MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)

SUMMER – 2019 EXAMINATION
MODEL ANSWER

Subject: Data communication **Subject Code: 22322**

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 more Importance (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.		**Attempt any FIVE of the following:**	**10**
	(a) **Ans.**	**Define Protocol. State key elements of Protocol.** A protocol is defined as "a set of rules that governs the communication between computers on a network". The key elements of protocol are as follows: 1.Syntax 2.Semantics 3.Timing	**2M** ***Definition 1M*** ***Any two elements 1/2M each***
	(b) **Ans.**	**List different types of guided media.** The different types of guided media are 1. Twisted pair cable 2. Co-axial cable. 3. Fiber -optic cable	**2M** ***Any two types 1M each***
	(c) **Ans.**	**Define line of sight propagation.** Line of sight propagation is a characteristic of electromagnetic radiation or acoustic wave propogation which means waves travel in	**2M**

		a direct path from the source to the receiver .Electromagnetic transmission includes light emissions travelling in a straight line. The rays or waves may be diffracted, refracted, reflected or absorbed by atmosphere an obstructions with material and generally cannot travel over the horizon or behind obstacles.	***Correct definition 2M***
	(d) Ans.	**Define multiplexing. List its type.** Multiplexing is the process in which multiple data streams, coming from different sources, are combined and transmitted over a single data channel or data stream. The following three major multiplexing techniques are discussed: • Frequency division multiplexing • Wavelength division multiplexing • Time division multiplexing	2M ***Definition 1M*** ***Types 1M***
	(e) Ans.	**Define switching. List its types.** The process by which nodes forward data at one of its inputs to one of its outputs is known as switching. The types of switching are: 1. Circuit Switching 2. Packet switching	2M ***Definition 1M*** ***Types ½M each***
	(f) Ans.	**List any four functions of Data link layer.** The functions of Data link layer are as follows: 1. Link establishment and termination 2. Physical addressing 3. Frame sequencing 4. Frame Acknowledgment 5. Error control 6. Flow control	2M ***Any four function ½M each***
	(g) Ans.	**Enlist various IEEE standards for wireless communication. (any four)** The various IEEE standards for wireless communication are as follows: • 802.11 • 802.11a • 802.11b • 802.11n • 802.11ac	2M ***Any four standards ½M each***

