STE A0150

26 wrote

average: 64.1 (75.4%)
maximum: 81.5 (95.9%)
minimum: 47. (55.3%)

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SCHOOL OF INFORMATION TECHNOLOGY AND ENGINEERING

COURSE: CEG3180
SEMESTER: Winter 2008

PROFESSOR: Jiying Zhao
DATE: February 16, 2008
TIME: 14:00 to 16:00

MIDTERM EXAMINATION

NAME and STUDENT NUMBER:________________________/________________

Mid-Term Exam

1. There are three (3) types of questions in this examination.

Part 1	**Multiple choice**	**24 marks**	
Part 2	**Short answer**	**42 marks**	
Part 3	**Long answers**	**19 marks**	
Total		**85 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=2Blog$_2$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 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

3. In CRC, binary equivalent of $x^8 + x^3 + x + 1$ is
a) 100001011 b) 100001011110
c) 10000101 d) 100001010

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

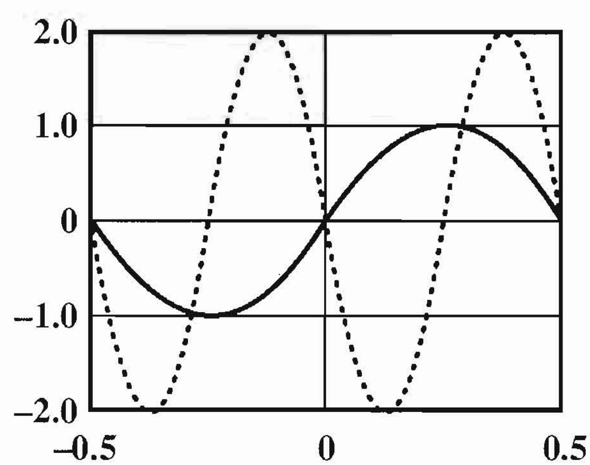
5. If the baud rate for a QAM signal is 1800 and the bit rate is 9000, how many bits are there per signal element?
a) 3 b) 4
c) 5 d) 6

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 represents sin(2πt), what does the dotted curve represent? That is, the dotted curve can be written in the form of Asin(2πft+ϕ). What are A, f, and ϕ?

sin(2πt+π)



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

9. If the frequency spectrum of a signal has bandwidth of 500 Hz with the lowest frequency at 600 Hz, what should be the sampling rate according to the Nyquist theorem?
   a) >600 samples/second
   b) >1000 samples/second
   c) >1200 samples/second
   d) >2200 samples/second

10 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

11 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) 00000
   b) 00111
   c) 11001
   d) 11110

12 The inner core of an optical fibre is ________ in composition.
   a) Glass or plastic
   b) Copper
   c) Hollow
   d) Liquid

Part 2 - Short-answer questions

13 **[6 marks]** In CRC, the data unit is 111111 and the divisor 1010. Calculate the CRC code (remainder).

```
           110011
      ___________
1010 ) 111111000
       1010
       ----
        1011
        1010
        ----
         001100
            1010
            ----
             1100
             1010
             ----
              110
```

CRC= 110

14 **[6 marks]** Suppose that the spectrum of a channel is between 3 MHz and 4 MHz, and SNR_{dB} = 24 dB. What is the capacity of the channel?

