WINTER – 19 EXAMINATION

Subject Name: Instrumentation Data Communieation **Model Answer** Subject Code: 22336

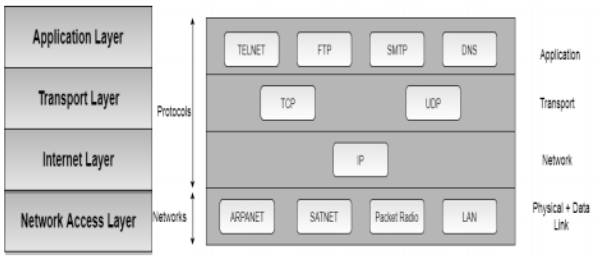
Important Instructions to examiners:

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
Q.1		**Attempt any five of the following:**	**10-Total Marks**
	a)	**Define Noise, Name the sources of noise.**	**2M**
	Ans:	**Noise**: it is defined as an unwanted form of energy which tend to interfere with the transmission and reception of the desired signal in a communication system. OR It is Random, undesirable electric energy that enters into communication system & interferes with the transmitted message. **Sources of noise:** 1. External Source 2. Natural source 3. Manmade source 4. Fundamental or internal source	**Definition 1M** **Any 2 sources of noise 1M**
	b)	**Name any four digital to analog modulation techniques.**	**2M**
	Ans:	**Digital to analog modulation techniques**: 1. Amplitude shift keying (ASK). 2. Frequency shift keying (FSK). 3. Binary phase shift keying (BPSK). 4. Quadrature phase shift keying (QPSK).	**each modulation ½ M**
	c)	**Give the classification of network based on geographical area.**	**2M**
	Ans:	**Classification of network based on geographical area**: 1. Local area network 2. Metropolitan area network	**2M**

		3. Wide area network 4. Personal Area Network	
	d)	**Name the optical source and two optical detectors.**	**2M**
	Ans:	**Optical source**: 1)LED 2) LASER **Optical detector** : 1) PIN photo diode 2) Avalanche photo diode	**1M each**
	e)	**State two specifications of IEEE 802.3.**	**2M**
	Ans:	**Specifications of IEEE 802.3:** 1. It is a standard specification for Ethernet. 2. It is method of packet based physical communication in a local area network, which is maintained by the Institute of Electrical and Electronics Engineers 3. It support a data rate of 10 megabits per second (Mbps) and specify these possible physical media	**Any 2 specifications 1M Each**
	f)	**State the advantages of client server model.**	**2M**
	Ans:	**Advantages of client server model:** 1. Centralized back up is possible. 2. Use of dedicated server improves the performance of whole system. 3. Security is better in these networks as all the shared resources are centrally administered. 4. Use of dedicated servers also increases the speed of sharing resources. 5. Up gradation and Scalability can be made easily by just upgrading the server. Also new resources and systems can be added by making necessary changes in server.	**2M(Any two)**
	g)	**State two features of Devicenet.**	**2M**
	Ans:	**Features of Devicenet:** (1) Network size – up to 64 nodes (2) Data packets – 0-8 bytes (3) Bus topology – linear power and signal on the same network cable **(4)** System features – removal and replacement of device from the network under power	**Any two features 2M**

Q.2		**Attempt any <u>THREE</u> of the following:**	**12-Total Marks**
	a)	**State the need for modulation.**	**4M**
	Ans:	The baseband transmission is a low frequency transmission. And it cannot transmit for long distance. So to overcome this limitation, modulation is required. Modulation is necessary in communication system because of the following reasons 1. Reduction in the height of antenna 2. Avoids mixing of signals 3. Increases the range of communication 4. Multiplexing is possible 5. Improves quality of reception	**4M** **any 4 reason**
	b)	**Define Multiplexing. State the need for multiplexing.**	**4M**

