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Data Comms Assignment 1

Question 1. $f(x) = \begin{cases} 0, & -\pi \le x < 0 \\ 1, & 0 \le x < \pi \end{cases}$ $f(x+2\pi) = f(x)$

$T = 2\pi$

find A_0:

$$A_0 = \frac{2}{T}\int_0^{2\pi} x(t)\,dt \Rightarrow \frac{2}{2\pi}\int_0^{\pi} 1\,dt = \frac{1}{\pi}\int_0^{\pi} t = 1\,\frac{\pi}{\pi}$$

$$A_0 = 1$$

$$f_0 = \frac{1}{T} = \frac{1}{2\pi} \Rightarrow 2\pi n f_0 t = nt$$

$$a_n = \frac{2}{2\pi}\int_0^{2\pi} x(t)\cos(2\pi n f_0 t)\,dt = \frac{1}{\pi}\int_0^{\pi} \cos(nt)\,dt = 0$$

$$b_n = \frac{2}{2\pi}\int_0^{2\pi} x(t)\sin(2\pi n f_0 t)\,dt = \frac{1}{\pi}\int_0^{\pi} \sin(nt)\,dt = \frac{1}{\pi}\int_0^{\pi} \frac{-\cos(nt)}{n}$$

$$= \frac{-\cos(\pi n) + 1}{\pi n}$$

$\therefore$ $B_1 = \frac{2}{\pi}$ $B_2 = 0$ $B_3 = \frac{2}{3\pi}$ $B_4 = 0$ $B_5 = \frac{2}{5\pi}$ ... and

$$f(x) = \frac{1}{2} + \frac{2}{\pi}\left(\sin x + \frac{\sin(3x)}{3} + \frac{\sin(5x)}{5} \ldots\right)$$

$f(x+2\pi) = f(x)$

Question 2. $f(x) = \begin{cases} -1 & -\pi \le x < 0 \\ 1 & 0 \le x < \pi \end{cases}$

$T = 2\pi \quad f_0 = \frac{1}{2\pi}$

$$A_0 = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-1)\,dx + \int_{0}^{\pi}(1)\,dx\right] = 0$$

$$A_n = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-1)\cos nx\,dx + \int_{0}^{\pi}(1)\cos nx\,dx\right] = 0$$

$$B_n = \frac{1}{\pi}\left[\int_{-\pi}^{0}(-1)\sin nx\,dx + \int_{0}^{\pi}(1)\sin nx\,dx\right] =$$

$$= \frac{1}{\pi}\left[\frac{1}{n}(1-\cos(-n\pi)) + 1-\cos(n\pi)\right]$$

$$= \frac{2}{\pi n}\left[1-\cos(n\pi)\right]$$

$\therefore B_1 = \frac{4}{\pi}, B_2 = 0, B_3 = \frac{4}{3\pi}, b_4 = 0, b_5 = \frac{4}{5\pi}, b_6 = 0$

$$f(x) = \frac{4}{\pi}\left(\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} \dots\right)$$

Question 3. Audio Signal range 400 to 4200

a. Using Nyquist 2 · highest freq = min samp

2 · 4200 = 8400 Hz

∴ Min Sampling Rate is 8400Hz

b.

