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

WINTER – 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.	**(a) Ans.**	**Attempt any FIVE:** **Define Protocol. Why it is needed?** A protocol is defined as "a set of rules that governs the communication between computers on a network". A protocol is needed for having communication between any two devices.	**10** **2M** ***Definition 1M*** ***Need 1M***
	(b) Ans.	**List types of Wireless Media.** The types of wireless media are as follows: • Radio wave communication • Microwave communication • Infrared communication • Satellite Communication	**2M** ***Each type ½M***
	(c) Ans.	**Define the term Communication medium.** It is defined as the physical path between transmitter and receiver.	**2M** ***Correct definition 2M***

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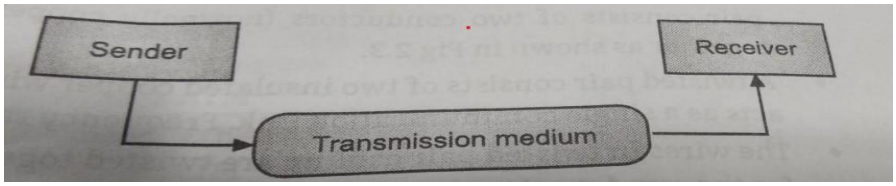
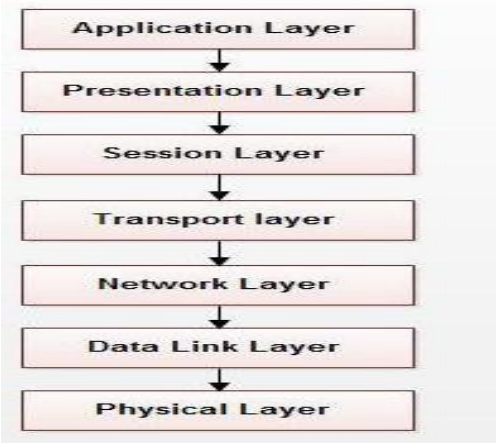
			
	(d) Ans.	**Define multiplexing. List its types.** **Multiplexing** is the process in which multiple data streams, coming from different sources, are combined and transmitted over a single data channel or data stream. The following three major multiplexing techniques are discussed: • Frequency division multiplexing • Wavelength division multiplexing • Time division multiplexing	**2M** ***Definition 1M*** ***Types 1M***
	(e) Ans.	**Define (i) FHSS, (ii) DSSS.** **(i) FHSS:** Frequency-hopping spread spectrum (FHSS) is a method of transmitting radio signals by rapidly switching a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver. **(ii) DSSS:** Direct Sequence Spread Spectrum (DSSS) is a spread spectrum technique whereby the original data signal is multiplied with a pseudo random noise spreading code that generates a redundant bit pattern for each transmitted bit.	**2M** ***Each definition 1M***
	(f) Ans.	**Draw OSI model.**  **7 Layers of OSI reference Model**	**2M** ***Correct diagram 2M***

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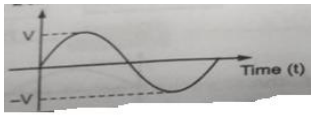
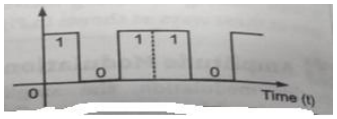
	(g) Ans.	**List features of 4G and Volte.** **Feature of 4G:** • 4G has high speed ,high capacity ,and low cost per bit • 4G has global access, service portability and scalable mobile services • 4G has seamless switching and a variety of Quality of service driven services • 4G has better scheduling and call admission control techniques **Features of Volte:** • Set up of the transmission path between the terminal and IMS • Security features for user authentication providing • Providing the core functionality for the establishment and termination of the call. • Support to call forwarding, caller ID presentation and restriction, call waiting and multiparty conference.	**2M** ***Any two features of 4G and Volte ½M each***
2.	**(a) Ans.**	**Attempt any THREE:** **Compare analog signal and digital signal. (any four points)**	**12** **4M**

Sr. No.	Terms	Analog signal	Digital signal
1	Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
2	Waves	Denoted by sine waves 	Denoted by square waves 
3	Representation	Uses continuous range of values to represent information.	Uses discrete or discontinuous values to represent information.
4	Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs, and other digital electronic devices.
5	Flexibility	Analog hardware is not flexible	Digital hardware is flexible in implementation.