Ans:	**Multiplexing** is the set of techniques that allows the simultaneous transmission of multiple signals across a signals data link **Need for multiplexing:** **1.** Sending many signals separately is expensive and requires more wires to send. So there is a need of multiplexing. **2.** The multiplexing divides the capacity of the low-level communication channel into several higher-level logical channels, one for each message signal or data stream to be transferred. **3.** Multiplexing also simplifies the drive electronics, reduces the cost	**1M** **3M**
c)	**Define Bandwidth with reference to analog system and digital systems.State the unit in the two systems.**	**4M**
Ans:	**1. Definition of Bandwidth with reference to analog system:** It is defined as the range of frequencies being passed by the medium. **OR** It is defined as the portion of the electromagnetic spectrum occupied by a signal. **OR** It may also defined as the frequency range over which an information signal is transmitted. **Unit of bandwidth of analog system is Hz** **2. Bandwidth with reference to digital system:** It is defined as the maximum bit rate that a medium is able to pass. **Unit of bandwidth of digital system is bits per second**	**correct definition with unit 2M each**
d)	**Draw a sketch of the layered architecture of TCP/IP model. State the function of each layer.**	**4M**
Ans:	**Diagram:**  **layered architecture of TCP/IP model** **Function of each layer:** **Layer 1**: **Host-to-network Layer** 1. Lowest layer of the all. 2. Protocol is used to connect to the host, so that the packets can be sent over it. 3. Varies from host to host and network to network. **Layer 2: Internet layer** 1. It is the layer which holds the whole architecture together. 2. It helps the packet to travel independently to the destination. 3. IP (Internet Protocol) is used in this layer.	**2M** **Function of each layer ½ M**

4. The various functions performed by the Internet Layer are:
    - Delivering IP packets
    - Performing routing
    - Avoiding congestion

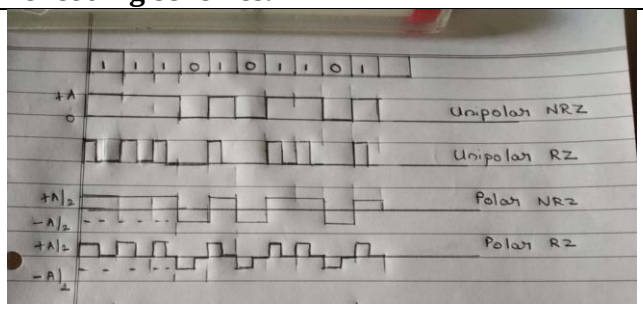
Layer 3: **Transport Layer**

1. It decides if data transmission should be on parallel path or single path.
2. Multiplexing, segmenting or splitting on the data is done in transport layer.
3. The applications can read and write to the transport layer.
4. Transport layer adds header information to the data.
5. Transport layer breaks the message (data) into small units

Layer 4: Application Layer:

The TCP/IP specifications described a lot of applications that were at the top of the protocol stack. Some of them were TELNET, FTP, SMTP, DNS etc.

1. TELNET is a two-way communication protocol which allows connecting to a remote machine and run applications on it.
2. FTP (File Transfer Protocol) is a protocol that allows File transfer amongst computer users connected over a network. It is reliable, simple and efficient.
3. SMTP (Simple Mail Transport Protocol) is a protocol, which is used to transport electronic mail between a source and destination, directed via a route.
4. DNS (Domain Name Server) resolves an IP address into a textual address for Hosts connected over a network.
5. It allows peer entities to carry conversation.

Q.3		**Attempt any THREE of the following:**	**12-Total Marks**
	a)	**Encode the data sequence 1110101101 using unipolar NRZ, unipolar RZ, polar NRZ and polar RZ encoding schemes.**	**4M**
	Ans:		**1M Each**
	b)	**State the function of Hubs, repeater, router and gateway.**	**4M**
	Ans:	**Hubs:** • A hub is a common connection point for devices in a network. • Hubs connect segments of a LAN. • It contains multiple ports so when a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets. • A hub interconnects two or more workstations into a local area network. • When a workstation transmits data frame to a hub, the hub immediately resends the data frame to all connecting links.	**1M Each**

