Université d'Ottawa
Faculté de génie

École de science informatique
et de génie électrique

uOttawa

L'Université canadienne
Canada's university

University of Ottawa
Faculty of Engineering

School of Electrical Engineering
and Computer Science

COURSE:	CEG3185	**PROFESSOR:**	Jiying Zhao
SEMESTER:	Winter 2015	**DATE:**	February 25, 2015
Room:	ART257	**TIME:**	14:30 to 15:50

MIDTERM EXAMINATION

NAME and STUDENT NUMBER:_____/_____

Mid-Term Exam

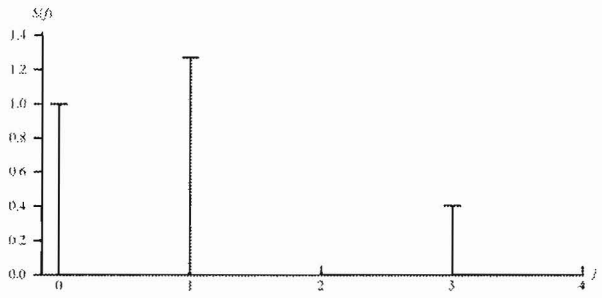
1. There are two (2) types of questions in this examination.

Part 1	**Multiple choice**	**30 marks**	
Part 2	**Short answer**	**35 marks**	
Total		**65 marks**	

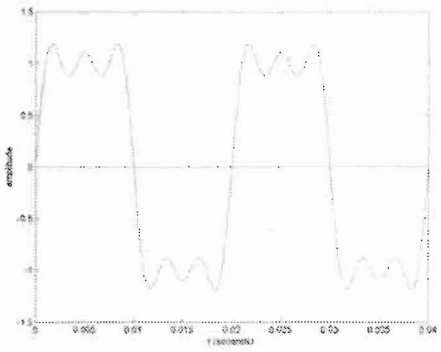
2. Answer briefly and to the point. The space allocated for each question is limited. In case of necessity you may use the other side of the pages to continue.

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

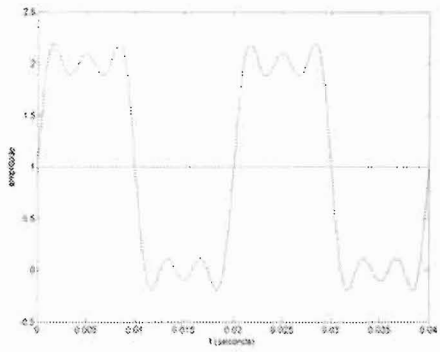
1.
Refer to the frequency components S(f) of a signal. Which of the following are most likely the corresponding signal?



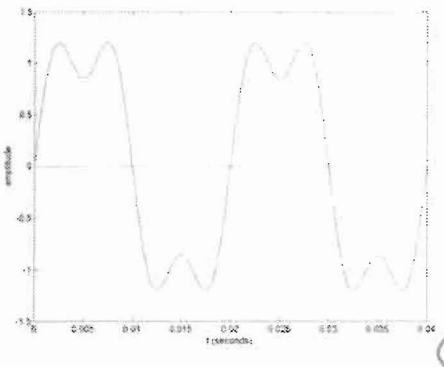
a)



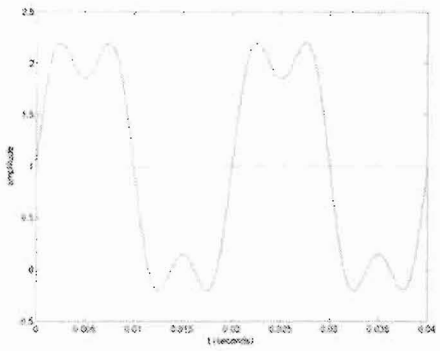
b)



c)



d)

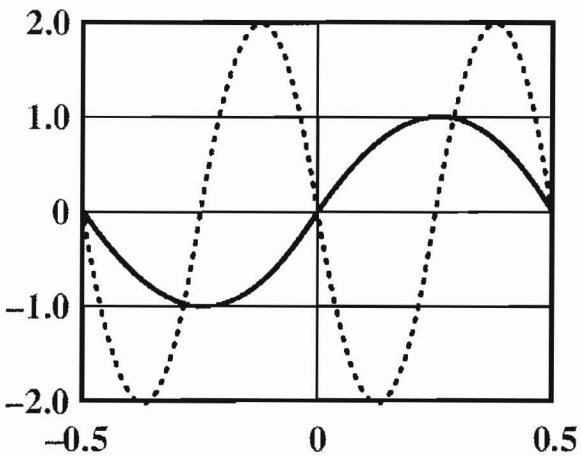


2. In CRC, if the data unit is 111111, the divisor 1011, and the remainder 110, what is the dividend (a number to be divided by a divisor) at the receiver?
   a) 111111011
   b) 111111110
   c) 1010110
   d) 110111111