Any four points 1M each

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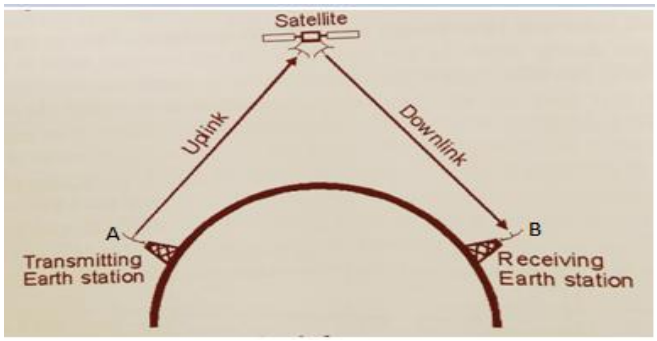
		6	Uses	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for computing and digital electronics.
		7	Security	Less secure	More secure
		8	Power	Analog instrument requires large power.	Digital signal requires negligible power.
		9	Cost	Low cost and portable.	Cost is high and not easily portable.
		10	Impedance	Low	High order of 100 megaohm
		11	Bandwidth	Less bandwidth required data transmission.	Higher bandwidth is required for data transmission.
	(b) Ans.	**Explain half duplex system and full duplex system with diagram.** **Half duplex system:** • In half duplex mode ,each station can more transmit and receive ,but not at the same time • When one device is sending the other can only receive and vice versa. • It is used in cases where there is no need for communication in both directions at the same time,the entire capacity of the channel can be utilized for each direction . • Walkie talkie and citizen bands are the examples  **Fig: Half duplex mode**	**4M** ***Each explanation 1M*** ***Each example 1M***

		Full Duplex System: • In full duplex mode, both stations can transmit and receive simultaneously • Signals going in one direction share the capacity of the channels doing in other direction • It is used when communication in both direction is required all the time. • Example :Telephone network  **Fig: Full duplex system**	
	(c) **Ans.**	**Explain satellite communication with diagram.** ***(Note: Any other relevant block diagram may also be considered).*** Satellites are the bodies that revolve around the earth just in same way moon revolves around the earth. Satellite communication is similar to terrestrial microwave communication except that satellite acts as one of the station. Satellite performs the functions of an antenna and the repeater together. Ground station A sends information to ground station B via the satellite. 	**4M** ***Explanation 2M*** ***Diagram 2M***

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		Two frequency bands are used for signals from earth to satellite (uplink) and from satellite to earth (downlink). Satellite takes uplink signal coming from sender, processes it and converts to downlink frequency and transmit it towards earth. The coverage area over which the signal of satellite is available is called as footprint of satellite.	
	(d) Ans.	**Explain working of circuit switching.** **Circuit switching:** • Circuit Switching is used in telephone networks. In telephone network, there is a two-way real time transmission of voice signal across a network. • In circuit switching the path which voice signal takes from sender to receiver is fixed as long as that conversation is an active. Before conversation starts the path between sender and receiver is established. This establishment of path is known as connection setup. • Once, the path is established data transfer starts and all voice signals coming from that sender specific to that particular connection follow same path. • After the whole data transfer both the parties who were engaged in conversation release the connection this is known as connection-oriented approach. Telephone networks are always connection oriented. Anything that is connection oriented means reliability and good quality. • Figure shows circuit switching concept. In circuit switching, routing (selection of path over network) is made when path is setup across the network. • After the link has been set between sender and receiver, information is forwarded continuously over the link. After the link has set up, no additional address information about receiver is required. • In circuit switching, a dedicated path is established between sender and receiver which is maintained for entire duration of conversation. • A telephone circuit carries voice samples that are 8-bits long and correspond to 125 μs of sampled voice. Here, sample does not have header describing its source and destination. We infer this from physical line on which it is present and the time at which is placed on the line.	**4M** ***Explanation 2M***

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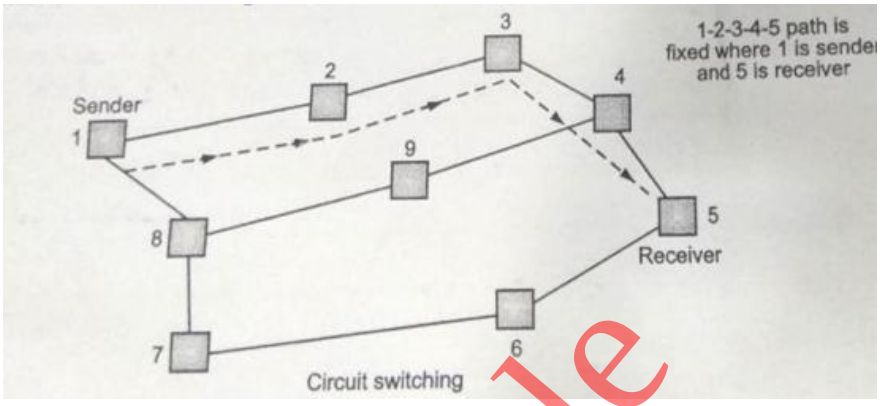
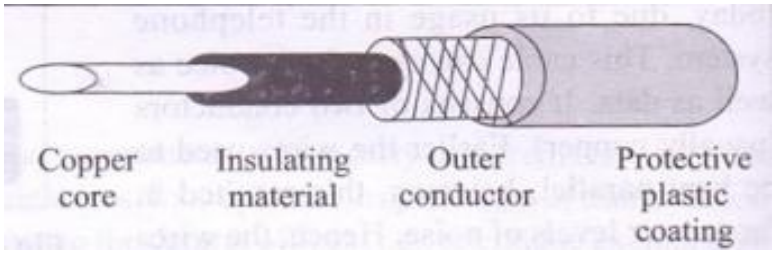
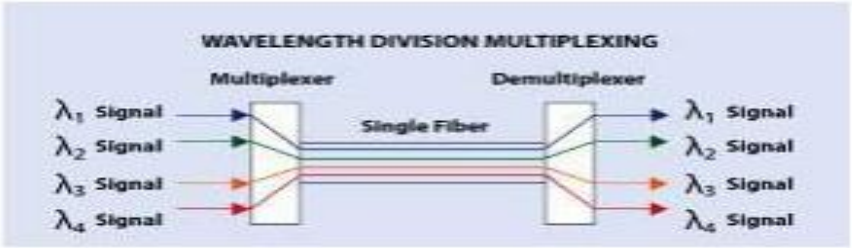
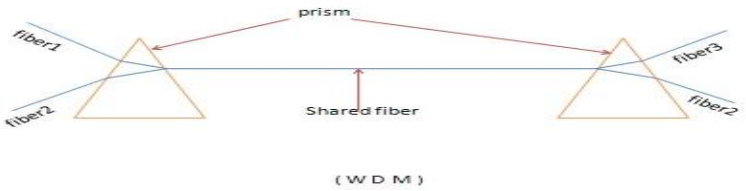
			***Diagram 2M***
3.	**(a)** **Ans.**	**Attempt any THREE:** **Calculate the baud rate for the given bit rate and type of modulation:** **(i) 4000 bps, FSK** **(ii) 6000 bps, ASK** For baud rate (S), we know that the formula is S=N/r N=S*r Where N is bit rate, S is baud rate r=no. of bits in signal elements. We need to calculate r for each case r=Log $_2$ L. **i) 4000 bps, FSK:** r=log$_2$ 2=1 S=4000bps/1=4000bauds. **ii) 6000bps, ASK:** For ASK, r=log$_2$ 2=1 S=6000bps/1=6000bauds.	**12** **4M** ***Each bit 2M***
	(b) **Ans.**	**Draw and explain Coaxial cable.** 	**4M** ***Diagram 2M***

