$ X pc = $\frac{(0.75)^2}{4}$ X 7.804 X 10^3 = 0.14062 X 7.804 X 10^3 $P_{USB} = P_{LSB}$ = 1097.39W = 1.097KW $P_{USB} = P_{LSB}$ = 1.097KW Carrier power = pc = 7.804KW Power in side bands = $P_{USB} = P_{LSB}$ = 1.097KW	***Carrier power calculation 2M*** ***Sideband power calculation 1M***