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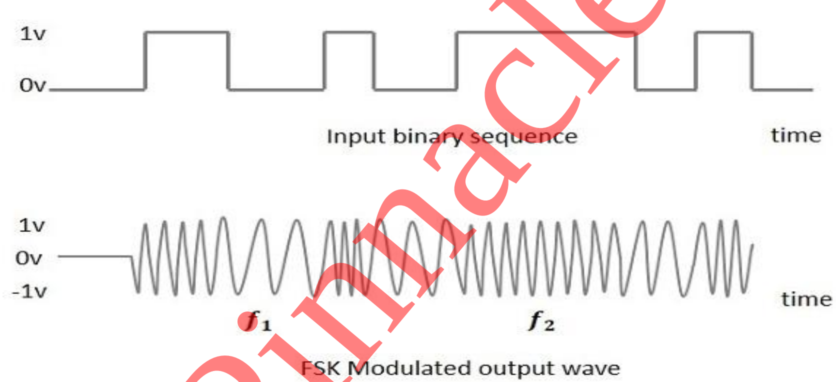
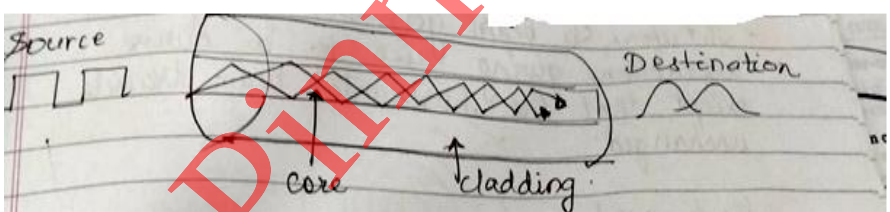
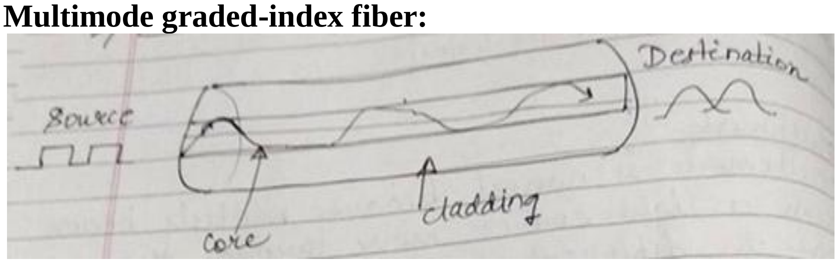
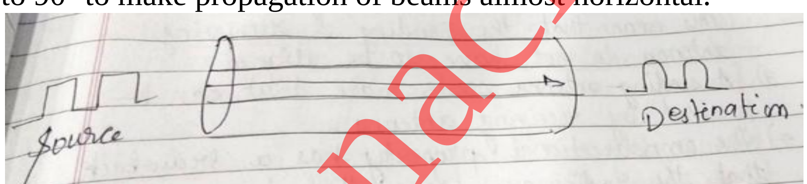
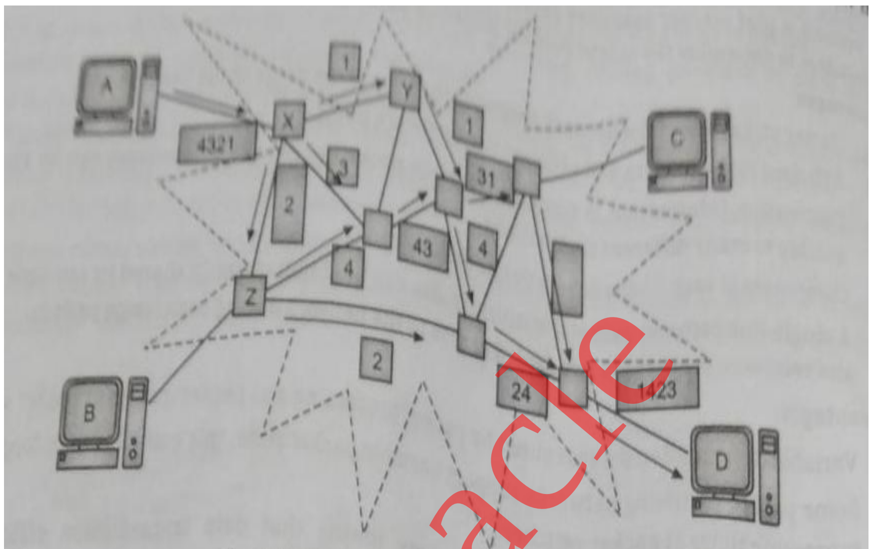
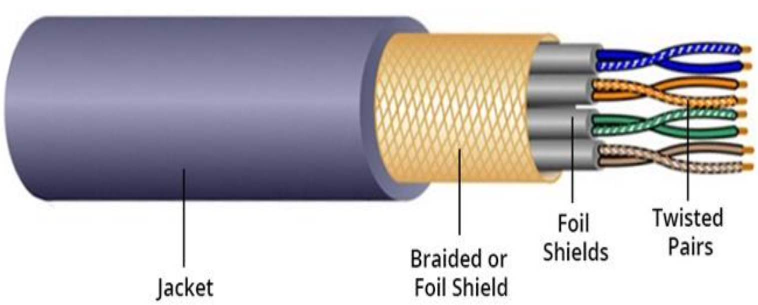
2.		**Attempt any THREE of the following:**	12
	(a) Ans.	**Explain the process of FSK modulation with diagram.** In FSK, frequency of sinusoidal carrier is shifted between two discrete values. One of these frequencies (f_1) represents a binary 1 and other value (f_2) represents binary 0.There is no change in amplitude of carrier. It consists of voltage controlled oscillators (VCO) which produce sinewaves at frequencies f_1 and f_0. Corresponding to "binary 0 "input, the VCO produces a sinewave of frequency f_0 whereas corresponding to binary 1 input VCO produces a sinewave of frequency f_1. 	4M *Explanation 2M* *Diagram 2M*
	(b) Ans.	**Explain any four standard organizations.** 1. ISO (International organization for standardization: The ISO is a multinational body whose membership is drawn mainly from the standards creating committees of various governments throughout the world. The ISO is active in developing cooperation in the realms of scientific, technological and economic activity. 2. International Telecommunication Union-Telecommunication Standards Sector (ITU-T): The United nations responded by forming as part of its International Telecommunication Union (ITU), a committee the consultative Committee for International Telegraphy and Telephony (CCITT). This committee was devoted to research and establishment of standards for telecommunications in general and for phone and data systems. 3. American National Standards Institute (ANSI): ANSI is private non-profit organization affiliated with U.S. federal government.	4M *Any four standard organizations 1M each*