		The co-axial cable is also called as coax. It has an inner central conductor made up of solid material like copper or aluminum. The inner conductor is surrounded by an insulating sheath which in turn is enclosed in an outer conductor (shield).Outer conductor is made up of braided sheath. This acts not only as second conductor for completing the circuit but also act as shield against noise. The outer conductor is covered by a plastic cover mostly made up of PVC to provide insulation and protection. It was developed for analog telephone networks. It is used to carry more than 10,000 voice channels at a time. Most popularly used in the cable TV system.	***Explanation 2M***
	(c) Ans.	**Draw and explain WDM.** WDM is an analog multiplexing technique to combine optical signals. Principle: Very narrow bands of light from different sources are combined to make a wider band of lights & at the receiver, the signal are separated by demultiplexer. WDM is designed to use the high data rate capability of fiber optic cable. The optical fiber data rate is higher that the data rate of metallic transmission cable. Using a fiber optic cable for one single line wastes available bandwidth. Multiplexing allows us to connect several lines into one. • WDM is conceptually same as FDM, except that the multiplexing & demultiplexing involve the optical signals transmitted through fiber optic cable. Very narrow band of lights of differential wavelengths are combined to make wide band of light. All wavelength travels through signal cable. • At receiver, the signals are separated by demultiplexer. • Combining & splitting of light sources are easily handled by prism. Prism bends a beam of light based on angle of incidence & frequency. Using this technique, multiplexer can be made to combine several input beams of light, each containing narrow band of frequencies into one output beam of wider band of frequencies. Demultiplexer does reverse process.  	**4M** ***Explanation 2M*** ***Diagram 2M***



(WDM)

(d) Ans. **Explain the process of Cyclic Redundancy Check (CRC) with suitable example.** — **4M**

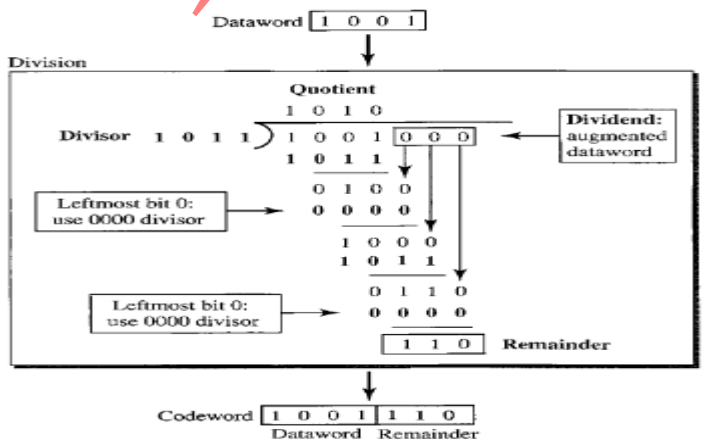
Encoder and Decoder explanation with example 2M each

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 data word 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 dataword to create the codeword.

