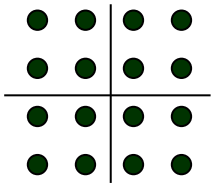
ECE 5600 Fall 2022 Mid-Term Exam **Name_Calvin_Passmore_____**

This exam is open-book, open note. You are not allowed to use the internet or talk to other students. Each problem has 5 pts. The exam sheet is due on Oct 28, 2022, at 5:00 pm.

1. What is the name of the modulation technique represented by the constellation diagram below?



Answer:

QAM-16

2. Why can 56kbps modems seemingly exceed the Shannon Limit?

Answer:

By converting from analog to digital and seemingly reducing the SNR, the bandwidth appears to break the Shannon Limit.

3. A communication channel using QAM-64 has a bandwidth of 2MHz.

a) What is the maximum possible data rate? _____12Mbps.

6 bit/symbol * 2Msym/sec = 12M bps

b) What is the minimum signal-to-noise ratio (dB) required to attain this rate? _____63 dB

$C = B \log_2(1 + SNR)$

$12M = 2M \log_2(1 + SNR)$

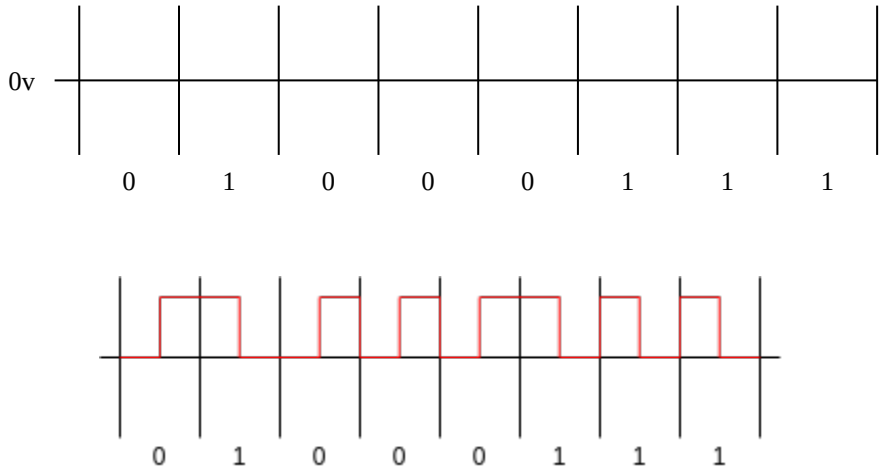
$\log_2(1 + SNR) = 6$

$SNR = 2^6 - 1$

4. What is the theoretical bandwidth of the 0.85 micron band of a fiber optic channel? (Assume the band is 0.06 microns wide)

_____25000 GHz_____

5. Show the Manchester encoding for the byte 01000111.

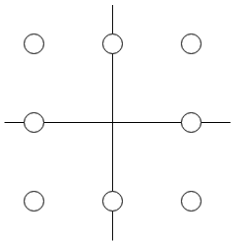


6. Which of the following frequency bands is NOT one of the ISM (Industrial, Scientific, Medical) bands?
   a) 108 MHz
   b) 900 MHz
   c) 2.4GHz
   d) 5.7GHz

Answer:

108 MHz is not one of the ISM bands

7. Draw a constellation diagram for 8PSK.



8. What is the broadcast MAC for Ethernet? 0xFFFFFFFF

9. What one factor has the greatest effect on DSL data rate?

The modem is what mostly slows down DSL

10. A 12-bit hamming code whose hexadecimal value is 0xE4F arrives at the receiver. What was the value that was transmitted in binary form? Assume no more than one 1 bit is in error. Show your steps.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Bit Number	1	2	3	4	5	6	7	8	9	10	11	12	
2	Code 0xE4F	1	1	1	0	0	1	0	0	1	1	1	1	
3														
4	Hamming bit													Error?
5	1	1		1		0		0		1		1		0
6	2		1	1			1	0			1	1		1
7	4				0	0	1	0					1	0
8	8								0	1	1	1	1	0
9														
10	Error value	0010												
11	Bit in error:	2												