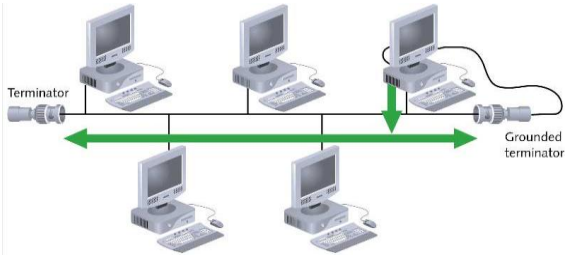
		Repeater: • The major function is to receive a network signal from one LAN terminal cable segment and to regenerate and retransmit the signal as it is in its original strength over a one or more other cable segment. • Basically repeater regenerates the strength of the signal before transmitting it. • They allow a cabling system to extend beyond its maximum allowed length by amplifying the network voltages so they travel farther. **Router** • Router determines the short path between source and destination of data transmission • Router performs the traffic direction function on "Internetwork" • Internet uses Routers to forward packets from one host to other. • A router is a device that forwards data packets between computer networks, creating an overlay internetwork. • A router is connected to two or more data lines from different networks. • When a data packet comes in one of the lines, the router reads the address information in the packet to determine its ultimate destination. • Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey. **Gateway** • A gateway is a network point that acts as an entrance to another network • Gateway is a router or a proxy server that routes between networks • Gateways, also called protocol converters, can operate at any network layer. • A computer server acting as a gateway node is often also acting as a proxy server and a firewall server(firewall is a system created to prevent unauthorized admission into a private network • In most homes a gateway is the device provided by the Internet Service Provider that connects users to the internet. • Gateway is one of the many ways we can communicate over the World Wide Web. • The gateway allows us to enter different networks on the internet so we can transmit data back and forth	
	c)	**Compare LAN and WAN on the basis of** **(i)Area covered (ii) Bandwidth** **(iii) Data rate (iv) Congestion**	**4M**

Ans: **1M Each**

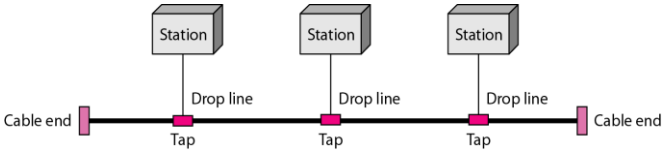
Parameter	LAN	WAN
Area Covered	Local Area only (schools,offices,homes)	Large geographical Areas(cities,states,nations)
Bandwidth	High Bandwidth for data Transfer	Low Bandwidth for data Transfer
Data rate	LANs have a high data transfer rate. High speed (1000 mbps)	WANs have a lower data transfer rate compared to LANs. Less speed (150 Mbps)
Congestion	Less congestion	More Congestion

d) **Draw the sketch of Bus topology and explain. State one advantage and one disadvantage.** **4M**

Ans: **Diagram:** **1M**



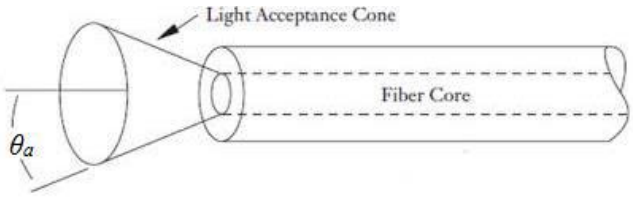
OR

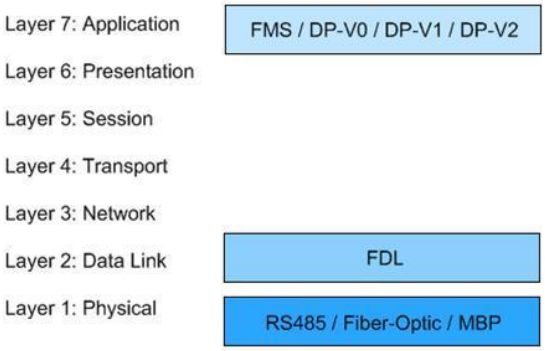


1M

Explanation:

