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
SEMESTER: Winter 2012

PROFESSOR: Jiying Zhao
DATE: February 28, 2012
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**	**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 $C=2B\log_2 M$ If C=18600 B=3100, what is M?

a) 2 b) 4
c) 8 d) 16

2 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 could 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

3. In CRC, binary equivalent of $x^8 + x^3 + x + 1$ is

a) 100001011 b) 100001011110
c) 10000101 d) 100001010

4. 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

5. When data are transmitted from device A to device B, the header from A's layer 4 is read by B's ____ layer.

a) Physical b) Transport
c) Application d) One of the above

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 When a beam of light travels through media of two different densities, if the angle of incident is greater than the critical angle, ____ occurs.

a) Reflection b) Refraction
c) Incidence d) None of the above

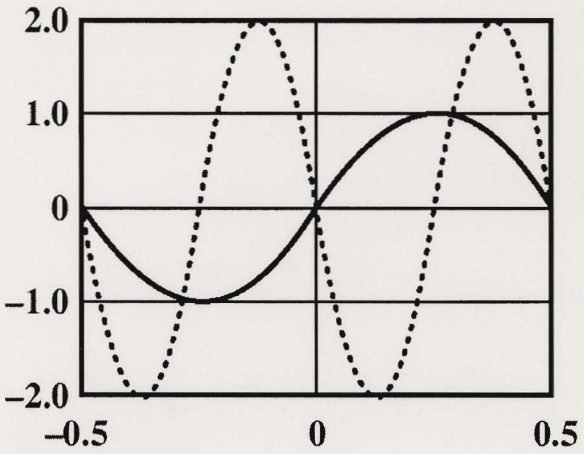
9 Hamming distance. For k=2 and n=5, we can make the following assignment:

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

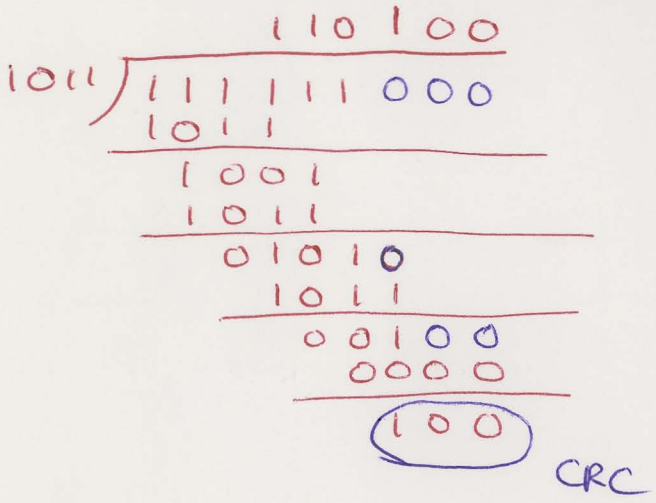
10. Refer to the figure to the right. If the solid curve is written in the form of $A\sin(2\pi ft+\phi)$, what are A, f, and ϕ?



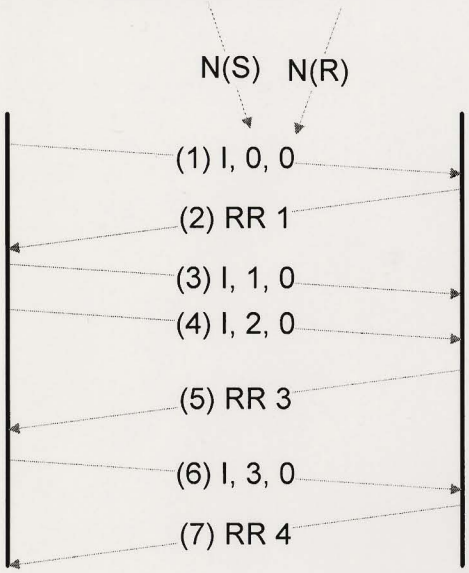
a) 2, 2, π
b) 1, 1, π
c) 1, 1, 0
d) 1, 2, 2π

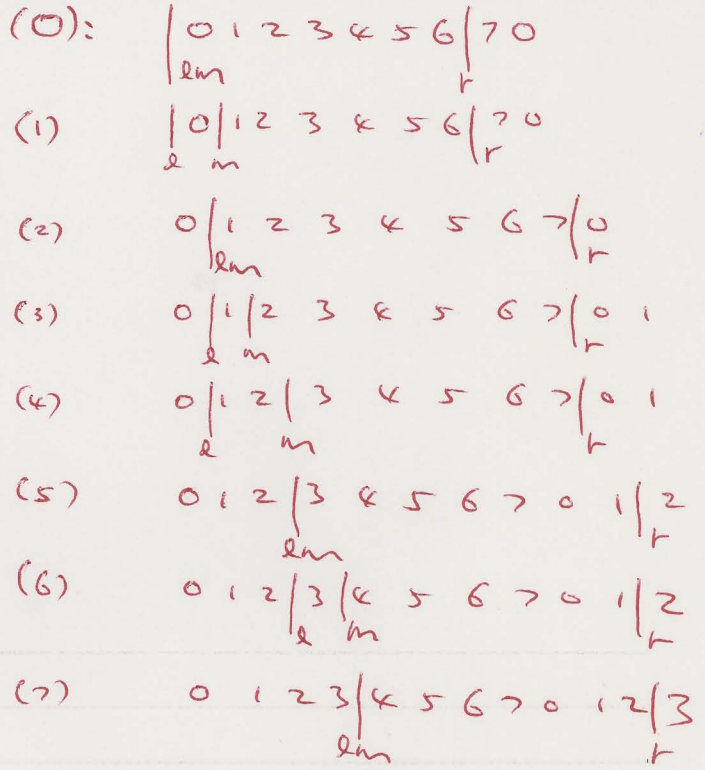
Part 2 - Short-answer questions

11 **[6 marks]** In CRC, the data unit is 111111 and the divisor 1011. Calculate the CRC code.

