

# KIBABII UNIVERSITY COLLEGE

UNIVERSITY EXAMINATIONS May-August 2012/2013

BACHELOR OF SCIENCE IN Computer Science

CSC 223 DATA COMMUNICATIONS

## INSTRUCTIONS

Answer question One and any other two questions

Time allowed for this exam is 3 Hours

### Question One

(30 marks)

#### 1. Multiple Choice(10 marks) – 0.5 point each

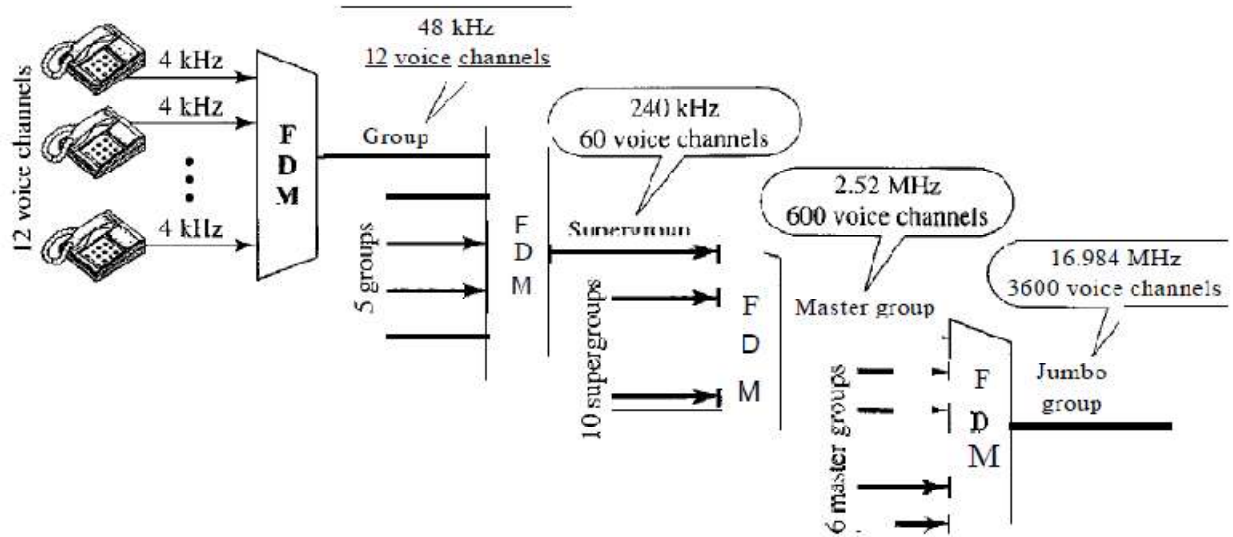
- 1) Before data can be transmitted, they must be transformed to \_\_\_\_\_.  
**A)** periodic signals  
**B)** electromagnetic signals  
**C)** aperiodic signals  
**D)** low-frequency sine waves
- 2) As frequency increases, the period \_\_\_\_\_.  
**A)** decreases  
**B)** increases  
**C)** remains the same  
**D)** doubles
- 3) When propagation speed is multiplied by propagation time, we get the \_\_\_\_\_.  
**A)** throughput  
**B)** wavelength of the signal  
**C)** distortion factor  
**D)** distance a signal or bit has traveled
- 4) Unipolar, bipolar, and polar encoding are types of \_\_\_\_\_ encoding.  
**A)** line  
**B)** block  
**C)** NRZ  
**D)** Manchester
- 5) Block coding can help in \_\_\_\_\_ at the receiver.  
**A)** Synchronization  
**B)** Error detection  
**C)** Attenuation  
**D)** (a) and (b)
- 6) In \_\_\_\_\_ transmission, bits are transmitted simultaneously, each across its own wire.  
**A)** Asynchronous serial  
**B)** Synchronous serial  
**C)** Parallel