		All ANSI activities are undertaken for the welfare of the united states and its citizen occupying primary importance. 4. Institute of Electrical and Electronics engineers (IEEE): IEEE is the largest professional engineering society in the world International in scope, it aims to advance theory, creativity, and product quality in the fields of electrical engineering, electronics and radio as well as in all related branches of engineering. 5. Electronic Industries Association (EIA): Aligned with ANSI, EIA is a nonprofit organization devoted to the promotion of electronics manufacturing concerns. Its activities include public awareness education and lobbying efforts in addition to standards development.	
	(c) **Ans.**	**Explain propagation modes in fiber optic cable with neat diagram.** The different propagation modes in fiber optic cable are as follows: • **Multimode step index fiber**: In multimode step index fiber, the core has one density and the cladding has another density.  Therefore at the interface, there is a sudden change that is why it is called step index. Multiple beams take different paths on reflection as shown in figure. The beam that strikes core at a smaller angle that has to be reflected many more times than the beam that shifted the core at a larger angle to reach other end. This means that at the destination, all beams do not reach simultaneously. It is used for short distances. • **Multimode graded-index fiber:** 	**4M** ***Explanation 2M*** ***Diagram 2M***

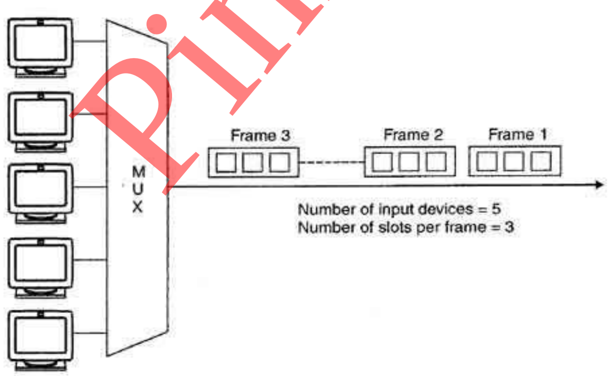
		• In this, core itself is made of a material of varying densities. • The density is the highest at the core and gradually decreases towards the edge. • Therefore, a beam gas through gradual refraction giving rise to a curve except that the horizontal beam travels unchanged. • **Single-mode:** • It uses step-index fiber and a highly focused source of light that limits beam to a small range of angles, all close to horizontal. • It is manufactured with much smaller diameter than that of multimode fiber and with substantially lower density. • The decrease in density results in a critical angle i.e. close enough to 90^0 to make propagation of beams almost horizontal. 	
	(d) Ans.	**Explain datagram approach for packet switching.** In the datagram approach of packet switching, each packet is considered as a totally independent packet from all others. Even when there are multiple packets sent by the same source to same destination for the same message, each packet is independent of all other packets from point of view of network and can follow different path. Figure Illustrate packet switching in datagram networks approach. Hence, computer A is sending four packets to another computer D. These four packets belong to the same original message, but travel via different routes and also can arrive at the destination D in a different order than how the source A has sent them.	**4M** ***Explanation 3M***

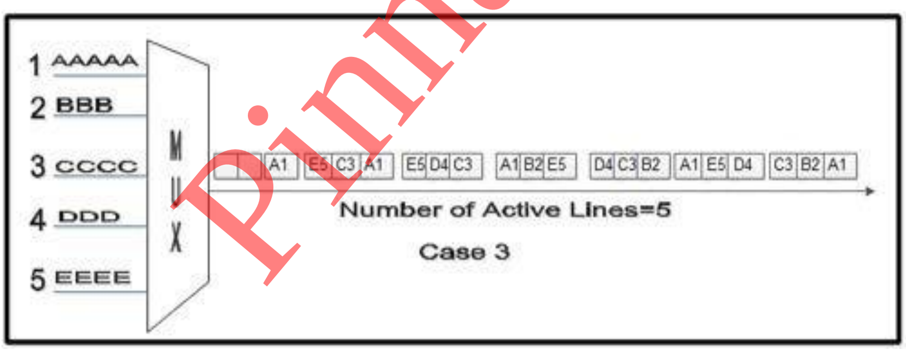
		 **Fig: Datagram Networks Approach** • Therefore, the destination node needs to have a buffer memory to store all the packets and resequence them to form original message. • Figure shows a datagram networks approach. • It is obvious that each packet must have a header containing the source and destination address, packet number, the CRC etc. • The reasons that the packet travel via. different routes is that the routing decisions are taken for every packets separately, each time at every node, as the packet travels from one node to the next.	***Diagram 1M***
3.	**(a)** **Ans.**	**Attempt any THREE of the following:** **Calculate the baud rate for the given bit rate and type of modulation:** **(i) 5000 bps, ASK (ii) 4000 bps, FSK** For baud rate (S), we know that the formula is: S=N/r. N = S * r Here, N is Bit rate, S is the Baud rate r = number of bits in signal elements So, at first we need to calculate r for each case. We know, $r = \log_2 L$.	**12** **4M** ***Each bit 2M***