3. If the frequency spectrum of a signal has bandwidth of 500 Hz with the highest frequency at 600 Hz, what should be the Nyquist sampling rate?
   a) 200 samples/second
   b) 500 samples/second
   c) 1000 samples/second
   d) 1200 samples/second

4. 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.

5. Refer to the figure to the right. If the solid curve represents $\sin(2\pi t)$, what does the dotted curve represent? That is, the dotted curve can be written in the form of $A\sin(2\pi ft+\phi)$. What are A, f, and ϕ?



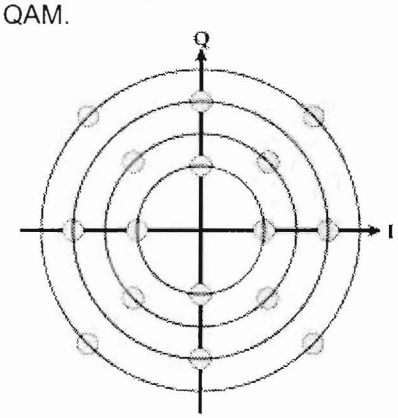
a) 2, 2, π
b) 2, 2, $\pi/2$
c) 2, 1, 0
d) 1, 2, 2π

6. If the baud rate for a QAM signal is 1800 and the bit rate is 9000, how many bits are there per signal element?
a) 3
b) 4
c) 5
d) 6

7. What category UTP is most used in high-speed LAN?
a) 2
b) 3
c) 4
d) 5

8. Binary equivalent of x^8+x^3+x+1 is
a) 100001011
b) 100001011110
c) 10000101
d) 100001010

9. Which of the following is not correct?
a) QAM can be used on telephone line to provide higher data rates compared with ASK, FSK, and PSK.
b) The following constellation is of 32-QAM.



c) QAM is used in ADSL.
d) QAM is used in cable-modem.

10. In which of the following does the baud rate always equal bit rate?
a) BFSK
b) QAM
c) 4-PSK
d) all of the above

11. What layer of the OSI model is concerned with the mechanical dimension of interfaces and electrical voltage levels?
    a) Physical
    b) Data link
    c) Network
    d) Transport

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

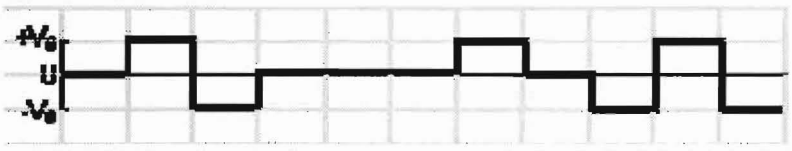
Data block	Codeword
00	00000
01	00111
10	11001
11	11110

    Now, suppose that a codeword block is received with the bit pattern 11100. What was most likely the codeword that was sent?
    a) 00
    b) 01
    c) 10
    d) 11

13. $C=2B\log_2 M$ If C=18600 B=3100, what is M?
    a) 2
    b) 4
    c) 8
    d) 16

14. The Fourier transform of a signal leads to the superposition of sine waves with frequencies 1f, 3f, 5f, 7f .... If we use a transmission line with a bandwidth of [5f, 10f], what would be the sine components detected on the receiver side?
    a) 5f, 7f, 9f, 10f
    b) 6f, 7f, 8f, 9f, 10f
    c) 5f, 7f,9f
    d) 3f,5f,7f,9f