- D)** (a) and (b)
- 7) Two common scrambling techniques are \_\_\_\_\_.
- A)** NRZ and RZ
  - B)** AMI and NRZ
  - C)** B8ZS and HDB3
  - D)** Manchester and differential Manchester
- 8) The most common technique to change an analog signal to digital data is called \_\_\_\_\_.
- A)** PAL
  - B)** PCM
  - C)** sampling
  - D)** none of the above
- 9) If the bit rate for an ASK signal is 1200 bps, the baud rate is \_\_\_\_\_.
- A)** 300
  - B)** 400
  - C)** 600
  - D)** 1200
- 10) Given an AM radio signal with a bandwidth of 10 KHz and the highest-frequency component at 705 KHz, what is the frequency of the carrier signal?
- A)** 700 KHz
  - B)** 705 KHz
  - C)** 710 KHz
  - D)** Cannot be determined from given information
- 11) Which multiplexing technique involves signals composed of light beams?
- A)** FDM
  - B)** TDM
  - C)** WDM
  - D)** none of the above
- 12) \_\_\_\_\_ utilization is the use of available bandwidth to achieve specific goals.
- A)** Frequency
  - B)** Bandwidth
  - C)** Amplitude
  - D)** None of the above
- 13) We can divide \_\_\_\_\_ into two different schemes: synchronous or statistical.
- A)** FDM
  - B)** TDM
  - C)** WDM
  - D)** none of the above
- 14) Transmission media are usually categorized as \_\_\_\_\_.
- A)** fixed or unguided
  - B)** guided or unguided
  - C)** determinate or indeterminate
  - D)** metallic or nonmetallic
- 15) Signals with a frequency above 30 MHz use \_\_\_\_\_ propagation.
- A)** ground
  - B)** sky
  - C)** line-of-sight
  - D)** none of the above
- 16) Which error detection method uses one's complement arithmetic?
- A)** Simple parity check
  - B)** Two-dimensional parity check
  - C)** CRC
  - D)** Checksum
- 17) In modulo-2 arithmetic, we use the \_\_\_\_\_ operation for both addition and subtraction.
- A)** XOR
  - B)** OR

- C) AND  
D) none of the above
- 18) In \_\_\_\_\_ coding, we divide our message into blocks, each of  $k$  bits, called \_\_\_\_.  
A) block; blockwords  
B) linear; datawords  
C) block; datawords  
D) none of the above
- 19) In modulo-11 arithmetic, we use only the integers in the range \_\_\_\_\_, inclusive.  
A) 1 to 10  
B) 1 to 11  
C) 0 to 10  
D) none of the above
- 20) A generator that contains a factor of \_\_\_\_\_ can detect all odd-numbered errors.  
A)  $x$   
B)  $x + 1$   
C) 1  
D) none of the above

## 2. Answer Following Questions(10 marks).( 2 points each)

- 1) Distinguish between baseband transmission and broadband transmission.
  - 2) Define analog transmission.
  - 3) Define the analog hierarchy used by telephone companies and list different levels of the hierarchy.
  - 4) Describe the need for switching and define a switch.
  - 5) In CRC, show the relationship between the following entities (size means the number of bits):The size of the dataword and the size of the codeword
3. (4 pts) If the peak voltage value of a signal is 20 times the peak voltage value of the noise, what is the SNR? What is the SNR<sub>dB</sub>?
4. (3 pts) Calculate the baud rate for the given bit rate and type of modulation.
- a. 2000 bps, FSK
  - b. 4000 bps, ASK
  - c. 6000 bps, QPSK
  - d. 36,000 bps, 64-QAM
5. (3 pts) In the analog hierarchy of Next Figure, find the overhead (extra bandwidth for guard band or control) in each hierarchy level (group, supergroup, master group, and jumbo group).



