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et de génie électrique

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Canada's university

University of Ottawa
Faculty of Engineering

School of Electrical Engineering
and Computer Science

COURSE: SEG3155
SEMESTER: Winter 2012

PROFESSOR: Jiying Zhao
DATE: February 28, 2012
TIME: 10:00 to 11:20

MIDTERM EXAMINATION

NAME and STUDENT NUMBER:_____/_____

Mid-Term Exam

1. There are two (2) types of questions in this examination.

Part 1	**Multiple choice**	**20 marks**	
Part 2	**Short answer**	**45 marks**	
Total		**65 marks**	

2. Answer briefly and to the point. The space allocated for each question is limited. In case of necessity you may use the other side of the pages to continue.
3. Initial all the pages.

▪ Part 1 - Multiple choice questions [2 marks each]:

1 Which of the following is not correct in TCP/IP architecture?

a) A TCP segment is encapsulated in an IP datagram.
b) A UDP segment is encapsulated in an IP datagram.
c) A UDP segment is encapsulated in a TCP segment.
d) An IP datagram is encapsulated in a second-layer frame.

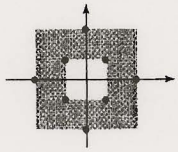
2 Which of the following is not correct?

a) A signal is defined to be periodic if and only if $s(t+T)=s(t)$, where the constant T is the period of the signal and $-\infty < t < +\infty$.
b) Not all periodic signals can be represented as a sum of sinusoids.
c) The frequency is the rate in Hertz (Hz) at which the signal repeats, and $T \times F = 1$.
d) A sinusoid is a periodic signal.

3 In which of the following does the baud rate always equal bit rate?

a) FSK
b) QAM
c) 4-PSK
d) all of the above

4 The following constellation represents _____.



a) ASK
b) FSK
c) PSK
d) QAM

5 In a Go-Back-N ARQ, if the window size is 63, what is the range of sequence number?

a) 0 to 63
b) 0 to 64
c) 1 to 63
d) 1 to 64

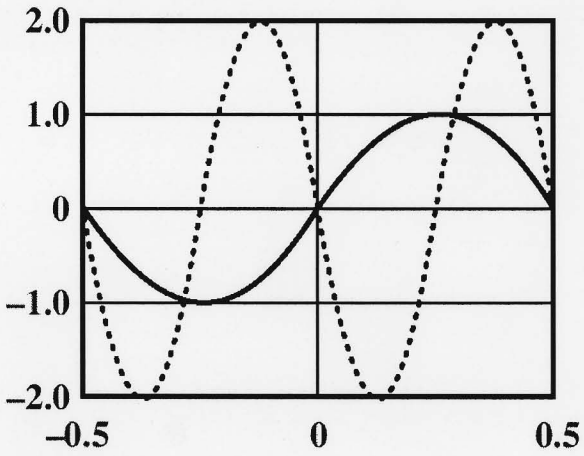
6 In selective reject, if the sender sent frames 0, 1, 2, and 3 and the receiver sent SREJ 2. What frame(s) will the sender resend?

a) 1, 2, 3
b) 1, 2
c) 2
d) 2, 3

7 The hexadecimal representation of ASCII code for character 'A' is 41H. Suppose the most significant bit is used for odd parity. Which of the following is not correct?

a) Including the parity bit, the code for 'A' is C1H.
b) Including the parity bit, the code for 'B' is C2H.
c) Including the parity bit, the code for 'C' is C3H.
d) Including the parity bit, the code for 'D' is C4H.