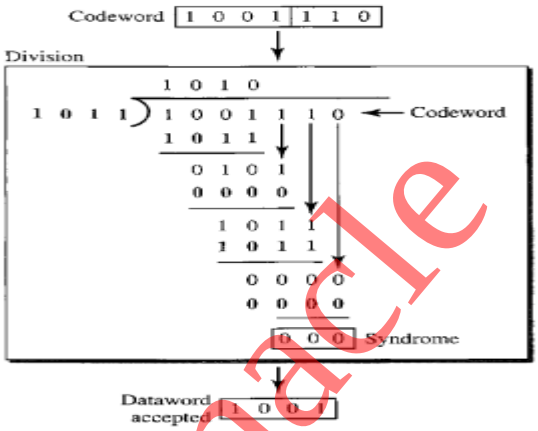
Example:

The encoder takes the data word 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 data word is separated from the received codeword and accepted. Otherwise, everything is discarded. **Example:**  	
4.	**(a) Ans.**	**Attempt any THREE:** **Draw and explain PSK with waveforms.** Phase-shift keying (PSK) is a digital to analog modulation scheme based on changing, or modulating, the initial phase of a carrier signal. PSK is used to represent digital information, such as binary digits zero (0) and one (1).The modulation of PSK is done using a balance modulator, which multiplies the two signals applied at the input. For a zero binary input, the phase will be 180° and for a high input, the phase reversal is of 0°. Following is the diagrammatic representation of PSK Modulated output wave along with its given input. The output sine wave of the modulator will be the direct input carrier or the inverted (180° phase shifted) input carrier, which is a function of the data signal. Amplitude and frequency of the original carrier signal is kept constant.	**12** **4M** ***Explanation 2M***

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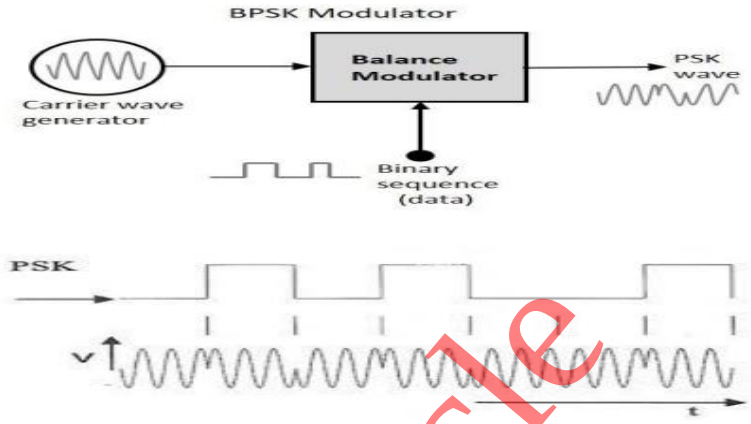
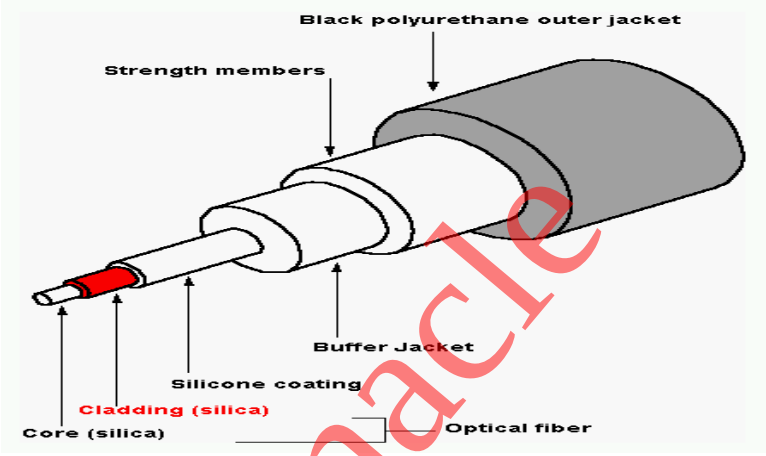
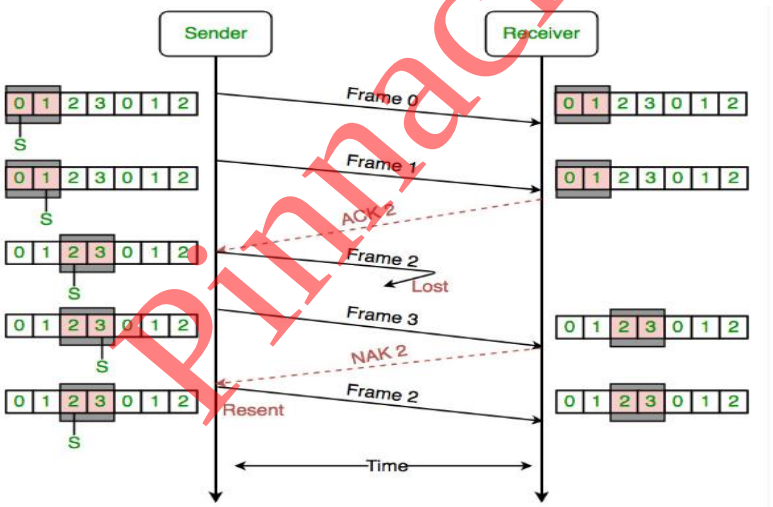
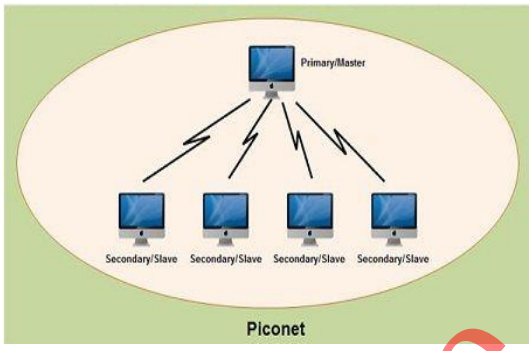
			***Diagram 2M***
	(b) Ans.	**Draw and explain fiber optic cable.** The optical fiber consists of three parts. **1. Glass core**: - The innermost layer in an optical fiber cable is the glass core. The light rays pass through this innermost glass core. Cladding layer: - The innermost glass layer is covered by the cladding layer. This layer is also made up of glass. But the refractive index of this layer is less than that of core layer. The cladding layer performs the following functions: 1.It provides strength to the optical fiber cable. **2. The cladding layer** acts like a mirror. It will reflect the light rays and will not allow them to escape outside the fiber. 3. When many optical fibers are packed in one cable the cladding layer avoids the interference between the light rays in the adjacent fibers. **3. Jacketlayer or Protective layer: -** i. Outmost layer in an optical fiber. ii. Provides mechanical strength to the optical cable. iii. Provides protection against environmental factors. Core and cladding are typically made of glass or plastic. Most important specification of the core is the index of refraction which is the value for light bending passing through the material and for the speed of that light could travel through material with. Cladding is having lower refractive index than the core. It allows light to stay inside the fiber and not escape into cladding, since it will be reflected. Coating is simply a protective layer that is protecting core and cladding from the fracture.	**4M** ***Explanation 2M***