- In local area networks where bus topology is used, each node is connected to a single cable.
- Each computer or server is connected to the single bus cable.
- A signal from the source travels in both directions to all machines connected on the bus cable until it finds the intended recipient.
- If the machine address does not match the intended address for the data, the machine ignores the data.
- Alternatively, if the data matches the machine address, the data is accepted.
- Since the bus topology consists of only one wire, it is rather inexpensive to implement when compared to other topologies.
- However, the low cost of implementing the technology is offset by the high

		cost of managing the network. • The bus topology requires proper termination at both ends • Terminators stop signals after reaching end of wire **Advantages of Bus Topology (Any one)** • Works well for small networks • Relatively inexpensive to implement • Easy to add to more nodes (computers) to it. • Cabling cost is less as the bus topology requires the least amount of cables to connect the computers. **Diasadvatages of Bus Topology (Any one)** • Heavy network traffic slows down the bus speed. In bus topology only one computer can transmit and others have to wait until the turn comes. • The BNC connectors used for expansion of the bus attenuates the signal. • A cable break or loose BNC connector will cause reflections and stop network activity. • Entire network shuts down if there is a break in the main cable. • Terminators are required at both ends of the backbone cable. • Difficult to identify the problem if the entire network shuts down	**1M** **1M**
Q.4	**(A)**	**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Explain Acceptance angle and Numerical aperture in a fiber optic cable.**	**4M**
	Ans:	**(i) Acceptance angle**(θ): It is the maximum angle made by the light ray with the fiber axis, so that light can propagate through the fiber after total internal reflection. Relation NA and acceptance angle: NA = Sin θ_a $\theta_a = Sin^{-1}$ (NA)  **ii)Numerical Aperture** Numerical Aperture is the light gathering ability or capacity of an optical fiber. More the NA the more efficient will be fiber. It is also known as figure of merit. NA is given by equation NA = $\sqrt{(n1^2 - n2^2)}$ Where n1 ---- refractive index of core n2 -----refractive index of cladding	**2M Each**
	b)	**Describe Profibus protocol. State the function of various layers.**	**4M**
	Ans:	**Profibus protocol layers:**	**2M**



Description:- **2M**

- PROFIBUS networks make use of three separate layers of the OSI Network model.
- First, PROFIBUS describes the application layer. There are multiple versions of PROFIBUS that handle different types of messaging at the application layer.
- Some of the types of messaging PROFIBUS supports include cyclic and acyclic data exchange, diagnosis, alarm-handling, and isochronous messaging.
- PROFIBUS does not define layers three through six. It does, however, define the data link and physical layers, layers one and two.
- The data link layer is completed through a Field bus Data Link, or FDL. The FDL system combines two common schemes, master-slave methodology and token passing. In a master-slave network, masters, usually controllers, send requests to slaves, sensors and actuators. The slaves respond accordingly.
- PROFIBUS also includes token passing, a system in which a "token" signal is passed between nodes. Only the node with the token can communicate.
- The token passing concept is like the speaking conch; only the person with the conch is allowed to talk.
- Finally, PROFIBUS defines a physical layer, though it leaves room for flexibility. PROFIBUS systems can have three types of media. E.g. Standard twisted-pair wiring system (RS485), fiber-optic transmission. PROFIBUS uses the bus topology.

PROFIBUS FMS

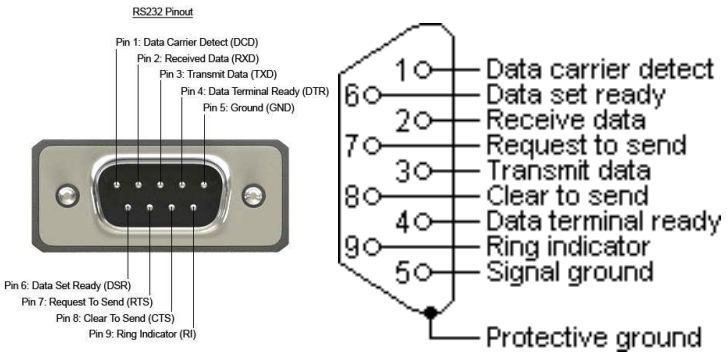
The initial version of PROFIBUS was PROFIBUS FMS, Field bus Message Specification. PROFIBUS FMS was designed to communicate between Programmable Controllers and PCs, sending complex information between them. This protocol was not appropriate for less complex messages or communication on a wider, more complicated network.