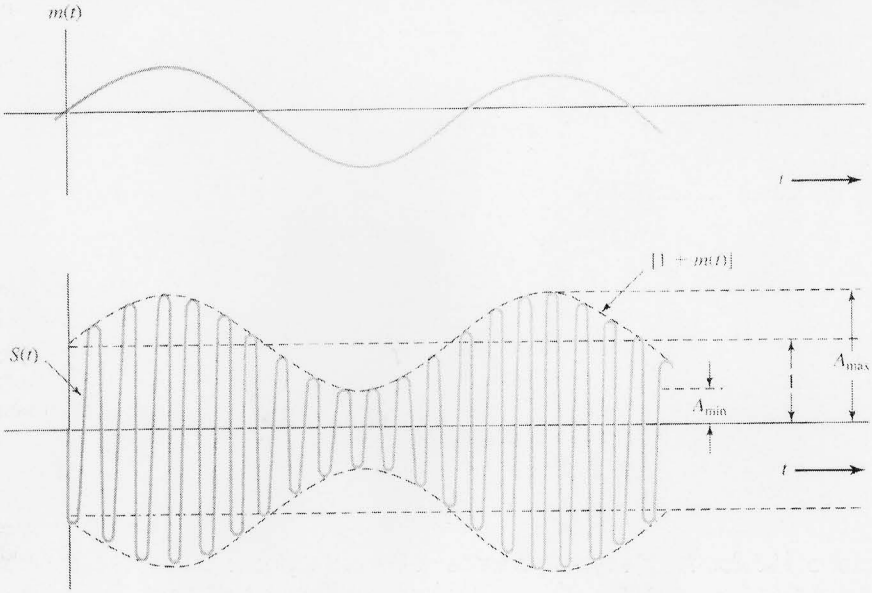
8. Refer to the figure to the right. If the solid curve is written in the form of $A\sin(2\pi ft+\phi)$, what are A, f, and ϕ?



a) 2, 2, π
b) 1, 1, π
c) 1, 1, 0
d) 1, 2, 2π

9 Look at the following two figures, which show m(t) and s(t). Which of the following is not correct?

a) The two figures describe amplitude modulation (AM).
b) m(t) on the top is the data to carry.
c) S(t) on the bottom is the modulated signal.
d) The two figures describe frequency modulation (FM).



10 Hamming distance. For k=2 and n=5, we can make the following assignment:

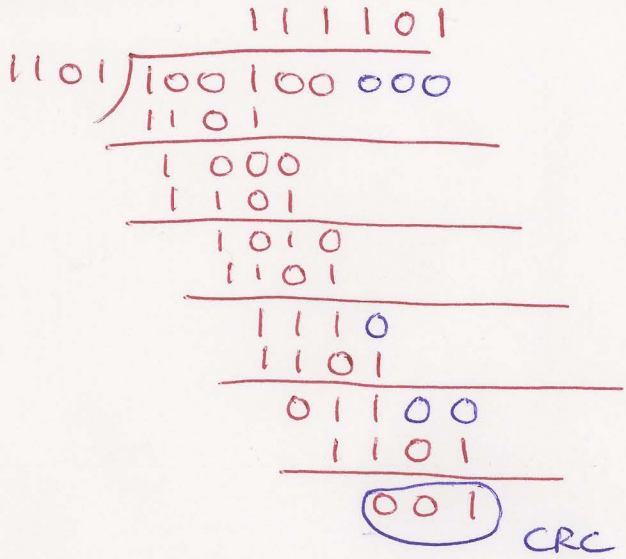
Data block	Codeword
00	00000
01	00111
10	11001
11	11110

Now, suppose that a codeword block is received with the bit pattern 11100. What could be most likely the codeword that was sent?

a) 00000
b) 00111
c) 11001
d) 11110

Part 2 - Short-answer questions

11 **[6 marks]** In CRC, the data unit is 100100 and the divisor 1101. Calculate the CRC code.



12 **[6 marks]** Suppose that the spectrum of a channel is between 300 Hz and 3300 Hz, and SNR_{dB} = 35 dB. What is the capacity of the channel?