		i)For ASK, $r = \log_2 2 = 1$ S=5000 bps/1=5000 baud ii) For FSK, $r = \log_2 2 = 1$ S=4000bps/1=4000 baud	
	(b) **Ans.**	**Explain the construction of Shielded Twisted Pair Cable.** STP is similar to UTP but with each pair covered by an additional copper braid jacket or foil wrapping. This shielding helps to protect the signals on the cables from external interference. Shielding provides a means to reflect or absorb electric fields that are present around cables. Shielding comes in a variety of forms from copper braiding or copper meshes to aluminized. STP is more expensive than UTP but has the benefit of being able to support higher transmission rates over longer distances. STP is heavier and more difficult to manufacture, but it can greatly improve the signaling rate in a given transmission scheme Twisting provides cancellation of magnetically induced fields and currents on a pair of conductors. Magnetic fields arise around other heavy current-carrying conductors and around large electric motors. Various grades of copper cables are available, with Grade 5 being the best and most expensive. STP is used in IBM token ring networks.  **Figure: Construction of Shielded Twisted Pair**	**4M** ***Explanation 2M*** ***Diagram 2M***

	(c) Ans.	**Five channels each with 200kHz bandwidth are multiplexed using FDM. Find minimum bandwidth of the link if guard band of 10kHz is used.** Five channels each with 200 kHz bandwidth are multiplexed using FDM. For five channels, we need at least four guard bands. Guard Bands of 10 KHz is used. This means that the required bandwidth is atleast **5*200+4*10=1040 KHz.**	4M ***Correct answer 4M***
	(d) Ans.	**Assuming odd parity, find the parity bit for each of the following data unit:** **(i) 1011010 (ii) 0010110** **(iii) 1001111 (iv) 1100000** Odd parity refers to number of '1' present in a byte to be transmitted should be odd. **(i) 1011010:** Step 1: Count the number of '1's in the byte Answer: 4 Step 2: compute the parity bit Answer: 1011010 1 Since the total number of 1's is 4, the odd parity will have a value of '1'. **(ii) 0010110:** Step 1: Count the number of '1's in the byte Answer: 3 Step 2: compute the parity bit Answer: 0010110 0 Since the total number of 1's is 3,the odd parity will have a value of '0'. **(iii) 1001111:** Step 1: Count the number of '1's in the byte Answer: 5 Step 2: compute the parity bit Answer: 1001111 0 Since the total number of 1's is 5, the odd parity will have a value of '0'.	4M ***Each bit 1M***

		(iv)1100000: Step 1: Count the number of '1's in the byte Answer: 2 Step 2: compute the parity bit Answer: 1100000 1 Since the total number of 1's is 2, the odd parity will have a value of '1'.	
4.	**(a)** **Ans.**	**Attempt any THREE of the following:** **A signal carries five bits in each signal element. If 1600 signal elements are sent per second, find the baud rate and bit rate in kbps.** Baud rate is number of signal elements per second. Bit rate is the number of bits per second. We also know that S=N/r where S is the baud rate, N is the bit rate and r is the bits in each signal element. In this case 1600 signal elements are sent per second. So baud rate is 1600. Now S=1600,r=5 and N is unknown. **So N=S*r=1600*5=8000 bps or 8 kbps.** Therefore the bit rate is 8kbps.	**12** **4M** ***Baud rate 2M*** ***Bit rate 2M***
	(b) **Ans.**	**Explain the reason for using different frequency bands for uplink and downlink in satellite communication.** The uplink frequency is the frequency which is used for transmission of signals from earth station transmitter to the satellite. The downlink frequency is the frequency which is used for transmission of signals from the satellite to the earth station receiver. Uplink frequency is different from downlink frequency for following reason: • The satellite transmitter generates a signal that would jam its own receiver; if both uplink and downlink shared the same frequency. • Trying to receive and transmit an amplified version of the same uplink waveform at same satellite will cause unwanted feedback or ring around from the downlink antenna back into the receiver. • Frequency band separation allows the same antenna to be used for both receiving and transmitting, simplifying the satellite	**4M** ***2 reasons-2M each***