B = 1 MHz

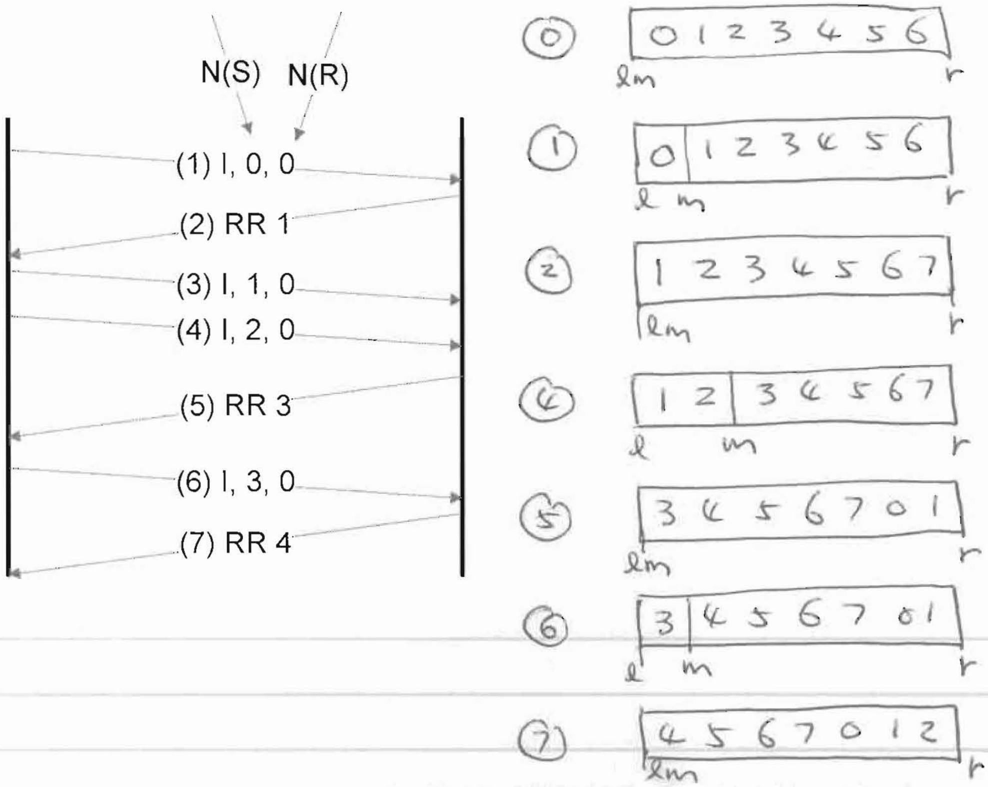
$SNR_{dB} = 10 \log_{10} SNR$

$24 = 10 \log_{10} SNR$

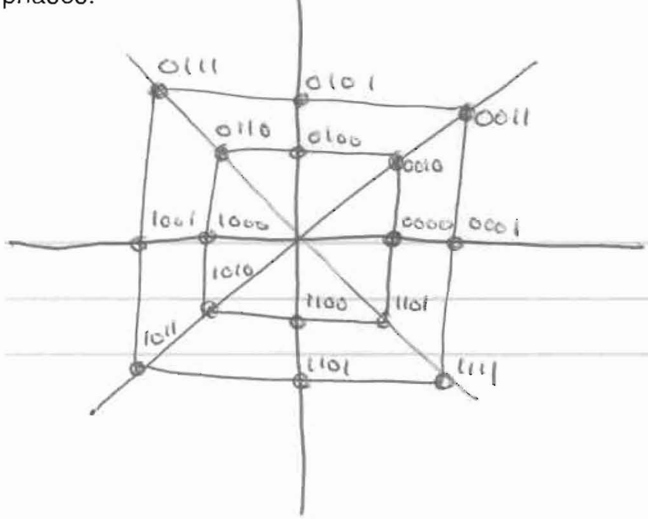
$SNR = 10^{2.4} = 251$

$C = B \log_2 (1+SNR) = 1 \cdot \log_2 (1+251) = 7.98$ MHz

15 **[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.



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



17 **[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 3V. What will be the PCM (pulse code modulation) code for this sample point?

8 bits → 0 ~ 255

$\frac{3+5}{5-(-5V)} \times 255 \doteq 204$ (~~77~~)

2|204; 2|102 0; 2|51 0; 2|25 1; 2|12 1; 2|6 0; 2|3 0; 2|1 1; 0 1

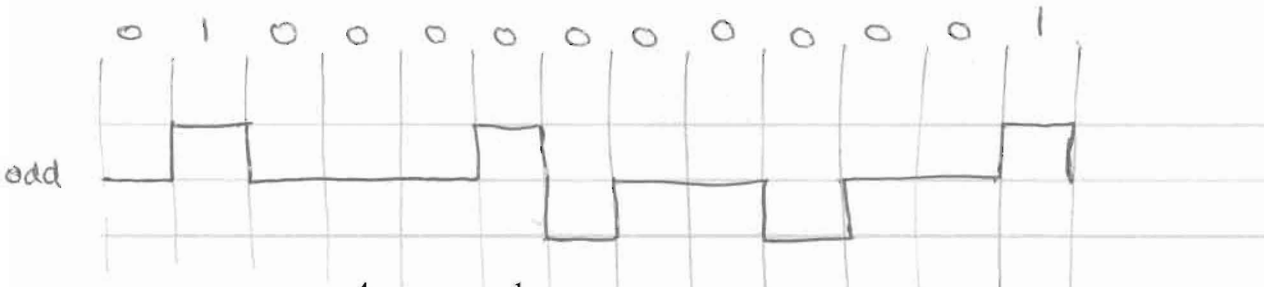
2|77; 2|38 1; 2|19 0; 2|9 1; 2|4 1; 2|2 0; 2|1 0; 0 1