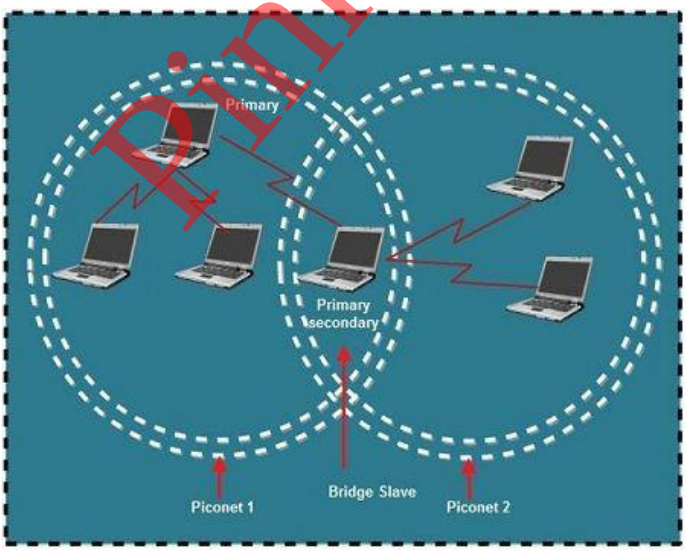
		Whether the fiber is single mode or multi-mode is defined by the thickness of the fiber optic stand. Thin core would support only single pathway for the light. Thicker core means more angles for input signal, thus being able to transmit data in multiple paths and modes.  	***Diagram 2M***
	(c) **Ans.**	**Calculate minimum number of bits in a PN sequence if we use FHSS with a channel bandwidth of B = 5KH$_z$ and B$_{ss}$ = 120 KH$_z$.** The no. of hops= 120 KHz/5KHz = 24 So we need $Log_2 24 = 4.58 \approx 5$bits. Hence minimum no. of bits in a PN sequence=5bits	**4M** ***Calculation of no. of hops - 3M*** ***Min no. of bits - 3M***
	(d) **Ans.**	**Explain selective reject ARQ.** Selective Repeat is part of the automatic repeat-request (ARQ). With selective repeat, the sender sends a number of frames specified by a window size even without the need to wait for individual ACK from the receiver as in Go-Back-N ARQ. The receiver may selectively reject a single frame, which may be retransmitted alone; this contrast with other forms of ARQ, which must send every frame from that point again. The receiver accepts out-of-order frames and buffers them. The sender individually retransmits frames that have timed out. The sender sends packet of window size N and the receiver acknowledges all packet whether they were received in order or not.	**4M** ***Explanation 2M***

		In this case, the receiver maintains a buffer to contain out-of-order packets and sorts them. The sender selectively re-transmits the lost packet and moves the window forward. • Sender can transmit new packets as long as their number is with W of all unACKed packets. • Sender retransmits un-ACKed packets after a timeout – Or upon a NAK if NAK is employed. • Receiver ACKs all correct packets. • Receiver stores correct packets until they can be delivered in order to the higher layer. • In Selective Repeat ARQ, the size of the sender and receiver window must be at most one-half of 2^m. 	***Diagram 2M***
	(e) Ans.	**Draw Bluetooth architecture. Explain function of various layers.** **Bluetooth Architecture (2 marks)** Bluetooth architecture defines two types of networks: 1. Piconet 2. Scatternet **1. Piconet:** • Piconet is a Bluetooth network that consists of one primary (master) node and seven active secondary (slave) nodes. • Thus, piconet can have upto eight active nodes (1 master and 7 saves) or stations within the distance of 10 meters.	**4M** ***Bluetooth Architecture 2M***