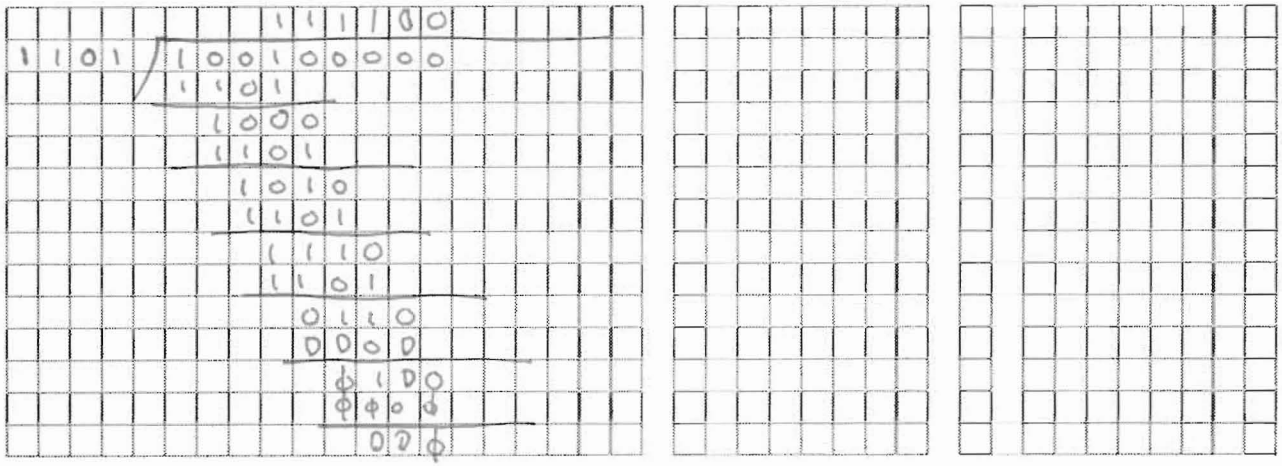
15. We consider the following AMI coded stream. What's the transmitted binary data.
    a) 01100010111
    b) 01011100111
    c) 10011110111
    d) none of the above



▪ Part 2 - Short-answer questions

6

16. **[8 marks]** The polynomial of a CRC generator is $x^3 + x^2 + 1$. The data to transmit is 100100, what is the CRC? Give an error pattern that cannot be detected by the above-mentioned CRC. 2



CRC: 110001

error: 1101

17. **[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?

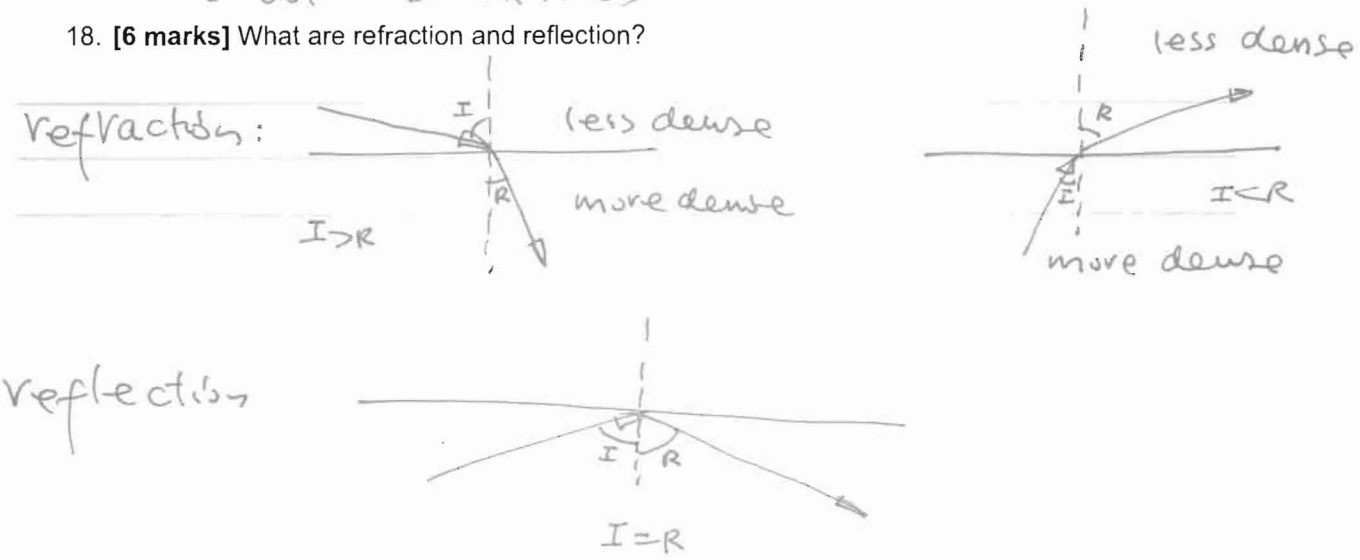
$SNR_{dB} = 35dB = 10\log_{10} SNR$ $\quad SNR = 10^{3.5} = 3162$

$C = B\log_2(1+SNR)$ $\quad B = 3300 - 300 = 3000$ Hz

$= 3000 \times \log_2(1+3162)$

$= 34881 = 3000 \times 11.63$

18. **[6 marks]** What are refraction and reflection?