		hardware. • To overcome the above-mention difficulties satellite repeaters must involve some form of frequency translation before power amplification. So, Uplink frequency is different from downlink frequency.	
	(c) Ans.	**Explain the process of asynchronous TDM with example.** **Asynchronous TDM:** 1. It is also known as statistical time division multiplexing. 2. Asynchronous TDM is called so because is this type of multiplexing, time slots are not fixed *i.e.* the slots are flexible. 3. Here, the total speed of input lines can be greater than the capacity of the path. 4. In synchronous TDM, if we have *n* input lines then there are *n* slots in one frame. But in asynchronous it is not so. 5. In asynchronous TDM, if we have *n* input lines then the frame contains not more than *m* slots, with *m* less than *n* $(m < n)$. 6. In asynchronous TDM, the number of time slots in a frame is based on a statistical analysis of number of input lines.  Asynchronous TDM 7. In this system slots are not predefined, the slots are allocated to any of the device that has data to send. 8. The multiplexer scans the various input lines, accepts the data from the lines that have data to send, fills the frame and then sends the frame across the link. 9. If there are not enough data to fill all the slots in a frame, then the frames are transmitted partially filled.	4M *Explanation 2M*

		Example: Asynchronous Time Division Multiplexing is depicted in fig. Here we have five input lines and three slots per frame. 1. In Case 1, only three out of five input lines place data onto the link i.e. number of input lines and number of slots per frame are same. 2. In Case 2, four out of five input lines are active. Here number of input line is one more than the number of slots per frame. 3. In Case 3, all five input lines are active. In all these cases, multiplexer scans the various lines in order and fills the frames and transmits them across the channel. The distribution of various slots in the frames is not symmetrical. In case 2, device 1 occupies first slot in first frame, second slot in second frame and third slot in third frame.  	*Example 2M*
	(d) Ans.	**Explain the process of Checksum with example.** **Checksum:** Checksum is an error detection method. Error detection using checksum method involves the following steps- **Step-01:** At sender side, • If m bit checksum is used, the data unit to be transmitted is divided into segments of m bits. • All the m bit segments are added. • The result of the sum is then complemented using 1's complement arithmetic.	4M *Explanation 2M*

- The value so obtained is called as checksum.

Step-02:

- The data along with the checksum value is transmitted to the receiver.

Step-03:

At receiver side,

- If m bit checksum is being used, the received data unit is divided into segments of m bits.
- All the m bit segments are added along with the checksum value.
- The value so obtained is complemented and the result is checked.

Then, following two cases are possible-

Case-01: Result = 0

If the result is zero,

- Receiver assumes that no error occurred in the data during the transmission.
- Receiver accepts the data.

Case-02: Result ≠ 0

If the result is non-zero,

- Receiver assumes that error occurred in the data during the transmission.
- Receiver discards the data and asks the sender for retransmission.

Checksum Example:

Example 2M

Consider the data unit to be transmitted is-
10011001111000100010010010000100
Consider 8 bit checksum is used.

Step-01:

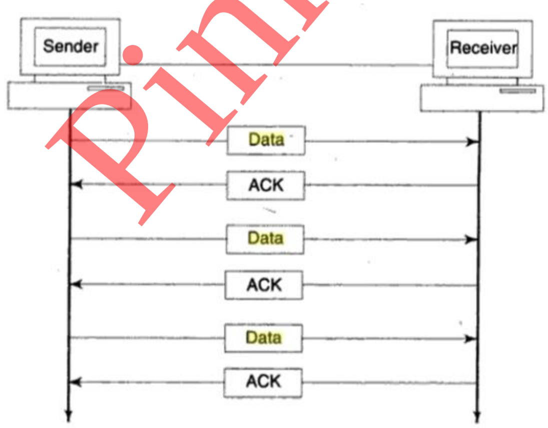
At sender side,
The given data unit is divided into segments of 8 bits as-