## SECTION B

### Question Two(20 marks)

#### 1. Answer Following Questions(10 marks).( 2 points each)

- 1) Why do optical signals used in fiber optic cables have a very short wave length?
  - 2) Define digital-to-analog conversion.
  - 3) Distinguish between synchronous and statistical TDM.
  - 4) Compare space-division and time-division switches.
  - 5) In CRC, show the relationship between the following entities (size means the number of bits): The size of the divisor and the remainder
2. (3 pts) How many bits can fit on a link with a 2 ms delay if the bandwidth of the link is
    - a. 1 Mbps?
    - b. 10 Mbps?
    - c. 100 Mbps?
  3. (3 pts) What is the number of bits per baud for the following techniques?
    - a. ASK with four different amplitudes
    - b. FSK with 8 different frequencies
    - c. PSK with four different phases

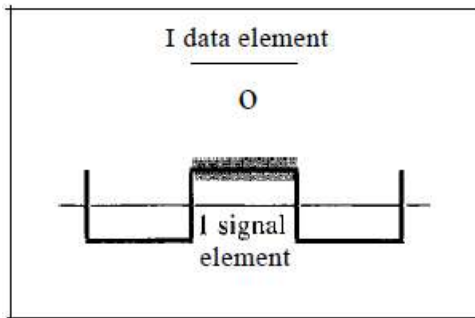
- d. QAM with a constellation of 128 points.
4. (4 pts) Ten sources, six with a bit rate of 200 kbps and four with a bit rate of 400 kbps are to be combined using multilevel TDM with no synchronizing bits. Answer the following questions about the final stage of the multiplexing:
- What is the size of a frame in bits?
  - What is the frame rate?
  - What is the duration of a frame?
  - What is the data rate?

### Question Three(20 marks)

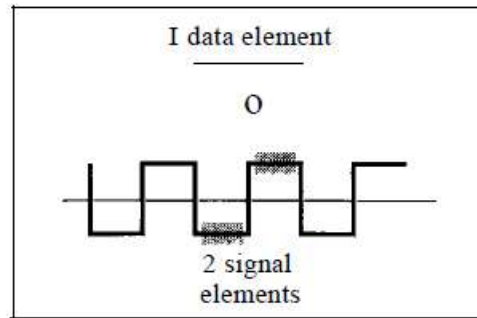
#### 1. Answer Following Questions(10 marks).( 2 points each)

- 1) Distinguish between data rate and signal rate.
  - 2) What are the two components of a signal when the signal is represented on a constellation diagram? Which component is shown on the horizontal axis? Which is shown on the vertical axis?
  - 3) Define FHSS and explain how it achieves bandwidth spreading.
  - 4) Define blocking in a switched network.
  - 5) In CRC, show the relationship between the following entities (size means the number of bits): The degree of the polynomial generator and the size of the divisor
2. (3 pts) Calculate the value of the signal rate for each case in Next Figure if the data rate is 1 Mbps and  $c = 1/2$ .

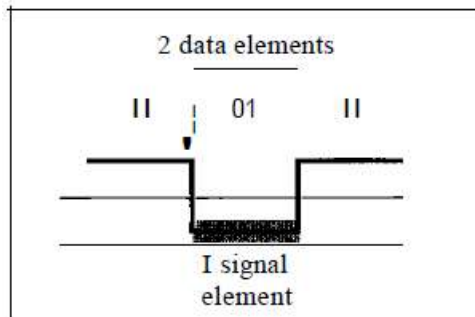
*Signal element versus data element*



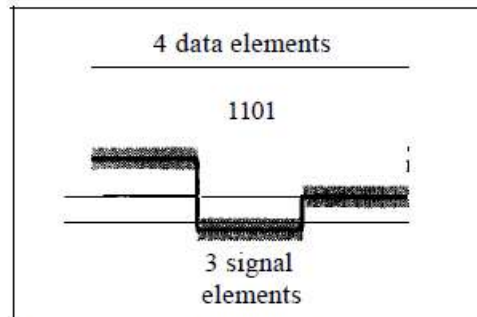
a. One data element per one signal element ( $r = 1$ )



b. One data element per two signal elements ( $r' = \frac{1}{2}$ )



c. Two data elements per one signal element ( $r = 2$ )



d. Four data elements per three signal elements ( $r' = \frac{4}{3}$ )

3. (3 pts) Draw the constellation diagram for the following cases. Find the peak amplitude value for each case and define the type of modulation (ASK, FSK, PSK, or QAM). The numbers in parentheses define the values of I and Q respectively.