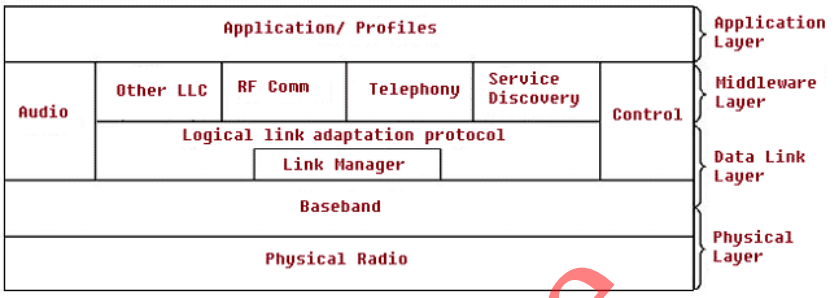


2. Scatternet:

- Scattemet is formed by combining various piconets.
- A slave in one piconet can act as a master or primary in other piconet.
- Such a station or node can receive messages from the master in the first piconet and deliver the message to its slaves in other piconet where it is acting as master. This node is also called bridge slave.



Function of various layer:
(one function of each layer expected)



Layers 2M

Radio Layer
- The Bluetooth radio layer corresponds to the physical layer of OSI model.
- It deals with ratio transmission and modulation.
- The radio layer moves data from master to slave or vice versa.
- It is a low power system that uses 2.4 GHz ISM band in a range of 10 meters.

Baseband Layer
- Baseband layer is equivalent to the MAC sublayer in LANs.
- Bluetooth uses a form of TDMA called TDD-TDMA (time division duplex TDMA).
- Master and slave stations communicate with each other using time slots.
- The master in each piconet defines the time slot of 625 µsec.
- In TDD- TDMA, communication is half duplex in which receiver can send and receive data but not at the same time.

Logical Link, Control Adaptation Protocol Layer (L2CAP)
- The logical unit link control adaptation protocol is equivalent to logical link control sublayer of LAN.
- The various function of L2CAP is:

1. Segmentation and reassembly
- L2CAP receives the packets of upto 64 KB from upper layers and divides them into frames for transmission.
- It adds extra information to define the location of frame in the original packet.

• The L2CAP reassembles the frame into packets again at the destination.

2. Multiplexing

• L2CAP performs multiplexing at sender side and demultiplexing at receiver side.

• At the sender site, it accepts data from one of the upper layer protocols frames them and deliver them to the Baseband layer.

• At the receiver site, it accepts a frame from the baseband layer, extracts the data, and delivers them to the appropriate protocol layer.

3. Quality of Service (QOS)

• L2CAP handles quality of service requirements, both when links are established and during normal operation.

• It also enables the devices to negotiate the maximum payload size during connection establishment.

5. **Attempt any TWO:** **12**

(a) **Differentiate coaxial, twisted pair and fiber optic cables. (any six points)** **6M**

Ans.

Sr. No.	Coaxial cable	Twisted pair cable	Fiber optic cable
1	Transmission of signals takes place in the electrical form over the inner conductor of the cable.	Transmission of signals takes place in the electrical form over the metallic conducting wires.	Signal transmission takes place in an optical forms over a glass fiber.
2	Coaxial having higher noise immunity than twisted pair cable.	In this medium the noise immunity is low.	Optical fiber has highest noise immunity as the light rays are unaffected by the electrical noise.
3	Coaxial cable is less affected due to external magnetic field.	Twisted pair cable can be affected due to external magnetic field.	Not affected by the external magnetic field.
4	Moderate expensive	Cheapest medium	Expensive

Any 6 points 1M each

5	Moderately high bandwidth	Low bandwidth	Very high bandwidth
6	Attenuation is low.	Attenuation is very high.	Attenuation is very low.
7	Installation is fairly easy.	Installation is easy.	Installation is difficult

(b) Ans. **Explain LRC and VRC for error detection with suitable example.** — **6M**

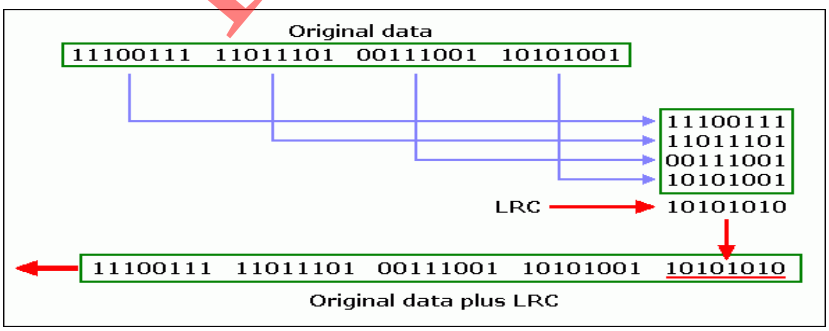
Longitudinal Redundancy Check:

A longitudinal redundancy check (LRC) is an error-detection method for determining the correctness of transmitted and stored data.