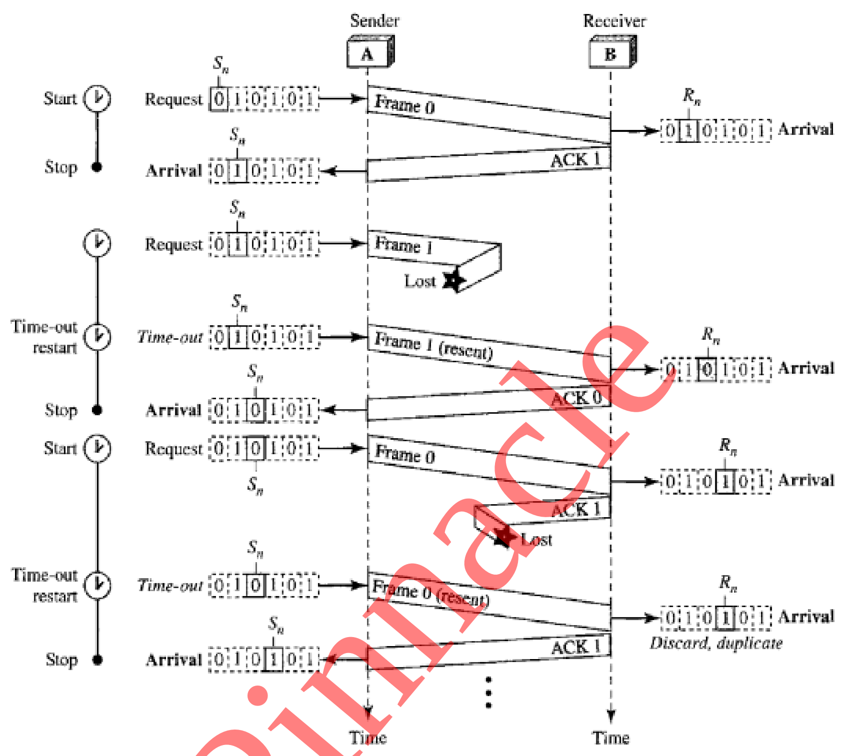
10011001	11100010	00100100	10000100

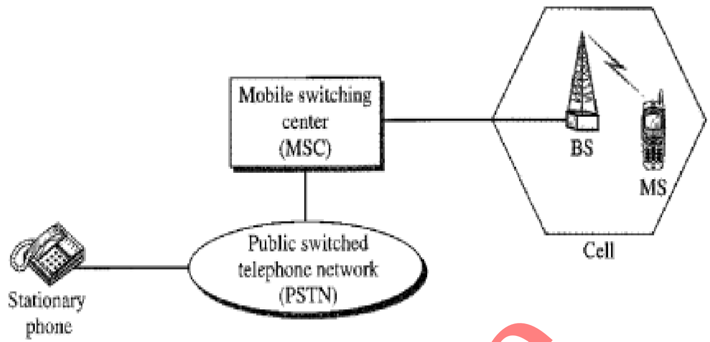
Now, all the segments are added and the result is obtained as-

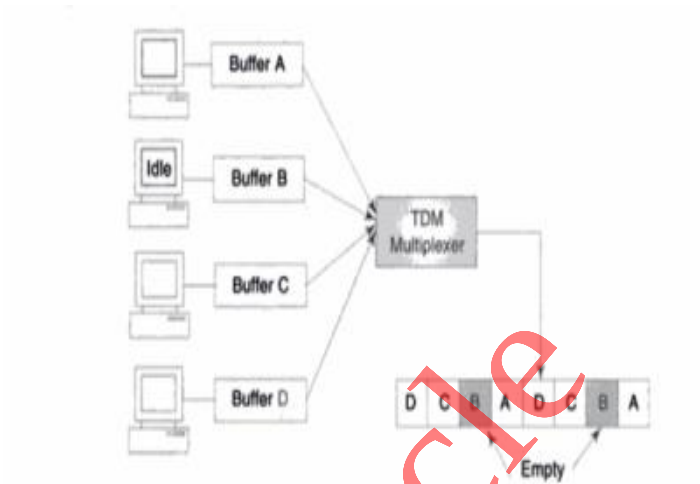
		• 10011001 + 11100010 + 00100100 + 10000100 = 1000100011 • Since the result consists of 10 bits, so extra 2 bits are wrapped around. • 00100011 + 10 = 00100101 (8 bits) • Now, 1's complement is taken which is 11011010. • Thus, checksum value = 11011010 Step-02: • The data along with the checksum value is transmitted to the receiver. Step-03: At receiver side, • The received data unit is divided into segments of 8 bits. • All the segments along with the checksum value are added. • Sum of all segments + Checksum value = 00100101 + 11011010 = 11111111 • Complemented value = 00000000 • Since the result is 0, receiver assumes no error occurred in the data and therefore accepts it.	
	(e) Ans.	**In Bluetooth communication calculate the length of frame for following scenarios:** **(i) Three slot (ii) Five slot** **Assume data rate = 1 mbps** In Bluetooth communication, when the link speed or data rate is 1Mbps each slot length is 625µs or 1600 hops/sec Packets can be of 1, 3, 5 slots. i) Since each slot length is 625µs, Total length of the frame containing three slots is 625*3=1875µs, Or 1600*3=4800 hops/sec ii) Since each slot length is 625µs, Total length of the frame containing five slots is 625*5=3125µs, Or 1600*=8000 hops/sec.	4M *Each bit 2M*
5.	(a) Ans.	**Attempt any TWO of the following:** **Explain Microwave transmission with its advantages and disadvantages.**	12 6M

