UNDER SELECTIVE ⇒ RECEIVER SUFFERS INCREASED EXTERNAL NOISE AND INTERFERENCE FROM ADJACENT STATIONS (Q IS LOW)

OVER SELECTIVE ⇒ RESULTS IN LOSS OF FIDELITY DUE TO CLIPPING OF UPPER FREQUENCIES (Q IS HIGH)

Week 12 review packet

1. Superheterodyne Receivers

a. Define Selectivity, including over and under selectivity.

SELECTIVITY REFERS TO THE ABILITY OF A RECEIVER TO DIFFERENTIATE BETWEEN THE DESIRED SIGNAL AND UNDESIRABLE FREQUENCIES

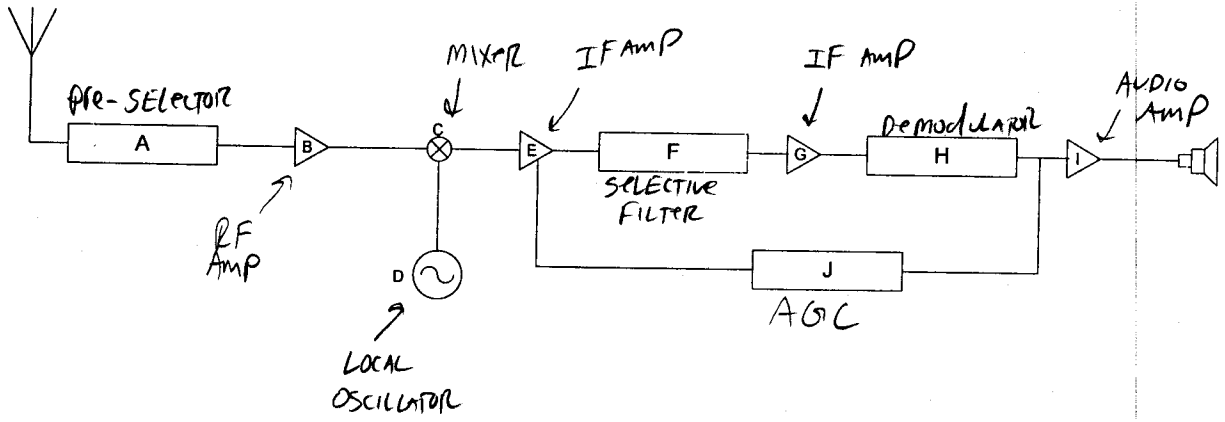
b. Define Sensitivity

WEAKEST SIGNAL THAT CAN BE RECEIVED AND STILL PRODUCE AN ACCEPTABLE OUTPUT

c. What is the defining characteristic of a superheterodyning system?

The IF remains fixed

Given the following block diagram, identify the various parts of a superheterodyning system:



d. If the intermediate frequency (IF) is 410KHz and we want to tune in 98.5FM, what do we need to "adjust" and to what frequency?

The LOCAL OSC. NEEDS TO BE ADJUSTED.

$410KHz = f_0 - 98.5MHz$ ⟩ $f_0 = 98.91\ MHz$

e. What is the purpose of the preselector?

TO ELIMINATE IMAGING

f. What is the purpose of the selective filter?

IT IS A BAND PASS FILTER CENTERED AROUND THE IF

g. Given your answer in d, if there was also a station transmitting at 99.32 MHZ, what would happen and why?

$99.32MHz - f_0 = 410KHz$ ⟵ SAME AS IF

(f_0 = 98.91MHz)

BUT NOTHING HAPPENS BECAUSE THE PRESELECTOR FILTERS OUT 99.32 MHz.

2. Antennas

a. What is one of the main characteristics that determine what frequency an antenna can effectively transmit? WAVELENGTH VS. LENGTH OF ANTENNA

b. What is the relationship between frequency and wavelength?

$$\lambda = \frac{c}{f}$$

c. What is antenna gain?

THE ABILITY TO FOCUS ELECTRO-MAGNETIC ENERGY IN A GIVEN DIRECTION

d. What is an isotropic source?

A POINT SOURCE THAT RADIATES ELECTRO-MAGNETIC ENERGY EQUALLY IN ALL DIRECTIONS

dBd → GAIN → RELATIVE TO A DIPOLE

e. What is dBi? dBd?

dBi → ANTENNA GAIN RELATIVE TO AN ISOTROPIC SOURCE,

f. What is the gain of a dipole in both ratio and dB?

2.16 dBi , RATIO = 1.64

g. If a dipole antenna has a gain of 32dBd, what is its gain in dBi?

$= 32 + 2.15 = 34.15\,dBi$

h. What is ERP and how is it calculated?

