Total 81%

PART A = 42

A.1.i)

Question: Which one of these signals will occupy the largest bandwidth, and why (intuitively)?

Answer: 'a' - The first graph displays a signal with a higher frequency as its wave more active which would interpret that the bandwidth of 'a' is large than the bandwidth of

4

A.1.ii)

Question: Imagine playing the recording of a voice at different volume levels, e.g. first quiet, then loud. How would the frequency spectrum of the signal change?

Answer: The frequency of the signal would not change. However, the amplitude of the signal would increase if we increase the volume levels. The frequency is related to the pitch of the sound not its amplitude.

4

A.2.i)

Question: Describe briefly the main operations taking place from the moment the DLL sends a frame to the Physical Layer to the moment a continuous signal representing that frame is sent over a physical medium.

Answer: The PL will initially have to undergo a process called modulation, during which it will break down the bit frame received from the DLL and process turn it into a signal made from 0s (negative voltage) and 1s (positive voltage). Following that the physical layer will calculate the correct data rate that shall be used and deal with synchronization (making sure the sender and receiver are synchronised). Finally, it will be required for the PL to determine what the best transmission mode should be (simplex/half-duplex/full-duplex) and what type of interface is going to be used as it can be ethernet, wireless and others. Modulation is only used for single signals over a channel so usually an additional process called Multiplexing is introduced in the physical layer that allows in multiple ways (FDM/WDM/TDM) to send multiple signals over the interface.

4

A.2.ii)

Question: Which ones of these quadrature amplitude modulation schemes will be more robust to noise on the channel, and why? Assume that the max and min values on each axis are the same in the two figures.

Answer: 'a' – As the points are more separated there is less chance of a noise and data error being encountered which makes the scheme more robust for this task. This helps eliminate the threat of hitting the wrong point.

4

A.2.iii)

Question: What is the Nyquist sampling frequency for the following signal, expressed as a sum of sinusoids? s(t) = 5 sin(10πt) + 10 sin(6πt + 30◦) + 2 sin(8πt + 45◦)

Answer: s(t) = 5Hz + 3Hz + 4Hz - Max frequency is 5Hz => Nyquist sampling frequency = 10Hz

4

A.3.i)

Question: Consider a noisy telephone line with a signal-to-noise ratio of 30dB. What would be the bandwidth needed to achieve a bit rate of 300 kbit/s? Is this the bandwidth allocated in reality to phone conversations? (Reminder: x in db = 10 log10 x)

Answer: B = Hlog2(1+S/N)Bits/second | 30db = 10log10(x) -> x = 1000 = S/N

5

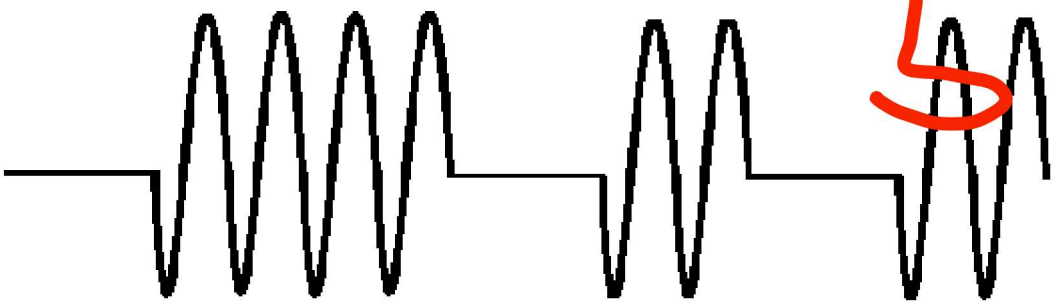
- ➔ H = 300000bit/s / log2(1+1000).bit/s
- ➔ H = 30.1kHz~ (30.098644518)

No, it is not. The frequency is way above the normal one for a telephone line by a great magnitude comparing 8kHz to 30.1kHz.

A.3.ii)