19. **[9 marks]** Consider an audio signal with spectral components in the range of 300 to 3000 Hz. Assume that the sampling rate is 1000 plus the Nyquist sampling rate.
    3 a) For SQNR = 30 dB, what is the number of uniform quantization levels needed?
    3 b) What data rate is required?
    3 c) Assume that the smallest PCM code (all bits are 0) is used to represent the lowest voltage and the biggest PCM code (all bits are 1) is used to represent the highest voltage. If the dynamic range of the signal is -5V to +5V, what is the PCM codes for voltage level +3V ?

a). $SQNR = 30 = 6.02n + 1.76$ $\quad n = \frac{(30 - 1.76)}{6.02} = 4.6910 \approx 5$

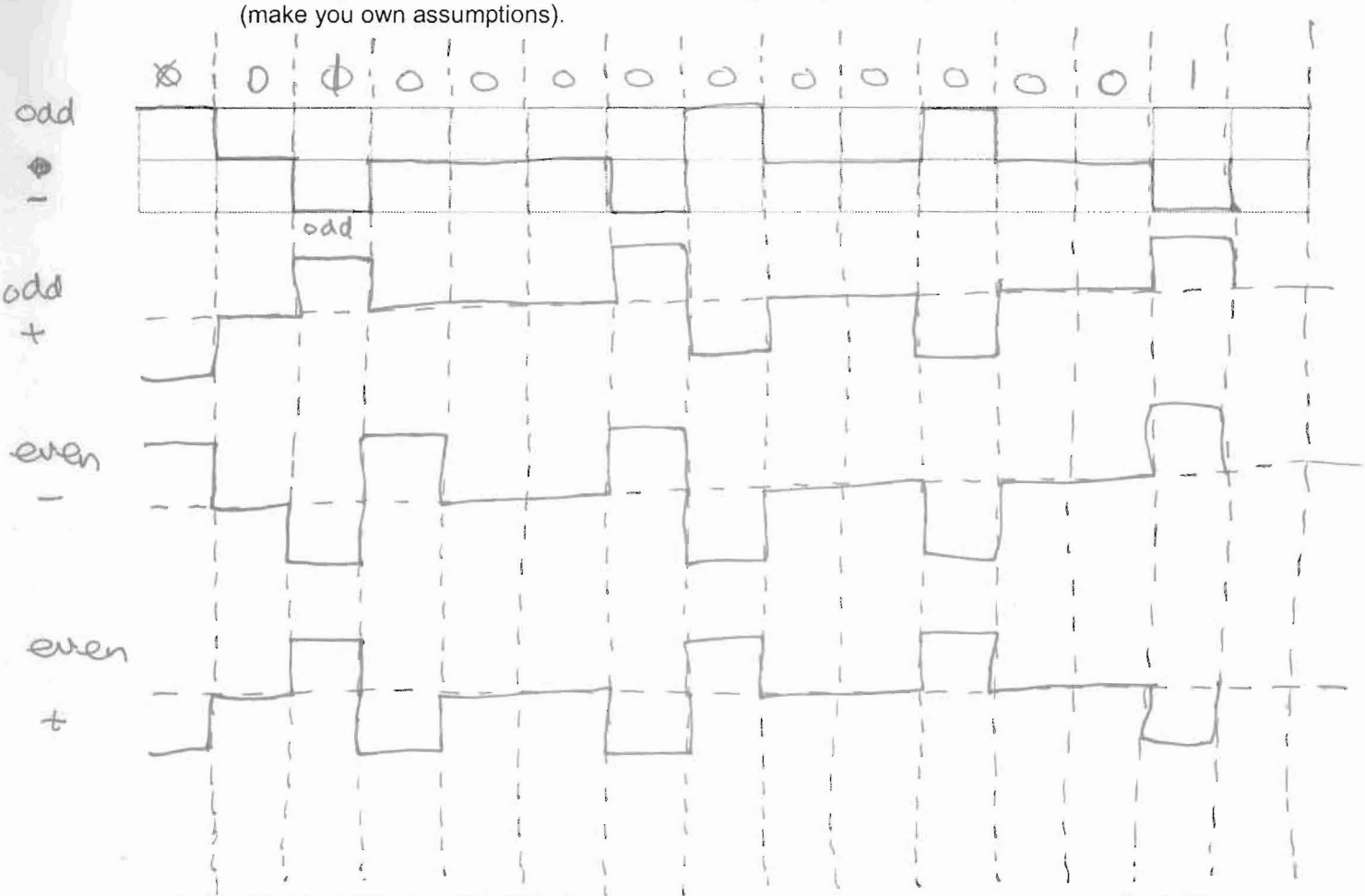
# of levels $= 2^5 = 32$

b). Sampling rate $= 1000 + 2 \times 3000 = 7000$

data rate $= 7000 \times 5 = 35000$ bps

c). $\frac{3-(-5)}{5-(-5)} \times 31 = \frac{8}{10} \times 31 \doteq 25 = (11001)_B$

20. **[6 marks]** Draw the HDB3 (refer to the following rules) encoding that represents 0100000000001 (make you own assumptions).



CEG3185 – Midterm Exam Annex
Winter 2015

Equations

<table>
<tr>
<td>Series:
$x(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty}(a_n \cos(2\pi n f_0 t) + b_n \sin(2\pi n f_0 t))$
$a_0 = \frac{2}{T}\int_0^T x(t)dt$
$a_n = \frac{2}{T}\int_0^T x(t)\cos(2\pi n f_0 t)dt$
$b_n = \frac{2}{T}\int_0^T x(t)\sin(2\pi n f_0 t)dt$</td>
<td>Fourier Transform:
$x(t) = \int_{-\infty}^{\infty} X(f)e^{j2\pi ft}dt \qquad j = \sqrt{-1}$
$X(f) = \int_{-\infty}^{\infty} x(t)e^{-j2\pi ft}dt \qquad j = \sqrt{-1}$</td>
</tr>
<tr>
<td>Signal Strength
Decibel gain: $G_{dB} = 10\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$</td>
<td>Thermal Noise: $N_0 = kT \qquad [W/Hz]$</td>
</tr>
<tr>
<td>Channel Capacity:
Nyquist formula: $C = 2B\log_2 M$