EFFECTIVE RADIATED POWER. ERP = INPUT POWER X ANTENNA GAIN (RATIO W/ RESPECT TO AN ISOTROPIC SOURCE)

i. Suppose we want to use a λ/2 dipole to transmit 1130AM. What is the length of the antenna?

$\lambda = \frac{c}{1130\,KHz} = 265.5\,m$, $\lambda/2 = 132.75\,m$

j. Name the 3 parts of a Yagi antenna

REFLECTOR, DIRECTOR, DRIVEN ELEMENT

k. Two ships are separated by 13 miles. One ship has a dipole and the other has a Yagi with a gain of 27 dBd. The dipole is transmitting a signal at 323 MHz and 154 W. What is the received power by the Yagi?

$$P_r = \frac{P_T G_T G_R \lambda^2}{16\pi^2 d^2}$$

$G_T = 1.64$

G_R; $27 + 2.15 = 29.15\,dBi$

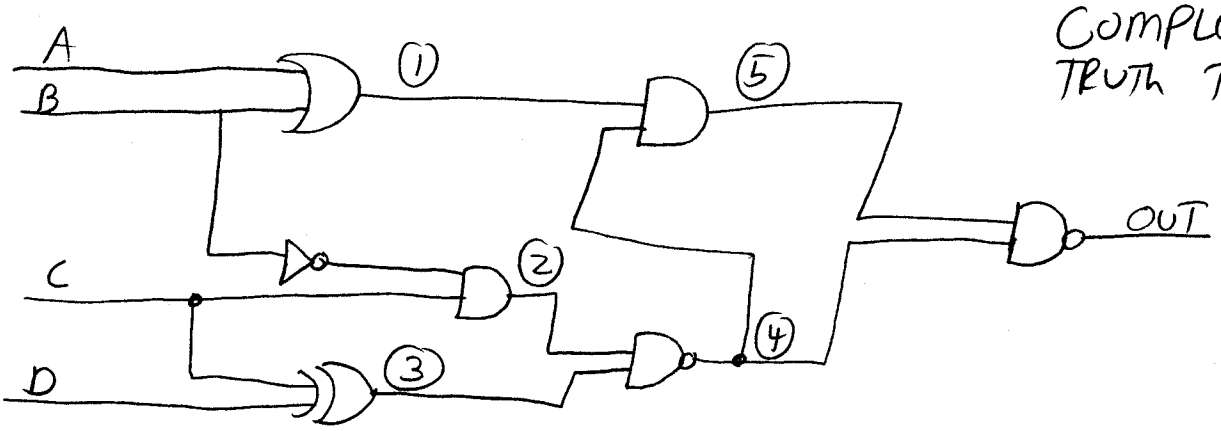
$G_R = 10^{\frac{29.15}{10}} = 822.24$

$P_T = 154\,W$

$\lambda = \frac{c}{323\,MHz} = 0.929\,m$

$d = (13\,miles)\left(\frac{1609\,m}{mile}\right) = 20.917\,Km$

$= 2.59\,\mu W$



COMPLETE THE TRUTH TABLE

A	B	C	D	$\overline{B}$	1 $A+B$	2 $\overline{B}\cdot C$	3 $C \oplus D$	4 $\overline{2 \cdot 3}$	5 $4 \cdot 1$	OUT $\overline{4 \cdot 5}$
0	0	0	0	1	0	1	0	1	0	1
0	0	0	1	1	0	1	1	0	0	1
0	0	1	0	1	0	0	1	1	0	1
0	0	1	1	1	0	0	0	1	0	1
0	1	0	0	0	1	1	0	1	1	0
0	1	0	1	0	1	1	1	0	0	1
0	1	1	0	0	1	1	1	0	0	1
0	1	1	1	0	1	1	0	1	1	0
1	0	0	0	1	1	1	0	1	1	0
1	0	0	1	1	1	1	1	0	0	1
1	0	1	0	1	1	0	1	1	1	0
1	0	1	1	1	1	0	0	1	1	0
1	1	0	0	0	1	1	0	1	1	0
1	1	0	1	0	1	1	1	0	0	1
1	1	1	0	0	1	1	1	0	0	1
1	1	1	1	0	1	1	0	1	1	0

3. Digital Transmittion

a. What are the advantages of digital over analog?

NOISE IMMUNITY
CAN USE Error correcting codes
EASY TO MULTIPLEX
NATIVE FORMAT FOR COMPUTERS
PERMITS DSP

b. If a -10 to 10V signal is quantized with a 12-bit A/D converter, what is the resolution? What is the dynamic range?

$q = \frac{V_{max} - V_{min}}{2^n} = \frac{20}{2^{12}} = 4.88\,mV$

$dR = 6.02N = (6.02)(12) = 72.24\,dB$

c. If an analog signal has a frequency spectrum as shown below, what is the minimum sampling frequency required and what is that frequency called? If it is sampled less than that, what happens?

