Student Number _____ Student Name: _____

# University of Saskatchewan
# EE 352 Communication Systems I
## Quiz #3 – Apr.4/2003

Time: 25 minutes

Permitted: - text, printed notes, student's own *hand-written* materials
Use the space below each question for your answer.

1 2
2 2
3 1½
4 1½
5 _____

7/10

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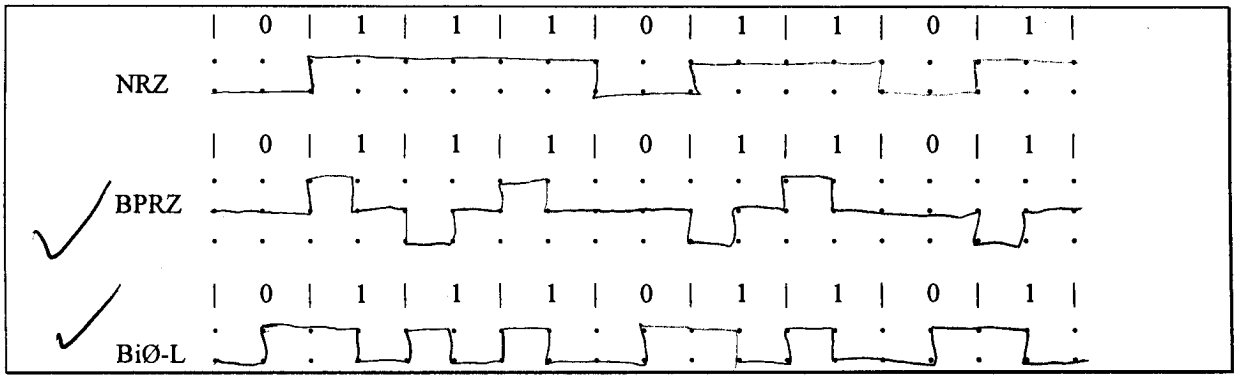
1 Illustrate non-return to zero (NRZ), bipolar return to zero (BPRZ) and Manchester (biphase-level) coding for the following binary sequence (2 pts)

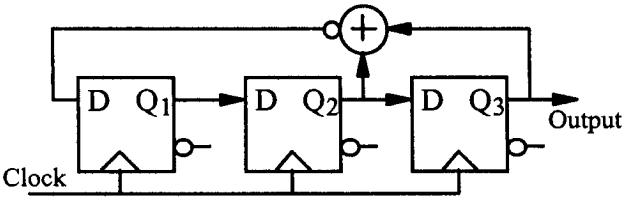



*2 A three-stage shift register is connected to produce a pseudorandom binary sequence (PRBS). This is also known as a maximal length (ML) or pseudonoise (PN) sequence. Assume that the resisters start in the all zero state (000) and that the output voltage levels are ±2 volts. The clock frequency is 7 MHz (3 pts)

i) What is the length and bit pattern of the output sequence? How often does the sequence repeat?

ii) Sketch the two-sided spectrum (Fourier series) of the output. Calibrate the frequency and amplitude scales in your illustration and include units.

iii) Calculate the power in the time domain. Consider Parseval's Theorem and estimate the power in the frequency domain up to the first spectral null.



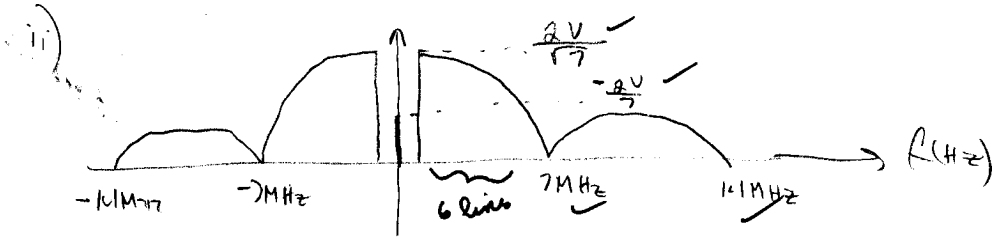

| | |
|---|---|
| 0 0 0 | 0 |
| 1 0 0 | 0 |
| 1 1 0 | 0 |
| 0 1 1 | 1 |
| 1 0 1 | 1 |
| 0 1 0 | 0 |
| 0 0 1 | 1 |