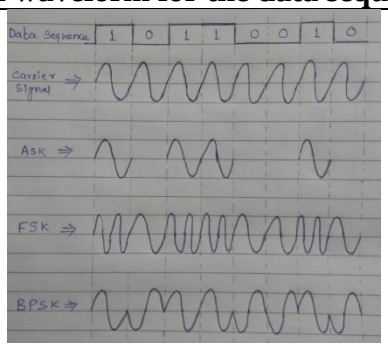
PROFIBUS DP

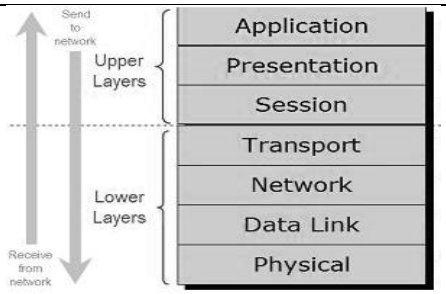
The second type of PROFIBUS is more universal. Called PROFIBUS DP, for Decentralized Periphery, this new protocol is much simpler and faster. PROFIBUS DP has, itself, three separate versions. Each version, from DP-V0 to DP-V1 and DP-V2, provides newer, more complicatedfeatures.

PROFIBUS PA

PROFIBUS PA is a protocol designed for Process Automation. In actuality,

		PROFIBUS PA is a type of PROFIBUS DP Application profile. PROFIBUS PA standardizes the process of transmitting measured data. **MBP Technology** Manchester Bus Powered technology (MBP) can be used with ROFIBUS PA. It permits transmission of both data and power.	
	c)	**Draw the 9 pin configuration of RS232 standard. State the function of the pins.**	**4M**
	Ans:	**Pin Diagram:**  **Functions of the pins in RS-232:-** • Pin1 is a data carrier detect it is receiving a carrier from a remote DCE. • Pin2 is a receive data pin, which is used to Carries data from DCE to DTE. • Pin3 is a transmit data pin, which is used to Carries data from DTE to DCE. • Pin4 is a data terminal ready pin, DTE is ready to receive, initiate, or continue a call. • Pin5 is signal ground pin. • Pin6 is data set ready pin, DCE is ready to receive and send data. • Pin7 is the request to send pin, DTE requests the DCE prepare to transmit data. • Pin8 is clear to send pin, DCE is ready to accept data from the DTE • Pin9 is ring indicator; DCE has detected an incoming ring signal on the telephone line.	**2M** **2M**
	d)	**State the features of HART networks.**	**4M**
	Ans:	HART is an acronym for **Highway Addressable Remote Transducer**. HART is a bi- directional communication protocol that provides data access between intelligent field instruments and host systems. • Digital device information is communicated by encoding a digital signal, generally using a technique known as Frequency Shift Keying on the same 4-20mA wiring used for analog communications. • The HART Protocol makes uses Frequency Shift Keying (FSK) standard to superimpose digital communication signals at a low level on top of the 4-20mA. This enables two-way field communication to take place and makes it possible for additional information beyond just the normal process variable to be communicated to/from a smart field instrument. • The HART Protocol communicates at 1200 bps without interrupting the 4-20mA signal and allows a host application (master) to get two or more digital updates per second from a smart field device. As the digital FSK signal is phase continuous, there is no interference with the 4-20mA signal	**4M**

	e)	**State the application of each of the following connectors.** **i. RJ – 45 iii. BNC – T** **ii. MT- RJ iv. ST**	**4M**
	Ans:	**i. RJ – 45** • It is used to connect computers onto Ethernet-based local area networks (LAN) • A registered jack (RJ) is a standardized physical network interface for connecting telecommunications or data equipment. **ii. BNC – T** BNC connectors are used with miniature-to-subminiature coaxial cable in radio, television and other radio-frequency electronic equipment, test instruments, and video signals. **iii. MT- RJ** A Mechanical Transfer Registered Jack (MT-RJ) is a connector used for fiber optic cables. **iv. ST** A straight tip connector (ST connector) is a connector used in fiber-optic cables that utilizes a bayonet-style plug and socket. The ST connector setup allows for unidirectional communication, so two ST connectors and two fiber cables are used for bidirectional communication.	**1M Each**
Q.5		**Attempt any <u>TWO</u> of the following:**	**12Total Marks**
	a)	**Draw ASK, FSK and BPSK waveform for the data sequence 10110010.**	**6M**
	Ans:		**2m each for correct waveform.**
	b)	**Draw the layered architecture of the OSI reference model and state function of Physical and Transport layer.**	**6M**
	Ans:	**Layered architecture of the OSI reference model**: OSI stands for **Open Systems Interconnection**. It has been developed by ISO – '**International Organization of Standardization**', in the year 1974. It is 7 layer architecture with each layer having specific functionality to perform. All these 7 layers work collaboratively to transmit the data from one person to another across the globe.	**3M for diagram**