$6.02n + 1.76 = 36$

$n = 5.68 \simeq 6$

∴ $M = 2^n = 2^6 = 64$

c. Sampling Rate = 8400

Data Rate = Samp · n = 8400 · 6

∴ data Rate = 50400 bps or 50.4 Kbps

D. $\Delta V = (5 - (-5))/64 = 0.15625$

PCM(-3.3) = $(-3.3 - (-5))/0.15625 = 10.88 \simeq 11$

PCM(2.9) = $(2.9 - (-5))/0.15625 = 50.56 \simeq 51$

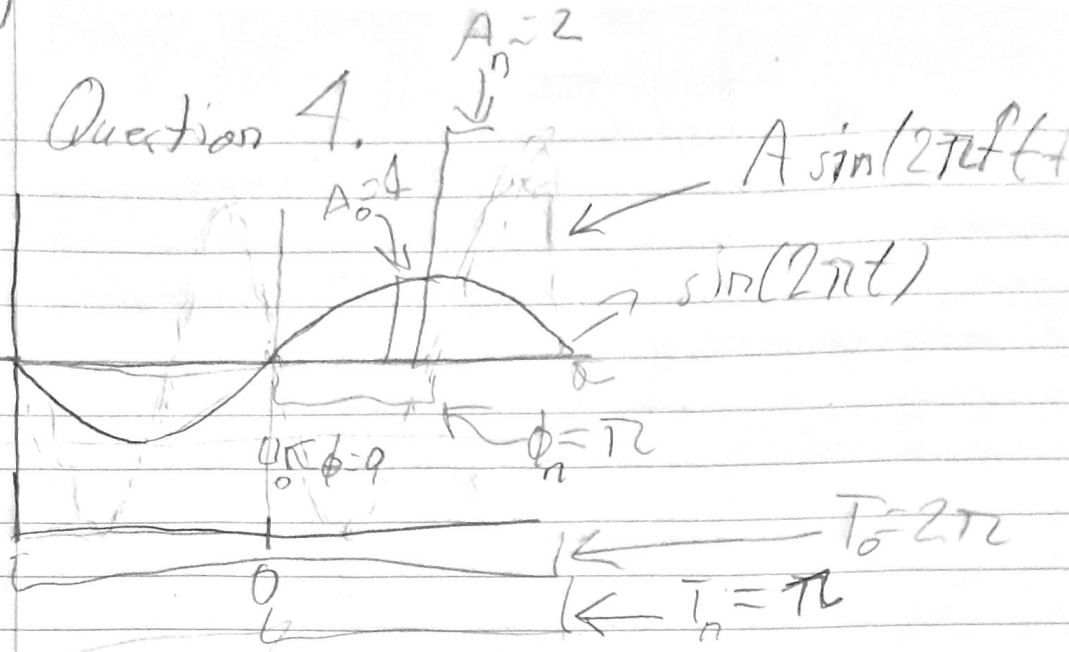
∴ PCM(-3.3) = 11 = 001011

PCM(2.9) = 51 = 110011

o = original

n = New

Question 4.



$A = 2$

$\frac{A_n}{A_o} = \frac{2}{1}$

$\phi = \pi$

$\phi = \phi_n - \phi_o = \pi - 0 = \pi$

$f = \frac{1}{T}$ $f_n = \frac{1}{\pi}$ $f_t = \frac{1}{2\pi}$

$\frac{f_n}{f_o} = f = 2$

$\therefore A = 2, f = 2, \phi = \pi$

Question 5.

$P_{signal_{DB}} = -40\ dBm$ $\quad P_{noise_{DB}} = -87\ dBm$

$P_{signal} = 10^{-4} = 1\times10^{-4}$ $\quad P_{noise} = 10^{-8.7} = 1\times10^{-8.7}$

$SNR = \frac{P_{signal}}{P_{noise}} = \frac{1\times10^{-4}}{1\times10^{-8.7}} = 50118.72$

$SNR_{DB} = 10\ Log_{10}(SNR)$

$SNR_{DB} = 46.999 \simeq 47$

$\therefore SNR = 50118.72$ and $SNR_{DB} = 47$

Question 6. $B = 4400\ Hz$ $\quad SNR_{DB} = 42_{DB}$

$SNR = 10^{\frac{SNR_{DB}}{10}} \simeq 15848.93$

$C_{th} = 4400\ Hz\ Log_2(SNR+1)$

$C_{th} = 61389.631\ Hz$ $\quad 61389.631 \cdot 0.8 = C_R = 49111.7$

$C_R = 2 \cdot B\ Log_2(M)$ $\quad \frac{49111.7}{2 \cdot 4406} = M = 47.86 \simeq 32$

round down.

$\therefore M = 32$

7. $P_1 = 3mW$ $loss = -0.4\ dB/km$

$loss\ total = -0.4 \cdot 14 = -5.6$

$-5.6 = 10 \log_{10}\left(\frac{P_2}{3mW}\right)$

$P_2 = 0.826268 \simeq 0.83mW$

$\therefore P_2$ is $0.83mW$

8.

Layer	Protocol Data Unit	address
Application	Message	Names
Transport	segment / user datagram	Port Numbers
Network	datagram	Logical address
Data link	Frame	Link Layer address
Physical	Bits	

