CS 331 Physical Layer

Questions:

Question 1 (Computation-based):

A digital signal has a bit interval of 0.00005 seconds (50 µs). What is the bit rate (bandwidth) of this signal in Kbps?

- Bit interval = 0.00005 seconds
- $Bit\ Rate = 1 \div bit\ interval$

$$Bit\ Rate = \frac{1}{0.00005} = 20{,}000\ bps$$

$$20{,}000\ bps = 20\ Kbps$$

Question 2 (Understanding-based):

The slides mention that a "repeater" is a physical layer device. What is the primary function of a repeater, and why is it necessary in digital transmission?

A repeater receives a weakened or distorted digital signal, regenerates it, and sends a refreshed copy onward.

It is necessary because signals lose strength and become distorted as they travel over long distances. The repeater allows the digital signal to travel farther without losing its original form.

Question 3 (Scenario-based):

You are setting up a network for a large office. You need to ensure that data from different departments can be sent over a single high-capacity link to the internet. Which physical layer concept from the slides would you apply here?

The appropriate physical-layer concept is **multiplexing**.

Multiplexing combines data from several departments into one high-capacity communication link. At the destination, a demultiplexer separates the combined data back into its individual streams.

Answer: Multiplexing

Question 4 (Computation-based):

A sender and receiver are separated by a distance of 2,000 km. The signal propagates through the medium at a speed of 2.0×10^8 m/s. What is the propagation time for a single bit to travel from the sender to the receiver?

$2{,}000\ km = 2{,}000{,}000\ m$

$$Propagation\ time = \frac{Distance}{Propagation\ speed}$$

$$= \frac{2{,}000{,}000}{2.0 \times 10^8} = 0.01$$

$0.01\ \text{sec} = 10\ miliseconds$

Question 5 (Understanding-based):

An analog signal has a frequency of 5 kHz. Explain what its period is and how frequency and period are mathematically related.

$$T = \frac{1}{f}$$

$f = 5\ kHz = 5{,}000\ Hz$

$$T = \frac{1}{5{,}000} = 0.0002\ sec$$

$0.0002\ sec = 200\ microsec$

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Question 6 (Scenario-based):

You are on a phone call and hear a faint conversation in the background from another call. What type of signal impairment is this, and under which broader category of impairment does it fall?

This impairment is called **crosstalk**. It occurs when a signal from one communication line interferes with another line.

Crosstalk falls under the broader impairment category of **noise**.

Question 7 (Computation-based):

A network has a bandwidth of 1 Mbps. You need to send a 1-Megabyte (MB) file. Ignoring propagation delay, what is the transmission time?

$1\ MB = 8\ Mb$

$$Transmission\ time = \frac{File\ Size}{Bandwith}$$

$$= \frac{8\ Mb}{1\ Mbps} = 8\ sec$$

Question 8 (Understanding-based):

What is the key difference between a simple signal and a composite signal, as described in the slides?

A **simple signal** consists of only one sine wave and therefore has one frequency.

A **composite signal** consists of multiple simple sine waves with different frequencies, amplitudes, or phases combined together.

Question 9 (Scenario-based):

You are designing a system to transmit digital data over a long distance. The system

experiences significant errors due to electrical equipment nearby. Which type of impairment is the primary source of these errors, and how might you mitigate it? (Refer to the concepts in the slides).

The primary impairment is **induced noise**, also known as electromagnetic interference. It occurs when nearby electrical equipment generates unwanted signals that interfere with data transmission. It belongs to the broader category of **noise**.

It can be reduced by:

- Using shielded or twisted-pair cables
- Moving network cables away from electrical equipment
- Using fiber-optic cables
- Applying noise-filtering or error-detection techniques

Question 10 (Computation-based):

A communication link has a bandwidth of 5 bps and a delay of 5 seconds.

a) What is the bandwidth-delay product for this link?

b) If a sender starts transmitting data and continues for 5 seconds, how many bits will be "in the pipe" (in transit) on the link?

- Bandwidth = 5 bps
- Delay = 5 seconds

$$Bandwith - delay\ product = Bandwith \times Delay$$

$$= 5 \times 5 = 25\ bits$$

b) **Bits in the pipe**

During five seconds, the sender transmits:

$$5 \text{ bps} \times 5 \text{ seconds} = 25 \text{ bits}$$