NYQUIST SAMPLE RATE. highest $f = 25\,KHz$
SO, SAMPLE RATE = 2X highest = 50 KHz

d. How many symbols can be created by this 12-bit converter?

$Symbols = 2^n = 2^{12} = 4096$ SYMBOLS

e. If each symbol is transmitted at the sample rate, what is the baud rate and the data rate?

$Baud = \frac{sym}{sec} = 50K\,\frac{sym}{sec}$

$DATA\ RATE = \frac{bits}{sec} = (50K\,\frac{sym}{sec})(\frac{12\ bits}{symbol}) = 600\ Kbps$

f. If I need to use binary to represent 6, 897 characters, how many bits do I need?

$n = 3.32\,Log(6897) = 12.74$ 13 BITS

g. If it takes 32 µS to transmit one of these 6,897 symbols, what is the baud rate and data rate?

$BAUD = \frac{1}{32\mu s} = 31.25\,K\,\frac{sym}{sec}$

$DATA\ RATE = (31.25\,K)(\frac{13\ BITS}{sym}) = 406.25\ Kbps$

h. Assume a channel has a bandwidth of 125 KHz. What is the maximum achievable symbol rate (that is, what is the max bps using 2 symbols)? Whose theorem is this?

$C = 2B = 2(125\,KHz) = 250K\,\frac{sym}{sec}$ (HARTLEY)

i. If this channel has an SNR of 47 dB, what is the maximum channel capacity? Whose theorem is this?

$C = 3.32(BW)\,Log(1+SNR)$ $47dB \Rightarrow 50119$

$= 3.32(125KHz)\,Log(50120) = 1.95\,Mbps$ (Shannon-HARTLEY)

j. Given the last 2 answers, how many bits per symbol do I need to achieve this maximum data rate?

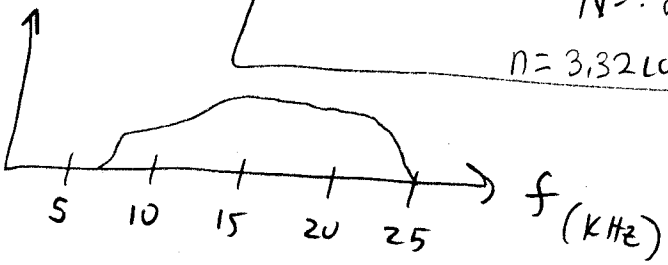
Given $C = 2BW\,Log_2 N = 6.64 \cdot BW \cdot Log_{10} N$

$1.95\,Mbps = (6.64)(125\,KHz)\,Log\,N$

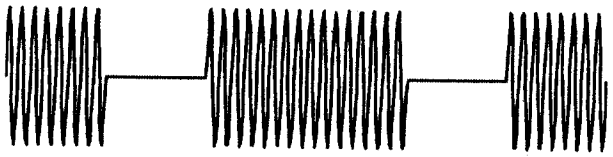
$N = .224$ SYMBOLS

$n = 3.32\,Log\,N = 3.32\,Log(224) = 8$ BITS

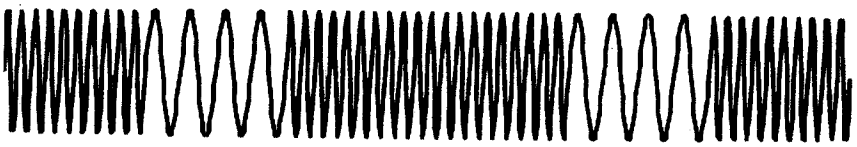
c)



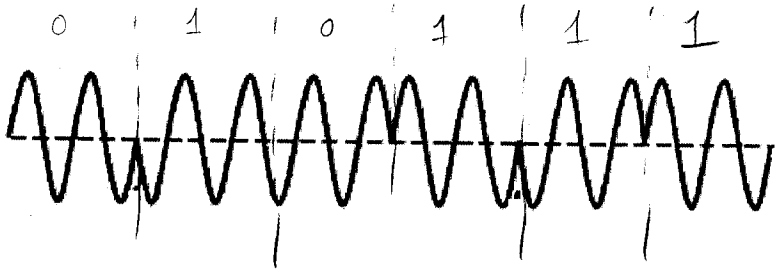
k. Identify the following digital modulation types:



