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Module: CSE 963: Computer Network 1
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Assignment: Homework 1
Note: I have provided answers to these questions based on lecture videos, my understanding, and a thorough review of the book "Data & Computer Communication" by William Stallings.

Q1: (10 points) Briefly explain the advantages and disadvantages of using layered architecture in computer networks.

Advantage:

1) Having layered architecture provide well-defined functions and tasks of each layer, even changing standard in one layer would not affect the layer above it or below it.
2) Troubleshooting is more efficient, as it's easy to pinpoint the problematic layer and rectify it.
3) In case I want to develop or modify some functionality in that case it would be easy to develop a layer without affecting while model.

Disadvantage:

1) It is overhead on data transmission as well as data packet because each layer has to ripe the payload or add the payload based on each layer functionality.
2) It introduces complexity and requires a deep understating, in my experience (who is new to this networking field), most time of the time, I forget to recall each layer's function and its effect on other layers. Remembering TCP/IP layers is somewhat easy but OSI layers is bit difficult.
3) I think it is necessary to mention that layered architecture introduce bit of complexity and may lead to performance degradation.

Q2: What tasks are performed by the data link layer and the transport layer?

Data link Layer:

- Facilitate Transmissions of data over the link to which the device is attached.
- It handles flow control and error control.
- It is responsible for the framing of the data received from the network layer.
- Adds MAC addresses of source and destination devices as a payload information for proper addressing within local network.

Transport layer:

- This layer provides End-to-end delivery of data b/w devices located on different networks.
- It breaks down the data into segments, e.g TCP, UDP
- Adds source and destination port numbers to the data as payload information, facilitating communication b/w specific process/services.

Q3: Draw the spectrum of the signal $s(t) = 4\sin(2\pi t) + 2\sin(6\pi t) + (8/\pi)\sin(7\pi t)$.
Also identify the absolute and effective bandwidths.

Please see below Image Q3.jpeg

Q4: What is the channel capacity for a teleprinter channel with a 300-Hz bandwidth and a signal-to-noise ratio of 3 dB, where the noise is a white thermal noise?

Kindly see below Image Q4.jpeg

Q5: A digital signaling system is required to operate at 9600 bps. If the signal encodes a 4-bit word, what is the minimum required bandwidth of that channel?

Kindly see below Image Q5.jpeg

Q3.

$s(t) = 4\sin(2\pi t) + 2\sin(6\pi t) + (8/\pi)\sin(7\pi t)$ — (1)

Let's compare this with a signal sign wave

$s(t) = A\sin(2\pi f t)$ where A = Amplitude, f = frequency, t = time domain.

arraye eq (1) in standard,

$s(t) = 4\sin(2\pi(1)t) + 2\sin(2\pi(3)t) + (8/\pi)\sin(2\pi(7/2)t)$

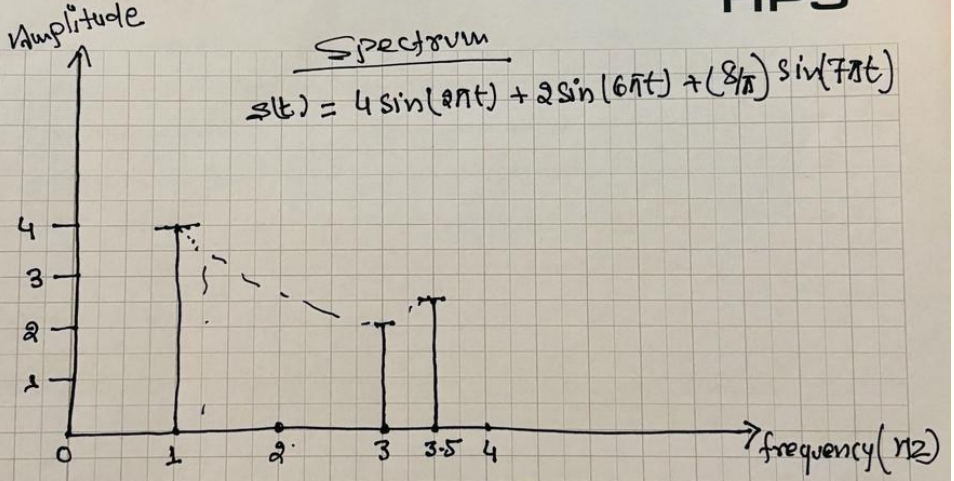
A = 4, f = 1, A = 2, f = 3, A = $(8/\pi)$, f = 7/2

Now, let's draw spectrum graph with respect to freq.

HPS

Spectrum

$s(t) = 4\sin(2\pi t) + 2\sin(6\pi t) + (8/\pi)\sin(7\pi t)$



(*) Absolute Bandwidth = $f_{high} - f_{low}$

$= 3.5 - 1$

$= 2.5$ Hz

(*) Effective Bandwidth = Absolute Bandwidth

$= 2.5$ Hz

Because given signal is of finite Bandwidth

(This you mentioned in Recorded video)

Q4. Given,

$B = 300\ Hz$

$SNR = 3\ dB$

We have to find C?

We know from Shannon-Hartely theorem

$$C = B \log_2(1 + SNR) \quad \text{---} \quad (1)$$

But here SNR is provided in dB, Now we need to convert this to linear SNR.

Therefore,

$$(SNR)_{dB} = 10 \log_{10}(SNR)$$

and

$$SNR = 10^{\frac{+SNR_{dB}}{10}} = 10^{(3/10)}$$

$$\Rightarrow \boxed{SNR = 1.995} \rightarrow (2)$$

Substitute eq (1) with SNR value (2)

$$C = 300 * \log_2(1 + 1.995)$$

$$= 300 \times \log_2(2.995)$$

$$= 300 \times 1.58$$

$$\boxed{C = 474.8\ bps\ (bits/sec)}$$

Q.5. Given

$C = 9600$ bps

Signal level $(M) = ?$

Find B (Bandwidth) $= ?$

and we know that,

$M = 2^{\text{word}} = 2^4 = 16.$

Based on Formula (Nyquist)

$C = 2B \log_2 M.$

$\Rightarrow C = 2B \log_2 16$

$\Rightarrow B = \frac{C}{2\log_2 16} = \frac{9600}{2 \times 4} = \frac{9600}{8}^{1200}$

$\Rightarrow \boxed{B = 1200 \text{ Hz}}$