Examples

App — This is a message

Trans — 5901, 6000

Net — 198.168.0.1 | 198.168.0.2

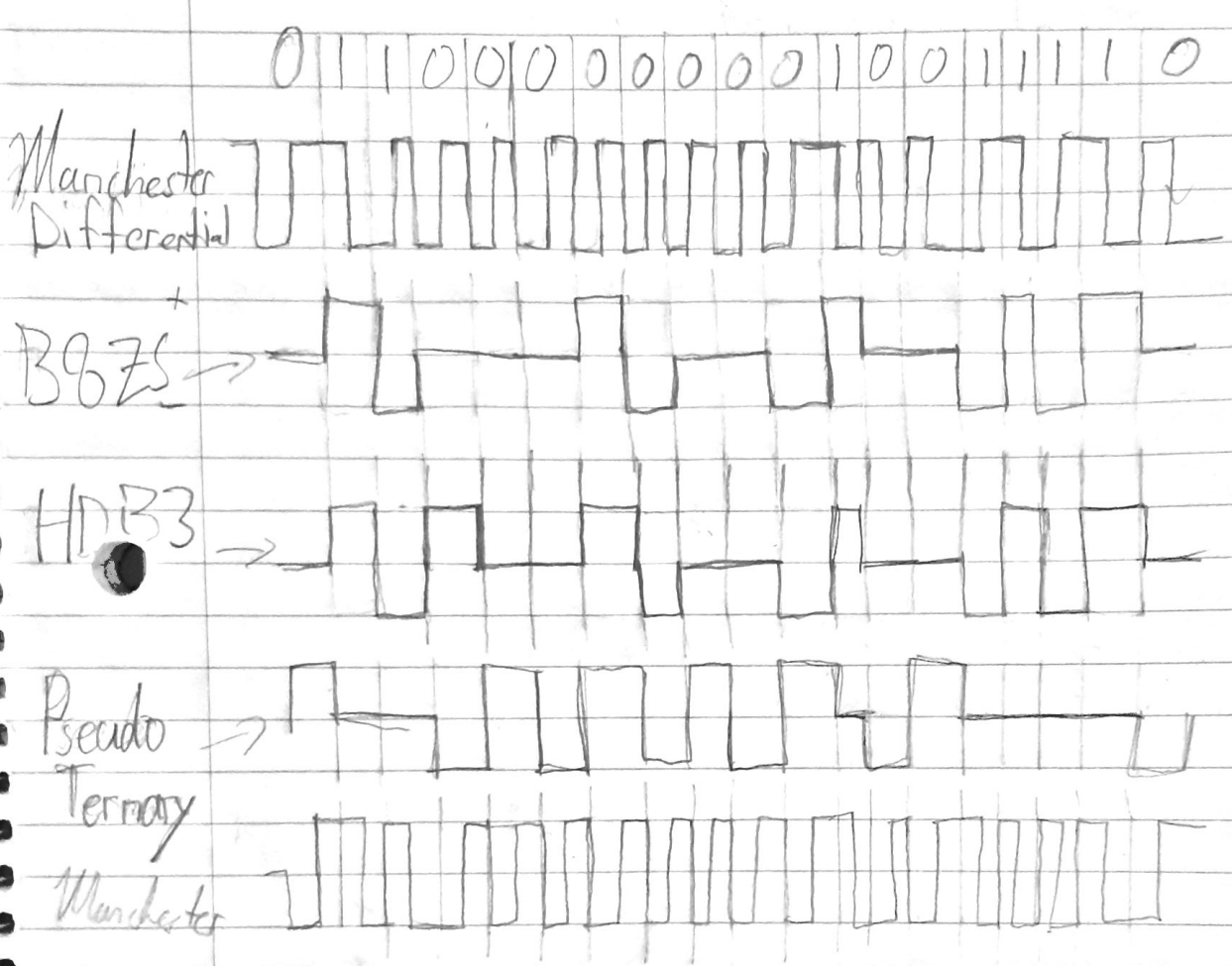
Data — 00-1B-7F-BB-9C-98 | 01-1C-2D-FC-4D-92

Phys — 1010000010010

Question 9

a) The encoding style is Manchester differential encoding

b)



c) Manchester Diff: Regular

Pros: -

- allows for clock synchronization on 0's.
- Error Detection = No Dc comp

Cons

- if all recieved is 1's (diff.) or 0's (reg) the clock can appear slower than it really is (Bad synch)
- relatively high Baud Rate (2x NRZ)
- Requires higher Bandwidth

HDB3 and B8ZS

Pros: - Error Detection capability
- No large sequences of zeroes to cool with synchronization
- Alternating pulses make synchronization simple
- No Reduction in data Rate
- No DC component

Cons:
- Bad at Range
- High signalling Rate
- Complex algorithm required for encode, decode.

Pseudo-Ternary Pros:
- No loss of sync if a long string of 0's
- Easy Error Verification
- simple design (easy to make)
- good use of Bandwidth

Cons:
- loss of sync in large String of 1's
- DC component
- not generally good for signals

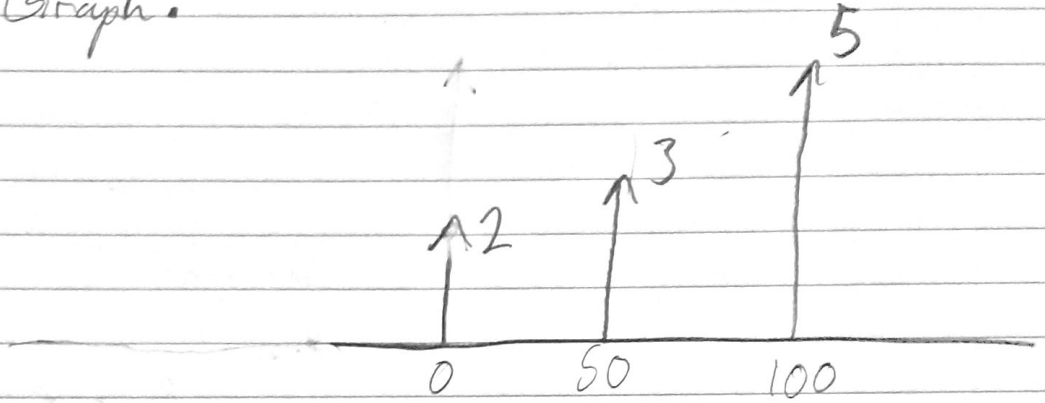
Question 10

$S(t) = 2 + 3\sin 100\pi t + 5\sin 200\pi t$

$= 2 + 3\sin 2\pi \cdot 50 \cdot t + 5\sin 2\pi \cdot 100 t$

Frequency Domain from $0 \rightarrow 100$

Graph:



Bonus: What type of Hacking?

The type of attack was DNS poisoning.

The attacker first uses a man in the middle to gain a leverage position in order to execute a DNS poisoning attack.

Packets from row 1 to 11 show the attack