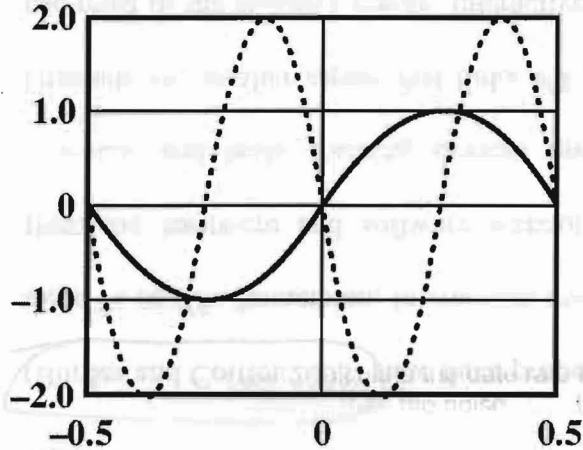


▪ **Part 1 - Multiple choice questions [2 marks each]:**

- 1 In an optical fiber, the inner core is _____ the cladding?
 a) Denser than b) Less dense than
 c) The same density as d) Another name for
- 2 Using Shannon formula to calculate the data rate for a given channel, if $C=B$, then _____.
 a) The signal is smaller than the noise b) The signal is greater than the noise
 c) The signal is equal to the noise d) Not enough information is given to answer the question
- 3 Refer to the following figure. 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
- 4 The hexadecimal representation of ASCII code for character 'A' is 41H. Suppose that 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 A signal is measured at two different points in a transmission media. The power is P_1 at the first point and P_2 at the second point. The ratio between P_1 and P_2 is 0 dB. This means _____.
 a) P_2 is zero. b) P_2 equals to P_1 .
 c) P_2 is much larger than P_1 . d) P_2 is much smaller than P_1 .
6. Binary equivalent of $x^8 + x^3 + x + 1$ is
 a) 100001011 b) 100001011110
 c) 10000101 d) 100001010
7. What category UTP is most used in high-speed LAN?
 a) 2 b) 3
 c) 4 d) 5

8. Encapsulation/decapsulation. As the data packet moves from Layer 3 to Layer 4, which of the following is correct?

- a) Layer-4 header is added. b) The header of Layer 3 is removed.
 c) The header of Layer 3 is replaced by the header of layer 4. d) There is no change to the Layer 3 packet (the layer 3 packet will be passed on to Layer 4 as it is).

9. Which of the following can be changed to improve antenna gain?

- a) Carrier frequency b) Diameter of the parabolic reflective antenna
 c) Carrier wavelength d) Speed of light

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 00100. What was most likely the codeword that was sent?

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

packet (the layer 3 packet will be passed on to Layer 4 as it is)

Part 2 - Short-answer questions

- 11 [6 marks] In CRC, the data unit is 1111111110 and the divisor 1011. Calculate the CRC code.

$$\begin{array}{r}
 1101000111 \\
 1011 \overline{) 1111111110000} \\
 \underline{1011} \\
 1001 \\
 \underline{1011} \\
 01011 \\
 \underline{1011} \\
 0001100 \\
 \underline{1011} \\
 1110 \\
 \underline{1011} \\
 1010 \\
 \underline{1011} \\
 001
 \end{array}$$

CRC is 001.

- 12 [6 marks] A transmission line has bandwidth of 8000 Hz. The measurement shows that $P(\text{signal}) = -52$ dBm, $P(\text{noise}) = -96$ dBm. (dBm = decibel-milliWatts) Calculate the theoretical highest bit rate (capacity) of this transmission line.

$$\text{SNR}_{\text{dB}} = 10 \log_{10} \frac{S}{N} = 10 \log_{10} \frac{\frac{S}{\text{mW}}}{\frac{N}{\text{mW}}} = 10 \log_{10} \frac{S}{\text{mW}} - 10 \log_{10} \frac{N}{\text{mW}}$$

$$= -52 - 96 = 24 \text{ dB}$$

$$\text{SNR} = 10^{(\text{SNR}_{\text{dB}}/10)} = 10^{2.4} = 25119$$

$$C = B \log_2(1 + \text{SNR})$$

$$= 8000 \times \log_2(1 + 25119)$$

$$= 8000 \times 14.62$$

$$= 116932 \text{ bps}$$

- 13 **[6 marks]** Two stations communicate via a 1-Mbps satellite link with a propagation delay of 270 ms. The satellite serves merely to retransmit data received from one station to another, with negligible switching delay. Using frames of 1024 bits with window size of 7, what is the utilization of the link?