11. How many analog phone lines are multiplexed in a T2 PCM? ___168 Lines_____

T1 – 24 voice channels

T2 – 7 T1's = 7*24 = 168

12. In the context of CDMA, are the following codes orthogonal? ___No_____
(1001), (1010), (1100), (1111)

	A	B	C	D	E	F	G
1	A	1	-1	-1	1		
2	B	1	-1	1	-1		
3	C	1	1	-1	-1		
4	D	-1	-1	-1	-1		
5							Sum
6	ABCD	2	-2	-2	-2		-4
7							
8							
9							
10							
11	AB	2	-2	0	0		0
12	AC	2	0	-2	0		0
13	AD	0	-2	-2	0		-4
14	BC	2	0	0	-2		0
15	BD	0	-2	0	-2		-4
16	CD	0	0	-2	-2		-4
17	ABC	3	-1	-1	-1		0
18	ABD	1	-3	-1	-1		-4
19	ACD	1	-1	-3	-1		-4
20	BCD	1	-1	-1	-3		-4

13. Assuming the following chip sequence codes: A = 1000, B = 1011, C = 0010, D = 1110, if the base station receives (-1,1,1,-3), which bit (if any) is each of the four transmitters sending?

A is sending __nothing__ (0, 1 or nothing)

B is sending ____0____ (0, 1 or nothing)

C is sending ____1____ (0, 1 or nothing)

D is sending ____1____ (0, 1 or nothing)

	A	B	C	D	E	F	G
1	A	1	-1	-1	-1		
2	B	1	-1	1	1		
3	C	-1	-1	1	-1		
4	D	1	1	1	-1		
5							
6	Received	-1	1	1	-3		Match?
7	AB'C	-1	-1	-1	-3		No
8	AB'D	1	1	-1	-3		No
9	ACD	1	-1	1	-3		No
10	B'CD	-1	1	1	-3		Yes

14. What is the minimum and maximum Ethernet payload (in bytes)?

Minimum = ___0_____

Maximum = ___1500__

15. In which of the following scenarios is an entry made to the ARP cache? (Circle all that apply)

a) An ARP request arrives that asks for this computer's MAC address
b) An ARP request arrives that asks for another computer's MAC address
c) An ARP reply arrives in response to a previous ARP request.
d) An IP frame arrives from a computer on the same subnet as this computer

16. What is time-division multiplexing?

Answer:

Time-division multiplexing is when systems are given times that they can talk on the network. It can be combined into larger and larger packets.

17. What is orthogonal frequency-division multiplexing?

Answer:

In OFDM, the channel bandwidth is divided into many sub-carriers that independently send data (e.g., with QAM). The sub-carriers are packet tightly together in the frequency domain. Thus, signals from each sub-carrier extend into adjacent ones.

18. What are the IP address ranges for each of the class A, B, and C licenses?

Class A: __1.0.0.0 – 127.255.255.255_____

Class B: __128.0.0.0 – 191.255.255.255_____

Class C: __192.0.0.0 – 223.255.255.255_____

19. Assume a telephone line has a bandwidth of 3100Hz and a Shannon limit of 35kbps. What must its signal-to-noise ratio be? Express your answer in dB.

35000 = 3100 log2(1 + SNR)

SNR = 2^(35000/3100)-1 = 2^(11.3)-1 = 2503.5

Answer: 2503.5 dB

20. Match the network layer with its function.

Application Layer _c____	a. provides end-to-end communication
Network Layer ____f__	b. converts data to the user's desired format
Physical Layer ____e__	c. user programs are part of this layer
Transport Layer ___a___	d. handles framing of data
Presentation Layer _b_____	e. deals with voltages, frequencies, radiation, etc.
Data-link Layer ___d___	f. handles routing through the subnet.