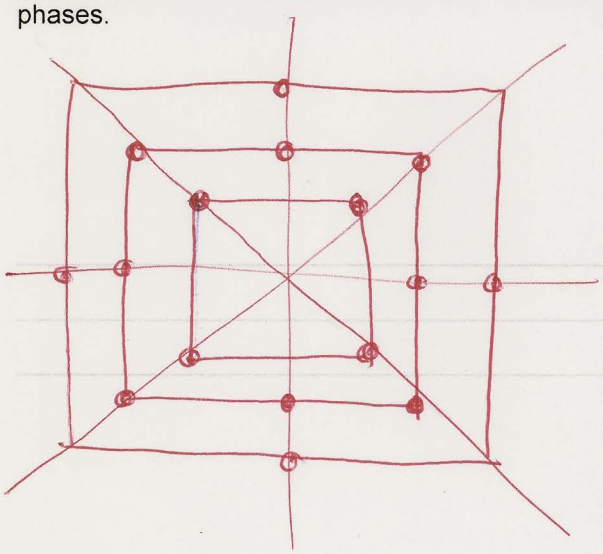


12 **[6 marks]** HDLC is used. Both the N(S) and N(R) are 3 bits. The sliding window size is 7. Before sending from "I,0,0", the frames in the sliding window are 0, 1, 2, 3, 4, 5, 6. Draw the sender-side's sliding window after steps (1), (2), (4), (5), (6), and (7), by clearly identifying left wall, middle wall, and right wall of the sliding window.





13 **[6 marks]** Draw a 16-QAM constellation of your own choice. Use four amplitudes and eight different phases.



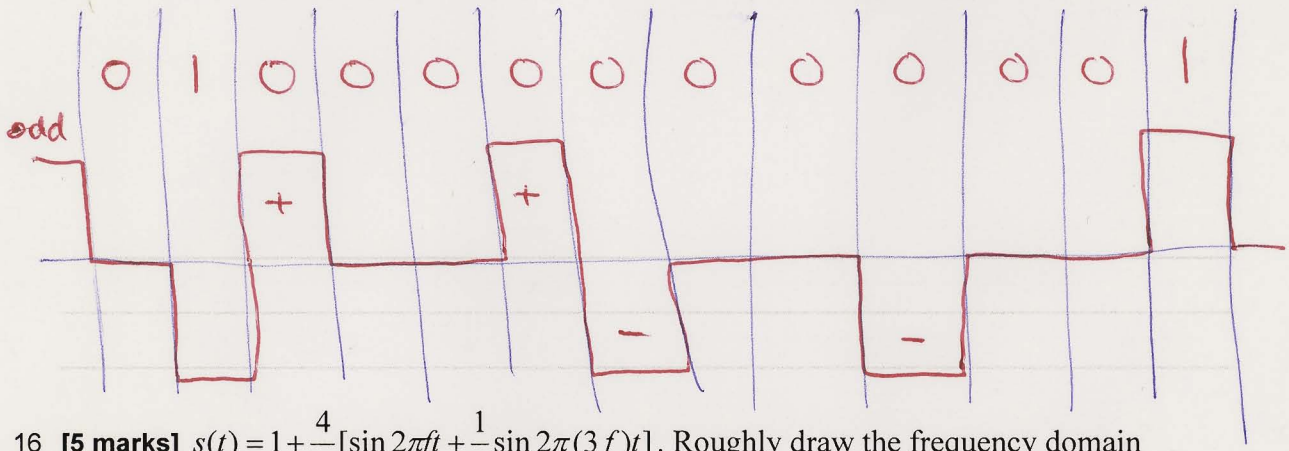
14 **[6 marks]** We use a sampling rate of 22 KHz to digitize a mono audio stream, whose dynamic range is from -5V to +5V. Each sample is coded with 8 bits. At one particular sample point, the voltage of the audio signal is 3.1 V. What is the date rate? What will be the PCM (pulse code modulation) code for this sample point?

③ data rate : $8 \times 22 \times 10^3 = 176000$ bps

③ $\frac{3.1-(-5)}{5-(-5)} \times 255 = \frac{8.1}{10} \times 255 = 207 = (11001111)_B$

15 **[6 marks]** Draw the HDB3 (refer to the following rules) encoding that represents 0100000000001 (make you own assumptions).

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

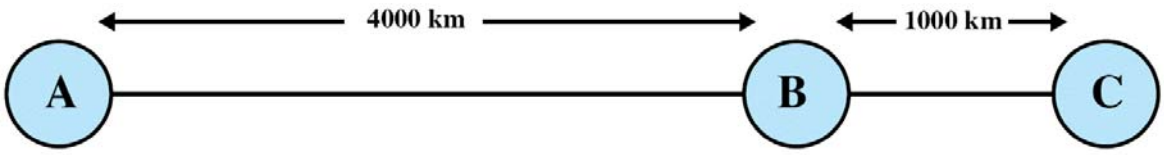


16 **[5 marks]** $s(t) = 1 + \frac{4}{\pi}[\sin 2\pi ft + \frac{1}{3}\sin 2\pi(3f)t]$. Roughly draw the frequency domain representation of s(t).

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