		Microwave: Electromagnetic waves having frequencies between 1 and 300GHz are called microwaves. Microwaves are unidirectional. When an antenna transmits microwave waves, they can be narrowly focused. This means that the sending and receiving antennas need to be aligned. The unidirectional property has an obvious advantage. A pair of antennas can be aligned without interfering with another pair of aligned antennas. The following describes some characteristics of microwave propagation: • Microwave propagation is line-of-sight. • Very high-frequency microwaves cannot penetrate walls. This characteristics can be a disadvantage if receivers are inside buildings. • The microwave band is relatively wide, almost 299 GHz. Therefore wider subbands can be assigned, and a high data rate is possible. • Use of certain portions of the band requires permission from authorities **Applications:** Microwaves, due to their unidirectional properties, are very useful when unicast (one-to-one) communication is needed between the sender and the receiver. They are used in cellular phones, satellite networks, and wireless LANs.	***Explanation 4M***
		Advantages: • Installation of towers and associated equipments is cheaper than laying down a cable of 100KM length. • Less maintenance as compared to cables. • Repeaters can be used. So effect of noise is reduced. • No adverse effects such as cable breakage. • Due to the use of highly directional antenna no interference is there. • Size of transmitter and receiver reduces due to the use of high frequency. **Disadvantages:** • Signal strength at the receiving antenna reduces due to multipath reception.	***Any two advantages and disadvantages 1M each***

		• The transmission will be affected by the thunderstorms and other atmospheric phenomenon.	
	(b) Ans.	**Explain stop and wait ARQ with example.** **Stop and Wait:** This is a very simple method where in the sender sends one frame of data and necessarily waits for an acknowledgement (ACK) from the receiver before sending the next frame. Only after the sender receives and acknowledgement for a frame does it send the next frame. Thus, the transmission always takes the form Data-ACK-Data-ACK….etc, where the Data frames are sent by the sender, and the ACK frames are sent by the receiver back to the sender. This is shown in figure. The stop-and wait- approach is pretty simple to implement. Every frame must be individually acknowledged before the next frame can be transmitted. However, therein also lies its drawback. Since the sender must receive each acknowledgement before it can transmit the next frame, it makes the transmission very slow.  **Example:**	**6M** ***Explanation 3M***

		 	*Example 3M*
	(c) **Ans.**	**Draw and explain Mobile Telephone System Architecture.** Cellular telephony is designed to provide communications between two moving units, called mobile stations (MSs), or between one mobile unit and one stationary unit, often called a land unit. A service provider must be able to locate and track a caller, assign a channel to the call, and transfer the channel from base station to base station as the caller moves out of range. To make this tracking possible, each cellular service area is divided into small regions called cells. Each cell contains an antenna and is controlled by a solar or AC powered network station, called the base station (BS). Each base station, in turn, is controlled by a switching office, called a mobile switching center (MSC). The MSC coordinates communication between all the base stations and the telephone central office. It is a computerized center that is responsible of connecting calls, recording call information, and billing.	**6M** *Explanation 4M*

		 Cell size is not fixed and can be increased or decreased on the population of the area. The typical radius of a cell is 1 to 12mi. High-density areas require more, geographically smaller cells to meet traffic demands than do low-density areas. Once determined, cell size to optimized to prevent the interference of adjacent cell signals. The transmission power of each cell is kept low to prevent its signal from interfering with those of other cells.	***Diagram 2M***
6.	**(a)** **Ans.**	**Attempt any TWO of the following:** **Explain process of synchronous time division multiplexing with its advantages.** **Synchronous TDM or TDM:** In the technique called synchronous TDM, also referred to as TDM, the time slice is allocated to a source node regardless of whether it wants to send some data or not. This is a fairly simple mechanism to identify, at a destination node, which data originated from which source node, since every source node has a fixed time slot. Therefore, the position of the data within the data frame specifies its origin. However, it can be a very wasteful scheme, because the time slot is allotted to a source node even if it has nothing to send.	**12** **6M** ***Explanation with diagram 5M***



A small buffer memory is associated with every source node. At any time, not all nodes may want to send some data. Regardless of this, the timing device in the multiplexer allocates some time for each node to transmit the data from its buffer, and then repeats this cycle. E.g. A-B-C-D-A-B-C-D etc. AS shown in the figure. By the time its turn comes next, if a node wants to transmit any data, it will have moved a small chunk to its buffer. If there is no data to be transmitted, the buffer will be empty but still the turn of the node will come.