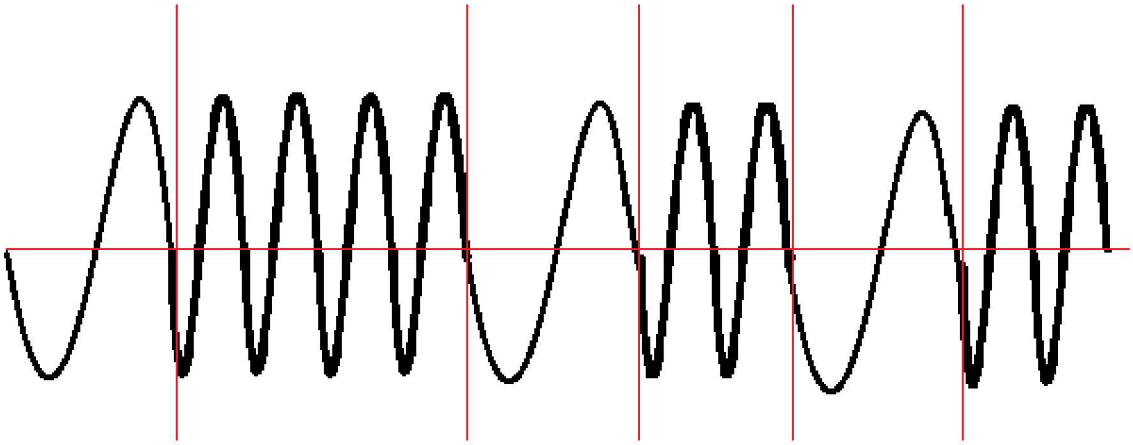
Question: A sequence of bits is illustrated in the figure below. Draw the modulated version of the sequence using (1) amplitude shift keying, (2) frequency shift keying.

1)



5

2)



A.3.iii)

Nyquist Theorem:

Bit Rate = 2H.log2(L)

1) 8k bit/s | 2 x 4000 x log2(2)
2) 56k bit/s | 2x 4000 x log2(128)

5

A.4.i)

Question: In terms of DLL protocols, why is it important to consider the round-trip delay of a channel and not just the one-way delay?

Answer: The Data Link Layer requires acknowledgement that the packet was received by the other network which can only be done if a round-trip delay is issued instead of a one-way delay which would not provide feedback to the DLL. This also provides information to how long it takes to receive a response from the other network.

3

A.4.ii)

Question: Briefly explain how the Manchester encoding scheme achieves maintaining clocks aligned at sender and receiver.

Answer: By encoding the output with transitions at the middle of each bit period. The transition that occurs in this process indicates the data. Additionally, it is made so transitions which are at the start of a period do not signify the data. As there is a transition in every bit, the receiver can easily align itself correctly with an error check every half bit period.

3

A.4.iii)

Question: Why is the bandwidth of a physical channel generally much smaller than the range of frequencies over which the channel attenuation is non-zero?

Answer: By using a smaller bandwidth, it allows the physical channel to send multiple information streams over the cable. You could have multiple small signals and streams be pushed through the channel at the same time. As an example, you could send 2 signals, with attenuation that is non-zero, of 1kHz simultaneously over the channel.

1

Part B: 16

B.1.i)

Question: What does this acronym stands for? (3 words maximum)

Answer: Network Address Translation

1 **B.1.ii)**

Question: Explain and illustrate with an example the meaning of T in this acronym. (100 words maximum)

unclear why the translation is needed

Answer: It is the function of remapping an IP address into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device. This can be used for networks with multiple devices as it could allow to privately assign each device an IP within its network this further allows for better security for the device. These private IP addresses are stored in the router in a NAT translation table.

no example or illustration

2 **B.2.i)**

The device doing the NAT needs to store some information in a table, what does that table look like? Briefly describe each component (100 words maximum in total).

Answer:

- Local IP address – IP address of the device in the network
- Local Source Port number – the port that the device is transmitting through
- Internet IP address – The IP address that represents the network (given by NAT provider)
- Source port number – port on the router that is used to return information to the device.

what is the role of rows?

1 **B.2.ii)**

Question: Discuss why this technology sits between the Network and Transport Layer

Answer: NAT requires the use of protocols from the Network layer as it would require the IPv4 protocols to store the translation tables while also requiring TCP protocols from the Transport layer to establish communication with internet services. Because of this NAT is placed in between both layers.

unclear and only vaguely related to the idea

7 **B.3)**

Question: Explain how this technology can improve the security of a network.

Answers: The key security that comes with NAT is the ability to hide devices behind a private IP address on the networks they are connected to. This makes I harder for devices outside of the network to identify which device they are communicating with as the NAT router will automate that process. Additionally, NAT firewalls are a common use of security that is used. The firewall will only allow specific data that the local device requested to be passed onto it. This allows the local device to be protected as no unwanted data can be received by it.

does not consider limitation but otherwise good

1 **B.4.i)**

Question: Explain why this is prevented by NAT without additional configuration. (150 words maximum)

Answer: Different game services which provide server features usually have a specific port which they use. When setting up a server on a router that uses network address translation that port gets changed by the router which blocks users outside of the local network access from using the server.

very confusing and does not relate to the need of an entry in the NAT table

B.4.ii)

Question: What is the name of the solution to this problem? (2 words maximum)

Answer: Port Forwarding