$$t_{\text{prop}} = 270 \text{ ms}$$

$$t_{\text{frame}} = 1024 / 1 \text{ Mbps} = 1.024 \text{ ms}$$

$$\alpha = t_{\text{prop}} / t_{\text{frame}} = 270 / 1.024 = 263.7$$

$$U = W / (1 + 2\alpha) = 7 / (1 + 2 \times 263.7) = 0.013$$

- 14 **[6 marks]** Consider an audio signal with spectral components in the range 300 to 3000 Hz.
- For quantization noise $\text{SNR}_{\text{dB}} = 40$ dB, what is the number of uniform quantization levels needed?
 - If the minimum required sampling rate is used, what data rate is required?
 - Assume that smallest PCM code (all bits are 0) is used to represent the lowest voltage and biggest PCM code (all bits are 1) is used to represent the highest voltage. If the dynamic range of the signal is -5V to $+5\text{V}$, what is the PCM codes for voltage levels $+4\text{V}$?

$$\text{a) } \text{SNR}_{\text{dB}} = 40 = 6.02n + 1.76$$

$$n = (40 - 1.76) / 6.02 = 6.3522 \approx 7$$

$$\# \text{ of levels} = 2^n = 128$$

$$\text{b) } 2 \times 3000 = 6000 \text{ samples/second}$$

$$\text{data rate} = 7 \times 6000 = 42000 \text{ bps}$$

c)

$$\frac{4 - (-5)}{5 - (-5)} \times 127 = \frac{9}{10} \times 127 = 114 \Rightarrow 1110010$$

15 [6 marks] The following Manchester stream contains exactly 12 bits. Draw the corresponding HDB3 encoding (make your own assumptions).

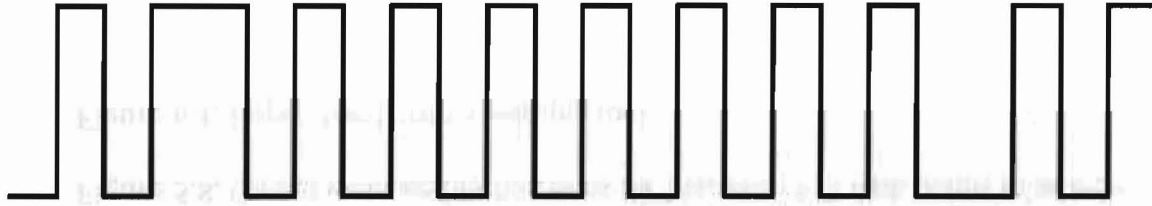
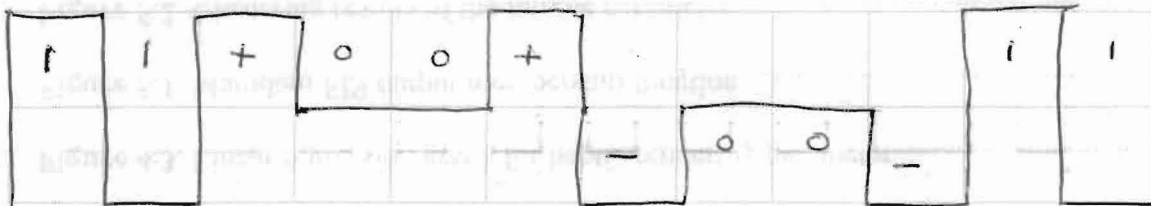