$B = 3300 - 300 = 3000\,Hz$

$SNR = 10^{\frac{SNR_{dB}}{10}} = 3162$

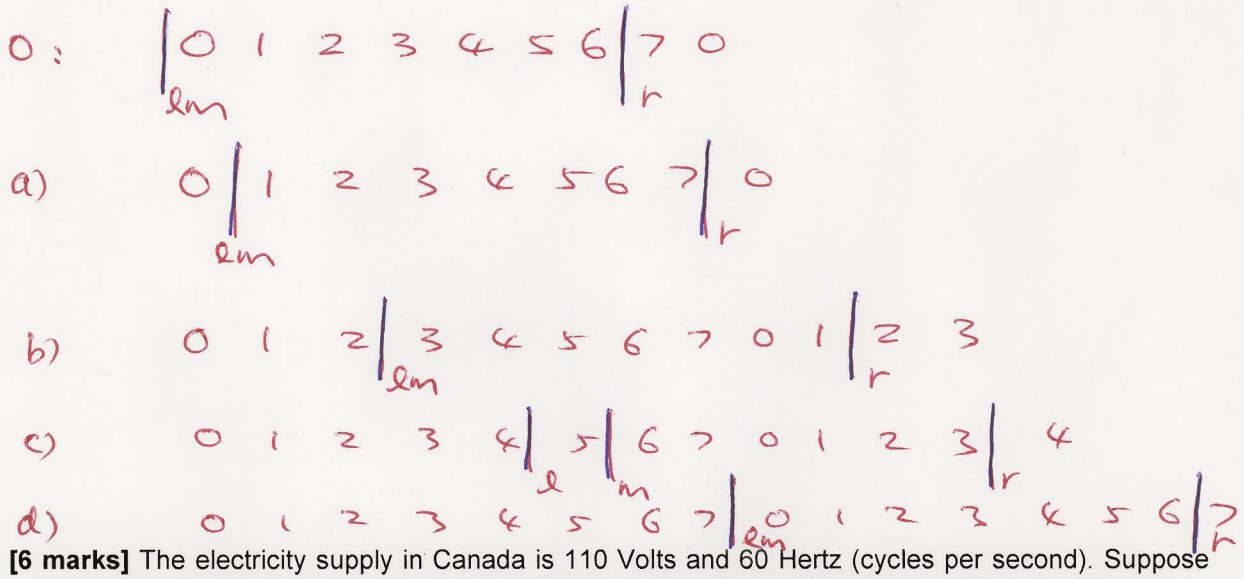
$C = B\log_2(1+SNR) = 3000 \times \log_2(1+3162)$

$= 3000 \times 11.6271$

$= 36881\ bps$

13 **[6 marks]** HDLC is used. Both N(S) and N(R) are 3 bits. The sliding window size is 7. Initially, the frames in the sliding window are 0, 1, 2, 3, 4, 5, 6. Draw the sender's sliding window for the system using Go-Back-N ARQ, given the following:

a) Frame 0 is sent; frame 0 is acknowledged.
b) Frame 1 and 2 are sent; frames 1 and 2 are acknowledged.
c) Frames 3, 4, and 5 are sent; frame 4 is acknowledged; timer for frame 5 expires.
d) Frames 5, 6, and 7 are sent; frames 4 through 7 are acknowledged.



14 **[6 marks]** The electricity supply in Canada is 110 Volts and 60 Hertz (cycles per second). Suppose we are sampling the electrical signal with a dynamic range from -120 volts to +120 volts. We want to observe up to the third harmonic. We use 1 byte to represent each PAM value. What will be the bit rate? What will be the PCM value (in binary) for a particular sampling point with a voltage of 100 volts?

Sampling rate: $60 * 3 * 2 = 360$ samples/second

(3) bit rate: $8 \times 360 = 2880$ bps

(3) $\frac{100-(-120)}{120-(-120)} * 255 = \frac{220}{240} * 255 = 234 = (11101010)_B$

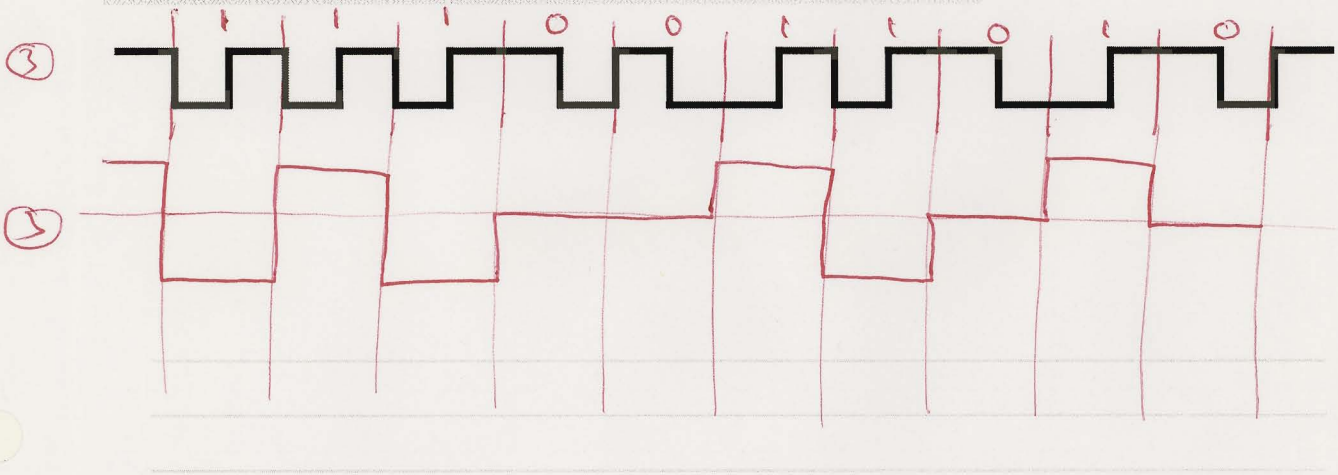
15 **[6 marks]** The following waveform belongs to a Manchester-encoded binary data stream. Give the data sequence. Then draw the HDB3 (refer to the following rules) encoding that represent the same data sequence.