Shannon Capacity: $C = B\log_2(1+SNR)$
Sinal to noise ratio (SNR):
$SNR_{dB} = 10\log_{10}(SNR)$</td>
<td>Decibel-milliwatt
$P_{dBm} = 10\log_{10}\left(P_{mW}/1[\text{mW}]\right)$</td>
</tr>
<tr>
<td>Parabolic Antenna Gain
$G_{dB} = 10\log_{10}\frac{4\pi f^2 A_e}{c^2}$
c is speed of light = 3 x 10^8 m/s
$A_e = 0.56A$ for parabolic antenna (A is area of the antenna façade).</td>
<td>Microwave loss:
$L = 10\log_{10}\left(\frac{4\pi d}{\lambda}\right)^2 dB$</td>
</tr>
<tr>
<td>PCM – quantization error
$SNR_{dB} = 20\log 2^n + 1.76 = 6.02n + 1.76$ [dB]</td>
<td></td>
</tr>
</table>

Encoding Techniques

Nonreturn to Zero-Level (NRZ-L)
0 = high level
1 = low level

Nonreturn to Zero Inverted (NRZI)
0 = no transition at beginning of interval (one bit time)
1 = transition at beginning of interval

Bipolar-AMI
0 = no line signal
1 = positive or negative level, alternating for successive ones

Pseudoternary
0 = positive or negative level, alternating for successive zeros
1 = no line signal

Manchester
0 = transition from high to low in middle of interval
1 = transition from low to high in middle of interval

Differential Manchester
Always a transition in middle of interval
0 = transition at beginning of interval
1 = no transition at beginning of interval

B8ZS
Same as bipolar AMI, except that any string of eight zeros is replaced by a string with two code violations

HDB3
Same as bipolar AMI, except that any string of four zeros is replaced by a string with one code violation

B8ZS Substitution Rules	
Polarity of Preceding Pulse	Encoding of eight zeros
−	000 − + 0 + −
+	000 + − 0 − +

HDB3 Substitution Rules		
	Number of Bipolar Pulses (ones) since Last Substitution	
Polarity of Preceding Pulse	Odd	Even
−	000 −	+ 00 +
+	000 +	− 00 −