LRC verifies the accuracy of stored and transmitted data using parity bits. It is a redundancy check applied to a parallel group of bit streams. The data to be transmitted is divided into transmission blocks into which additional check data is inserted.

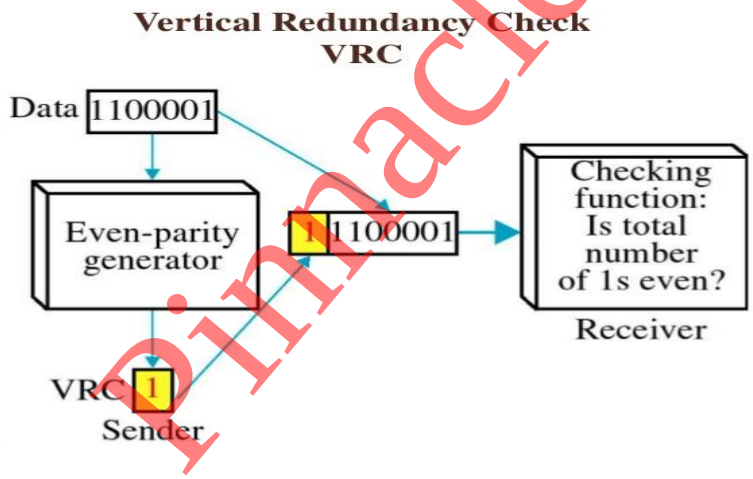
In this error detection method, a block of bits is organized in a table with rows and columns. Then the parity bit for each column is calculated and a new row of eight bits, which are the parity bits for the whole block, is created. After that the new calculated parity bits are attached to the original data and sends to the receiver.

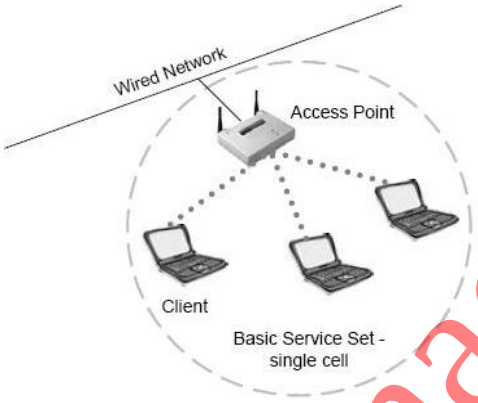
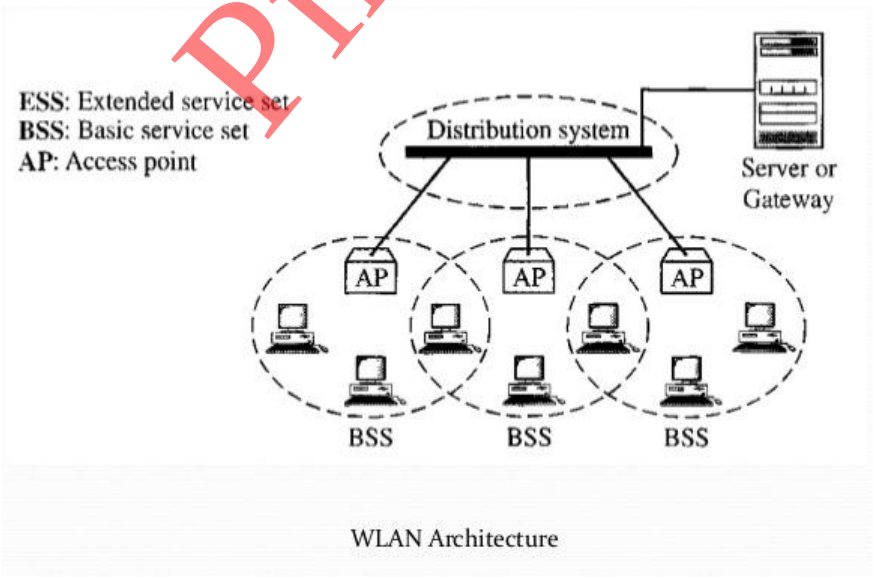
Each explanation with example 3M



Vertical Redundancy check:

Vertical redundancy check (VRC) is an error-checking method used on an eight-bit ASCII character. In VRC, a parity bit is attached to each byte of data, which is then tested to determine whether the transmission is correct. VRC is considered an unreliable error-detection method because it only works if an even number of bits is

		distorted. In this error detection technique, a redundant bit called parity bit is appended to every data unit so that total number of 1's in the unit (including parity bit) becomes even. The system now transmits entire extended unit across the network link. At the receiver, all eight received bits are checked through even parity checking function. If it counts even 1's data unit passes. If it counts odd number of 1's, it means error has been introduced in the data somewhere. Hence receiver rejects the whole data unit. Similar way odd parity VRC can also be implemented. In this method, total number of 1's in should be odd before transmission.  	
	(c) **Ans.**	**Explain WLAN with diagram. Also state its advantages and disadvantages.** A wireless local area network (WLAN) is a wireless distribution method for two or more devices that use high-frequency radio waves and often include an access point to the Internet. A WLAN allows users to move around the coverage area, often a home or small office, while maintaining a network connection. The two types of services are 1. Basic services set (BSS) 2. Extended Service Set (ESS) **1. Basic Services Set (BSS)** • The basic services set contain stationary or mobile wireless stations and a central base station called access point (AP).	**6M** ***Description 2M***