Function of Physical layer:

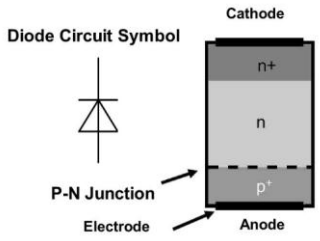
- Defines the electrical and mechanical connections at the physical level or the communication channel itself.
- This layer is responsible for ultimate transmission of digital data bits from the Physical layer of the sending (source) device over network communications media to the Physical layer of the receiving (destination) device
- Examples: Ethernet cables, Token Ring networks, hubs and other repeaters

Function of Transport layer:

- This layer provides transparent transfer of data between end systems, or hosts.
- It is responsible for end-to-end error recovery and flow control.
- It ensures complete data transfer.
- It breaks the data groups into smaller units so that they are handled more efficiently by the network layer.

3M Each function

	(c)	**With a neat sketch, explain the working of P-i-N Photo diode. Compare P-i-N photo diode and Avalanche photo diode.**	**6M**
	Ans:	**Diagram:**	**1 ½M**



1 ½M

Working :

- The term PIN diode gets its name from the fact that includes three main layers. Rather than just having a P-type and an N-type layer, it has three layers such as
  - P-type layer
  - Intrinsic layer
  - N-type layer
- The working principle of the PIN diode exactly same as a normal diode. The main difference is that the depletion region, because that normally exists between both the P & N regions in a reverse biased or unbiased diode is larger.
- In any PN junction diode, the P region contains holes as it has been doped to make sure that it has a majority of holes. Likewise the N-region has been doped to hold excess electrons.
- The layer between the P & N regions includes no charge carriers as any electrons or holes merge as the depletion region of the diode has no charge carriers it works as

an insulator.

- The depletion region exists within a PIN diode, but if the PIN diode is forward biased, then the carriers come into the depletion region and as the two carrier types get together, the flow of current will starts.
- When the PIN diode is connected in forward biased, the charge carriers are very much higher than the level of intrinsic carrier's attention.
- Due to this reason the electric field and the high level injection level extends deeply into the region. This electric field assists in speeding up of the moving of charge carriers from P to N region, which consequences in quicker operation of the PIN diode, making it an appropriate device for high frequency operations.
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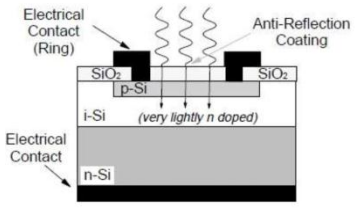
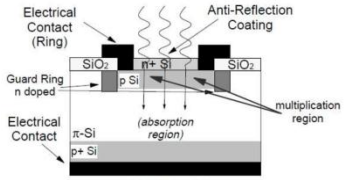
Comparison between P-i-N photo diode and Avalanche photo diode:

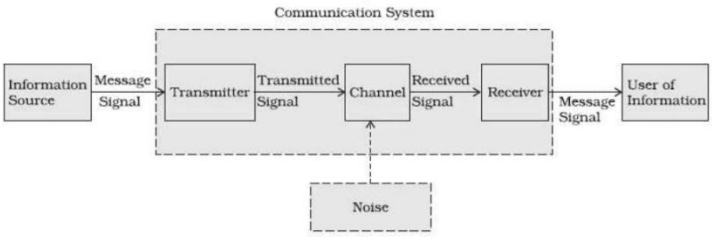
Sr.No.	P-i-N photo diode	Avalanche photo diode
1		
2	i-region in PIN diode is lightly n-doped	i-region in avalanche diode is lightly p-doped.
3	PIN diode has less reverse bias voltage than Avalanche photo diode. (about 3v)	Avalanche photo diode has very high reverse bias voltage (about 50 v)