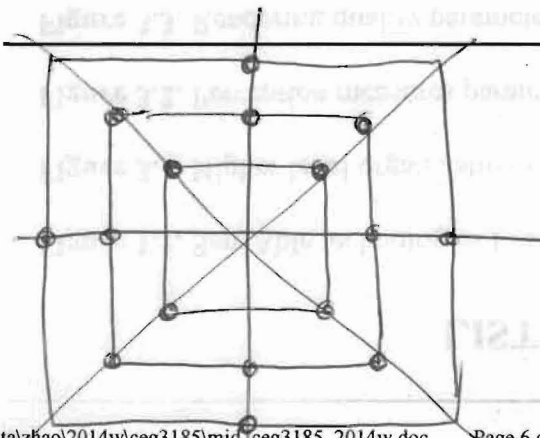
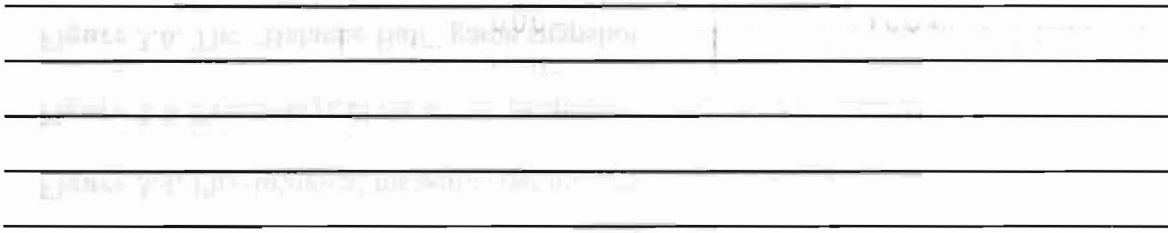
Table 5.4 HDB3 Substitution Rules

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

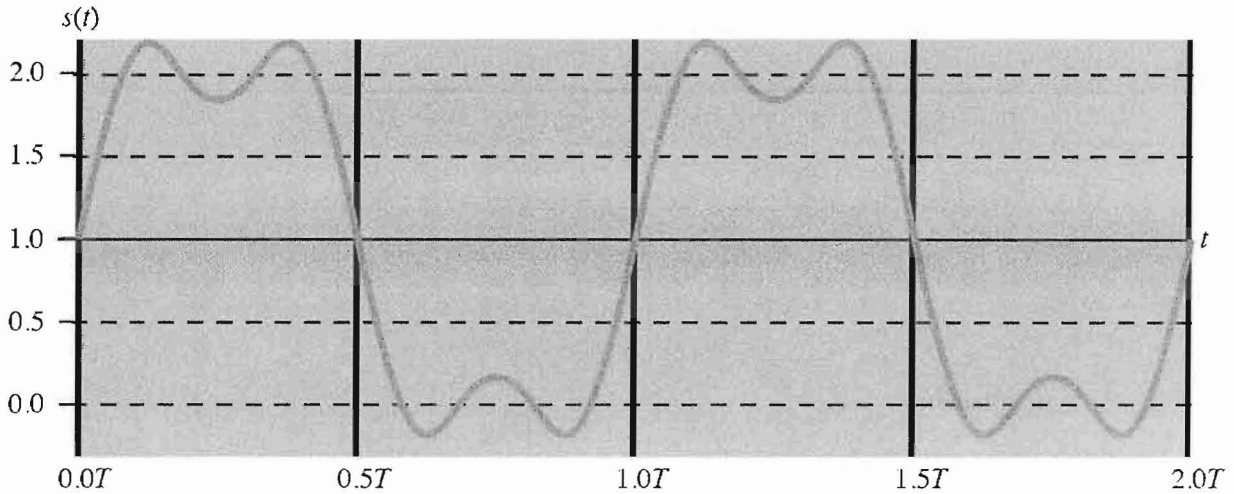
one of the possible: (even at start)



16 [4 marks] Draw a 16-QAM constellation of your own choice. Use four amplitudes and eight different phases.

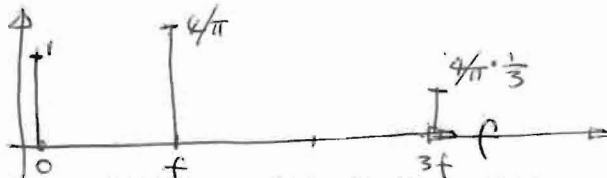


- 17 [6 marks] Roughly draw the frequency domain representation of the following signal. When $T=1 \mu s$, what is the bandwidth of the signal?



$f = 1 \text{ MHz}$

(a) $s(t) = 1 + (4/\pi) [\sin(2\pi ft) + (1/3) \sin(2\pi(3f)t)]$



$B = 3f - 0$
 $= 3 \text{ MHz}$

- 18 [5 marks] In the sender's window, there are packets number 0, 1, ..., 14. Show the sender's sliding window after the sender has sent packets 0 to 11 and has received ACK 8.