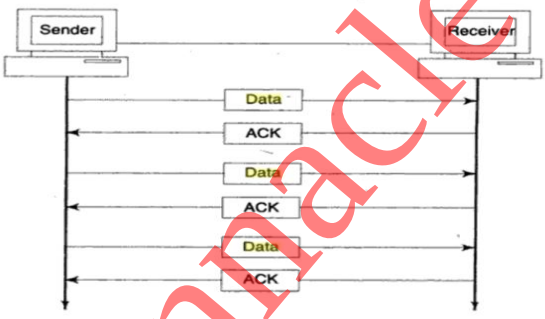
		• The use of access point is optional. • If the access point is not present, it is known as stand-alone network. Such a BSS cannot send data to other BSSs. This type of architecture is known as adhoc architecture. • The BSS in which an access point is present is known as an infrastructure network.  **2. Extend Service Set (ESS)** • An extended service set is created by joining two or more basic service sets (BSS) having access points (APs).  WLAN Architecture **Advantages of WLANs:** • They provide clutter-free homes, offices and other networked	***Diagram 2M***

		places. • The LANs are scalable in nature, i.e. devices may be added or removed from the network at greater ease than wired LANs. • The system is portable within the network coverage. Access to the network is not bounded by the length of the cables. • Installation and setup are much easier than wired counterparts. • The equipment and setup costs are reduced. **Disadvantages of WLANs:** • Since radio waves are used for communications, the signals are noisier with more interference from nearby systems. • Greater care is needed for encrypting information. Also, they are more prone to errors. So, they require greater bandwidth than the wired LANs. • WLANs are slower than wired LANs.	***Any 2 advantages 1M*** ***Any 2 Disadvantages 1M***
6.	**(a)** **Ans.**	**Attempt any TWO:** **Two channels one with a bit rate of 150 kbps and another with a bit rate of 140 kbps are to be multiplexed using pulse stuffing TDM with no synchronization bits. Answer the following questions.** **(i) What is the size of a frame in bit?** **(ii) What is the frame rate?** **(iii) What is the duration of frame?** We need to add extra bits to the second source to make both rates = 150kbps. Now we have two sources, each of 150 Kbps. a. The frame carries 1 bit from each source. Frame size = 1 + 1 = 2 bits. b. Each frame carries 1 bit from each 150-kbps source. Frame rate = 150,000 frames/s. c. Frame duration = 1 /(frame rate) = 1 /150,000 = 6.66µs.	**12** **6M** ***Each bit 2M***
	(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	**6M**

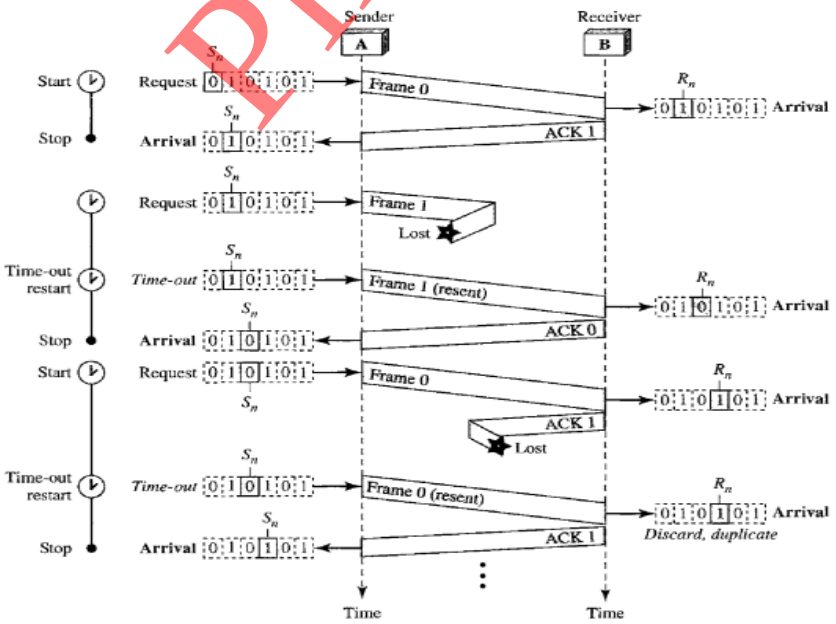
and acknowledgement for a frame does it send the next frame. Thus, the transmission always takes the form Data-ACK-Data-ACK….etc, where the Data frames are sent by the sender, and the ACK frames are sent by the receiver back to the sender. This is shown in figure.

Explanation 4M

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:



Example 2M

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MODEL ANSWER

Subject: Data Communication **Subject Code:** 22322

	(c) **Ans.**	**In a digital medium with a data rate of 12 mbps. How many 64 kbps voice channels can be carried if DSSS is used with Barker sequence?** Solution: 12mbps=12000kbps So number of 64kbps voice channels that can be carried if DSSS is used with Barker sequence: 12000/64=187.5 channels	**6M** ***Correct answer 6M***