i) $2^3-1 = 8-1 \Rightarrow$ ✓

if CLK = 7MHz $T = \frac{1}{7MHz} = 149.85ns$

$\Rightarrow T = 1\mu s$ repeat every $1\mu s$ ✓

ii)




iii) power is [illegible] with amplitude 2V

*3 a) Complete the table below for digital transmission signals used in North America. (1 pt)

| | DS1 | DS1-C | DS3 | STS-1 |
|---|---|---|---|---|
| Number of voice signals | 24 ✓ | 48 ✓ | 672 | 672 |
| Transmission bit rate (Mb/s) | 1.544 | 3.152 | 44.736 ✓ | 51.84 ✓ |
| Number of bits per Multiframe (or STS-1 frame) | 3316 ✓ | 1272 | 4760 | 6480 |
| Duration of the Multiframe (us) | 1500 | 403.6 ✓ | 106.4 | 125 |
| Nuumber of framing bits per Multiframe (or STS-1 frame) | 12 ✓ | 12 | 31 | 16 ✓ |
| Checksum (truncated) | 3853 | 1738 | 5614 | 7344 |

-1

b) What is the probability that a given 16 bits of random data will resemble the STS-1 framing word? What is the probability that this pattern will occur at least once within the "random" data (or other overhead) portions of a 125 us STS-1 frame? (1 pt)

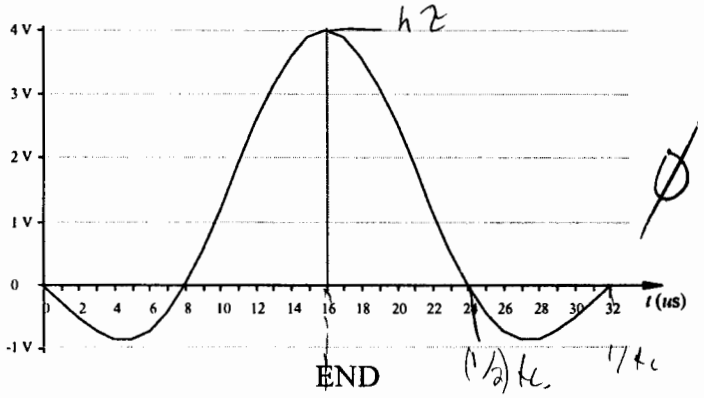
Bad Wording

a) $P = 1 - (1 - 2^{-16})^{(513 \times 8079)} = 7.7 \times 10^{-3}$

b) $P_{FA} = 2^{-16} = 15.26 \times 10^{-6}$ ✓

*4 A transversal filter is constructed from a binary shift register with 16 taps. The transversal filter is arranged to generate an approximation to a single sin $\pi f_b t / \pi f_b t$ pulse truncated at $t = 2/f_b$ where the bit rate $f_b$ = 100 kb/s. The clock rate of the shift register is 4 times the bit rate thus each sidelobe of the time response has 4 samples and the main lobe has 8 samples. The peak voltage of the transmitted pulse is 4 volts. (3 pts)

i) On scales below, sketch the time response of the filter output (i.e. the approximation).
ii) On a two-sided calibrated frequency axis, sketch the spectrum of the transmitted signal if the sin $\pi f_b t / \pi f_b t$ pulse were not truncated.
iii) Approximately sketch the spectrum of the truncated transmitted pulse. Note that the transmitted pulse can be modeled as the product of a single sin $\pi f_b t / \pi f_b t$ pulse and a gating pulse and that the resulting spectrum is the convolution of the two spectra in the product.




END

i)


ii)