~~0100 1101~~

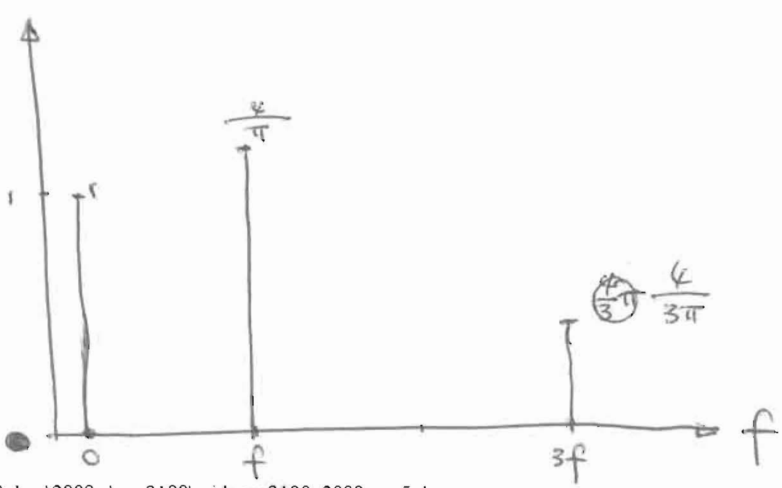
1100 1100

18 **[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-



19 **[6 marks]** $s(t) = 1 + \frac{4}{\pi}[\sin 2\pi ft + \frac{1}{3}\sin 2\pi(3f)t]$. Please roughly draw the frequency domain representation of s(t).

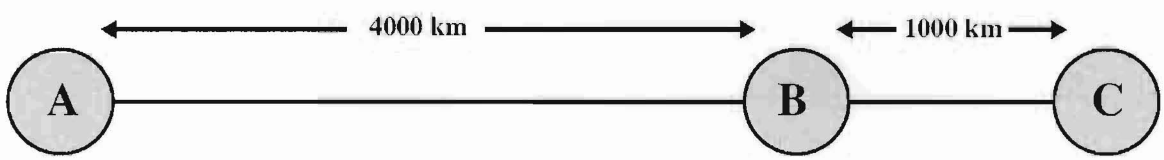


▪ Part 3 - Long-answer questions

20 [**19 marks**] In the following figure, frames are generated at node C and sent to node A through node B. Determine the minimum data rate required between nodes B and A so that the buffers of node B are not flooded, based on the following:

- The data rate between C and B is 150 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 B and A, a sliding window protocol with a window size of 3 is used.
- Between C and B, 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 B and A should be the same as the effective data rate between C and B.



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 C and node B, R=150 kbps.

① C→B, stop-and-wait

$$U_{CB} = \frac{1}{1+2a_{CB}}$$

$$a_{CB} = \frac{T_{prop}}{T_{frame}} = \frac{5\times10^{-6}\times 1000}{1000/(150\times10^3)} = \frac{5\times10^{-3}}{\frac{1}{150}} = 0.75$$

$$U_{CB} = \frac{1}{1+2\times0.75} = 0.4$$

$$U_{eCB} = 150\times10^3\times0.4 = 60{,}000 \text{ bps}$$

② B→A, sliding window, $W=3$, assume $W<1+2a_{BA}$

$$U_{BA} = \frac{W}{1+2a_{BA}}$$

assume the nominal bit rate between B and A is x bps

$$a_{BA} = \frac{T_{prop}}{T_{frame}} = \frac{5\times10^{-6}\times4000}{1000/x} = 20\times10^{-6}x$$

$$U_{BA} = \frac{3}{1+2\times20\times10^{-6}\cdot x} = \frac{3}{1+40\times10^{-6}\cdot x}$$

$$U_{eBA} = U_{BA}\cdot x = \frac{3x}{1+40\times10^{-6}x}$$

③ $U_{eCB} = U_{eBA}$

$$60{,}000 = \frac{3x}{1+40\times10^{-6}\times x}$$

$$3x = 60000 + 2.4x$$

$$0.6x = 60000$$

$$x = 100\,000 \text{ bps} = 100 \text{ kbps}$$