- Two points at (2, 0) and (3, 0).
- Two points at (3, 0) and (-3, 0).
- Four points at (2, 2), (-2, 2), (-2, -2), and (2, -2).
- Two points at (0, 2) and (0, -2).

4. (4 pts) Two channels, one with a bit rate of 190 kbps and another with a bit rate of 180 kbps, are to be multiplexed using pulse stuffing TDM with no synchronization bits. Answer the following questions:

- What is the size of a frame in bits?
- What is the frame rate?
- What is the duration of a frame?
- What is the data rate?

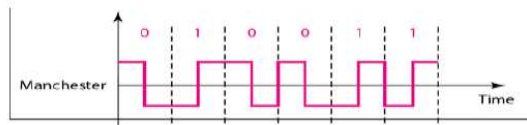
**Question Four (20 marks)**

**1. Answer Following Questions(10 marks).( 2 points each)**

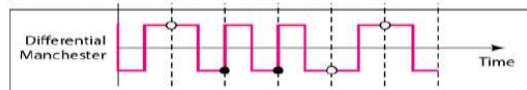
- 1) Define a DC component and its effect on digital transmission.
- 2) Which characteristics of an analog signal are changed to represent the lowpass analog signal in each of the following analog-to-analog conversions?
  - a. AM
  - b. FM
  - c. PM
- 3) What is the purpose of cladding in an optical fiber?
- 4) Distinguish between forward error correction versus error correction by retransmission.
- 5) In CRC, show the relationship between the following entities (size means the number of bits): The degree of the polynomial generator and the size of the remainder

2. (3 pts) A Manchester signal has a data rate of 100 Kbps. Using Next Figure, calculate the value of the normalized energy (P) for frequencies at 0 Hz, 50 KHz, 100 KHz.

**Manchester Encoding**



- 0 → transition from High to Low in the middle  
1 → transition from Low to High in the middle



- 1 → No transition at the beginning of interval  
0 → transition at the beginning of interval  
Always transition in the middle of the interval

3. (3 pts) What is the required bandwidth for the following cases if we need to send 4000 bps?

Let  $d = 1$ .

- a. ASK
  - b. FSK with  $2\Delta f = 4$  KHz
  - c. QPSK
  - d. 16-QAM
4. (4 pts) A path in a digital circuit-switched network has a data rate of 1 Mbps. The exchange of 1000 bits is required for the setup and teardown phases. The distance between two parties is 5000 km. Answer the following questions if the propagation speed is  $2 \times 10^8$  m:
- a. What is the total delay if 1000 bits of data are exchanged during the data transfer phase?
  - b. What is the total delay if 100,000 bits of data are exchanged during the data transfer phase?
  - c. What is the total delay if 1,000,000 bits of data are exchanged during the data transfer phase?

d. Find the delay per 1000 bits of data for each of the above cases and compare them. What can you infer?

### **Question Five(20 marks)**

#### **1. Answer Following Questions(10 marks).( 2 points each)**

- 1) Define scrambling and give its purpose.
  - 2) Distinguish between a link and a channel in multiplexing.
  - 3) How does sky propagation differ from line-of-sight propagation?
  - 4) What is the Hamming distance? What is the minimum Hamming distance?
  - 5) What kind of error is undetectable by the checksum?
- 2.** (3 pts) What is the Nyquist sampling rate for each of the following signals?
- a. A low-pass signal with bandwidth of 200 KHz?
  - b. A band-pass signal with bandwidth of 200 KHz if the lowest frequency is 100 KHz?
- 3.** (3 pts) A corporation has a medium with a 1-MHz bandwidth (lowpass). The corporation needs to create 10 separate independent channels each capable of sending at least 10 Mbps. The company has decided to use QAM technology. What is the minimum number of bits per baud for each channel? What is the number of points in the constellation diagram for each channel? Let  $d = 0$ .
- 4.** (4 pts) Assuming even parity, find the parity bit for each of the following data units.
- a. 1001011
  - b. 0001100
  - c. 1000000
  - d. 1110111