3M

Q.6 **Attempt any TWO of the following:** **12Total Marks**

(a) **Draw the basic block diagram of communication system. State the function of each block.** **6M**

Ans: **Basic Block diagram** of communication system: **3M**



3M

Function of each block:

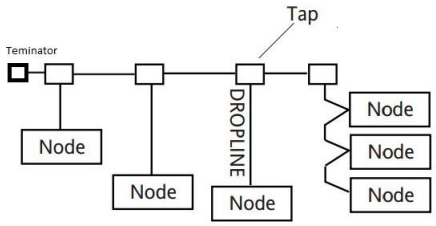
Information source:- Human generates a message that we call the information or intelligence signal. This signal is fed to the transmitter.

Transmitter:- It is the collection of electronic components & circuits designed to convert the information into a signal suitable for transmission over a given communication medium.

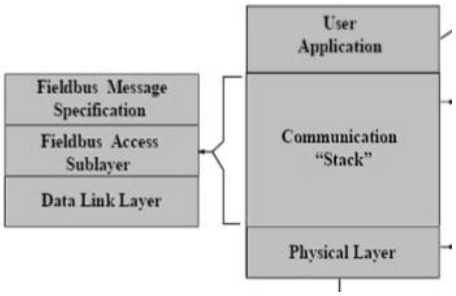
It may be simple as microphone or as complex as a microwave radio transmitter.

Communication channel:- It is the medium by which the electronic signal is sent from one place to another.

- It may be a pair of wires that carry voice signal from microphone to headset.

		• It may be fiber-optic cable that carries the message on a light wave. • It may be radio. Radio is wireless communication **Receiver**: It is another collection of electronic components & circuits that accept the transmitted message from the channel & convert it back into a form understandable by human. Again it may be simple earphone or complex electronic receiver. **Noise**: It is Random, undesirable electric energy that enters into communication system & interferes with the transmitted message. Noise may come from the atmosphere or produce internally by transmitter	
	(b)	**Develop the Device net network for 6 nodes.**	**6M**
	Ans:	**Diagram:**  **Devicenet network for 6 nodes:** • Devicenet is open communication protocol used in industrial automation to inter connect I/O and control devices. • Devicenet uses a trunk line and drop line topology to connect nodes for communication. • To develop a Devicenet network terminating resistor (**TR**) is used. It is 121Ω resistor that is connected to the end of the trunk line. There are two terminating r resistor per network. • Node is an addressable device that communicates on the network. • Tap T is a branching point the trunk line. • Trunk line is a network cable between terminators it is usually a thick cable. • Drop line is the network cable between trunk and node, each drop line may be no longer than 6 meters. • Power supply of a 24 V DC source that powers network, there may be multiple power supplies on a network.	**3M** **3M**
	c)	**Describe with sketch foundation field bus protocol architecture.**	**6M**
	Ans:	**Foundation Field Bus** • Foundation Fieldbus is an all-digital, serial, two-way communications system that serves as the base-level network in a plant or factory automation environment. • It is an open architecture, developed and administered by FieldComm Group.	**3M**

Layered architecture of Fieldbus :



Function of each layer: **3M**

Physical layer:-

- Translating messages into physical signals on the wire - and vice versa.
- The physical layer also provides the common electrical interface for all FOUNDATION fieldbus devices.
- It is defined by approved standards (IEC 61158-2 and ANSI/ISA 50.02,)

Data Link & Application layers:-

- It combines several technologies that together control transmission of data on the fieldbus.
- The data link and applications layers provide a standard way of "packaging" the data, as well as managing the schedule for communication and function-block execution
- They enable process control while providing standardization and interoperability.

User layer:

- It enables user to interact with the other layers and with other applications.
- The user layer contains
  - i. **Resource blocks** - describes characteristics of the fieldbus device such as device name, mfr. and serial number, etc.
  - ii. **Transducer blocks** - used to configure devices
  - **iii.** **Function blocks** - The Control System Strategy is built using Function Blocks. Input and output parameters of Function Blocks can be linked over the fieldbus.