Advantages:

- An order is maintained
- No addressing information is required, channel capacity should be large.

Advantages 1M

(b) Explain process of CRC (Cyclic Redundancy Check) with example. **6M**

Ans.

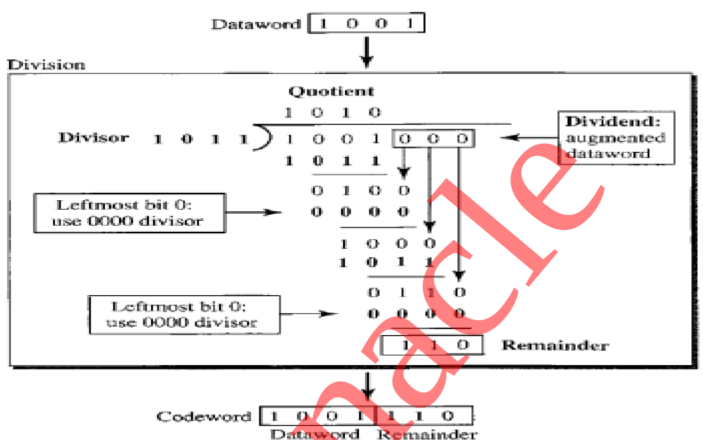
CRC Encoder:

In the encoder, the dataword has k bits (4 here); the codeword has n bits (7 here). The size of the dataword is augmented by adding $n - k$ (3 here) 0s to the right-hand side of the word. The n-bit result is fed into the generator. The generator uses a divisor of size $n - k + 1$ (4 here), predefined and agreed upon. The generator divides the augmented dataword by the divisor (modulo-2 division). The quotient of the division is discarded; the remainder $r_2\ r_1\ r_0$ is appended to the

Encoder and Decoder explanation with example 6M dataword to create the codeword.

Example:

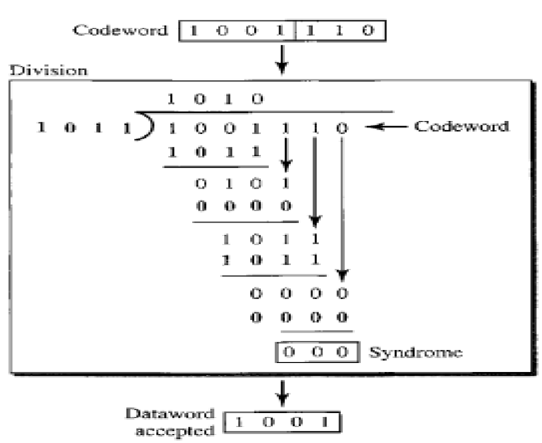
Let us take a closer look at the encoder. The encoder takes the dataword and augments it with $n - k$ number of 0s. It then divides the augmented dataword by th divisor, as shown in Figure.



CRC Decoder:

The codeword can change during transmission. The decoder does the same division process as the encoder. The remainder of the division is the syndrome. If the syndrome is all 0s, there is no error; the dataword is separated from the received codeword and accepted. Otherwise, everything is discarded.

Example:



(c) Explain DSSS mechanism with neat diagram. **6M**

Ans.

Direct Sequence Spread Spectrum:

The direct sequence spread spectrum (DSSS) technique also expands the bandwidth of the original signal, but the process is different. In DSSS, we replace each data bit with n bits using a spreading code. In other words, each bit is assigned a code of n bits, called chips, where the chip rate is n times that of the data bit.

Explanation 4M

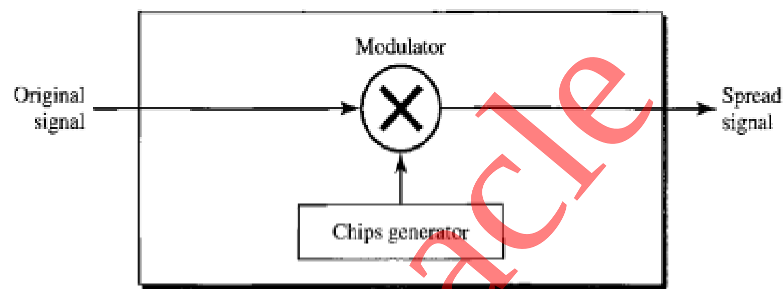


Figure: Concept of DSSS

Block diagram 2M

As an example, let us consider the sequence used in a wireless LAN, the famous Barker sequence where n is 11. We assume that the original signal and the chips in the chip generator use polar NRZ encoding. Figure shows the chips and the result of multiplying the original data by the chips to get spread signal.