	Number of bipolar pulses (ones) since last substitution	
Polarity of preceding pulse	Odd	Even
-	000-	+00+
+	000+	-00-

Manchester

0 = transition from high to low in middle of interval

1 = transition from low to high in middle of interval

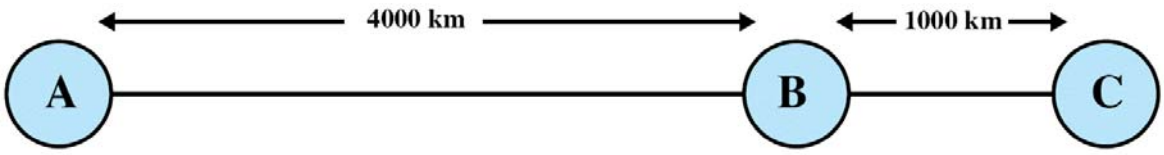


16 **[5 marks]** $s(t) = 8 + 3\sin 100\pi t + 5\sin 200\pi t$. Roughly draw the frequency domain representation of s(t).

17 [**10 marks**] In the following figure, frames are generated at node A and sent to node C through node B. Determine the minimum data rate required between nodes B and C so that the buffers of node B are not flooded, based on the following:

- The data rate between A and B is 100 kbps.
- The propagation delay is 5μs/km for both lines.
- There are full duplex lines between the nodes.
- All data frames are 1000 bits long: ACK frames are separate frames with negligible length.
- Between A and B, a sliding window protocol with a window size of 3 is used.
- Between B and C, stop-and-wait is used.
- There are no errors.

Hint: In order not to flood the buffers of B, the average number of frames entering and leaving B must be the same over a long interval. In other words, the effective data rate between A and B should be the same as the effective data rate between B and C.



Note:

$$a = \frac{t_{prop}}{t_{frame}}$$

For stop-and-wait flow control, the maximum possible utilization of the link can be calculated as $U = \frac{1}{1+2a}$.

For error-free sliding-window flow control with a window size of W, the maximum possible utilization of the link can be calculated as $U = \begin{cases} 1 & W \geq 1+2a \\ \frac{W}{1+2a} & W < 1+2a \end{cases}$.

For both stop-and-wait and sliding-window, the effective data rate (actually how many bits of data can be transmitted per second) can be calculated as $R_e = R \times U$, where R is the given nominal data rate. For example, in this question, between node A and node B, R=100 kbps.

① $U_{AB} = \dfrac{3}{1+2a_{AB}}$

$a_{AB} = \dfrac{t_{prop_{AB}}}{t_{frame_{AB}}} = \dfrac{5\times10^{-6}\times4000}{1000/(100\times10^{3})} = 2$ ④

$U_{AB} = \dfrac{3}{1+2\times2} = 0.6$

$U_{eAB} = U_{AB} \times 100\times10^{3} = 60\times10^{3}$ bps

② $a_{BC} = \dfrac{t_{prop_{BC}}}{t_{fram_{BC}}} = \dfrac{5\times10^{-6}\times1000}{1000/x} = 5x\cdot10^{-6}$

$U_{BC} = \dfrac{1}{1+2a_{BC}} = \dfrac{1}{1+5x\cdot10^{-6}\times2}$

$U_{eBC} = \dfrac{1}{1+5x\cdot10^{-6}\times2}\cdot x$ ④

③

$U_{eAB} = U_{eBC}$

$60\times10^{3} = \dfrac{x}{1+5x\cdot10^{-6}\times2} = \dfrac{x\times10^{6}}{10^{6}+5x\times2}$

$x\cdot10^{3} = 60\times(10^{6}+10x) = 60\times10^{6}+600x$ ②

$400x = 60\times10^{6}$

$x = 150\times10^{3}$ bps