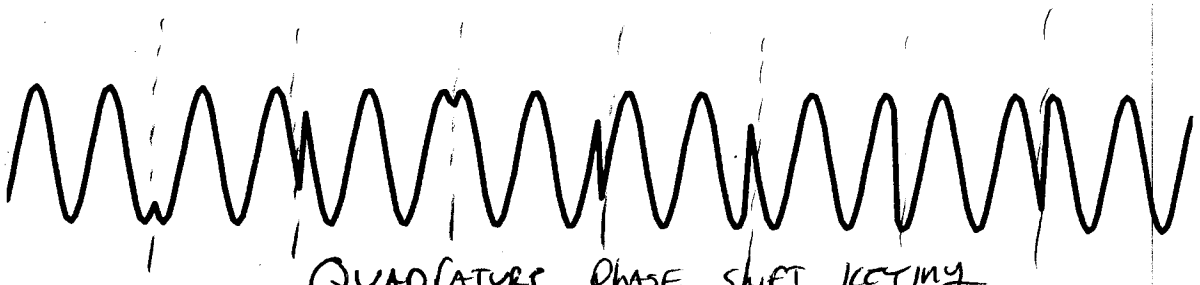
On-off keying (OOK)



Frequency shift keying (FSK)



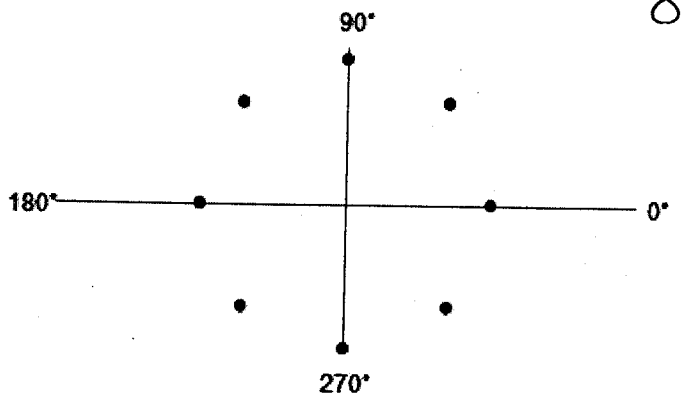
Binary phase shift keying (BPSK)



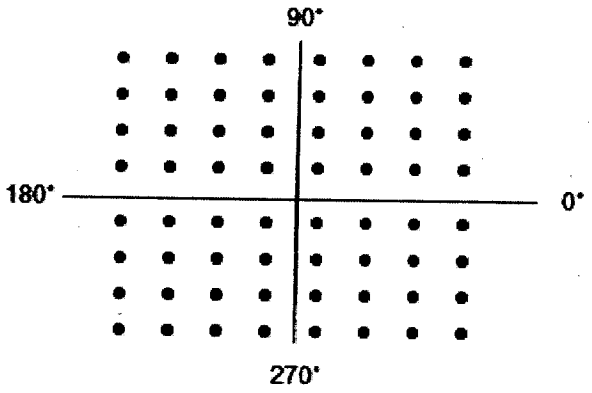
Quadrature phase shift keying (QPSK)

4-PSK

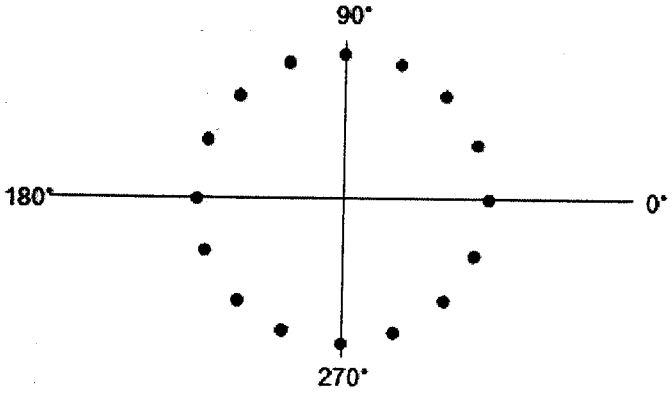
I. Identify the following digital modulation type, how many symbols are represented by each, and the number of bits per symbol:



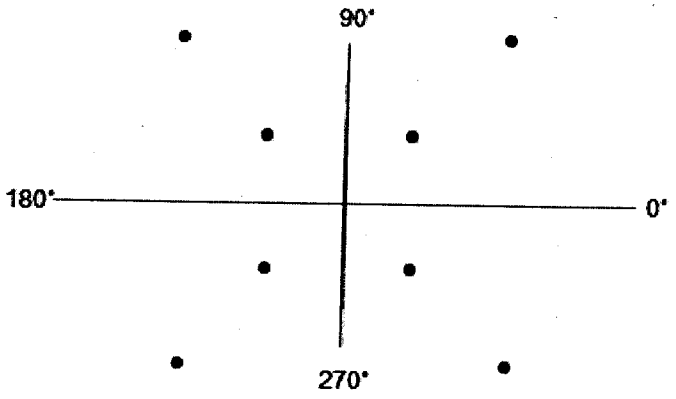
8-PSK, 8 symbols
(3 bits per symbol)



64-QAM, 64 symbols
(6 bits per symbol)

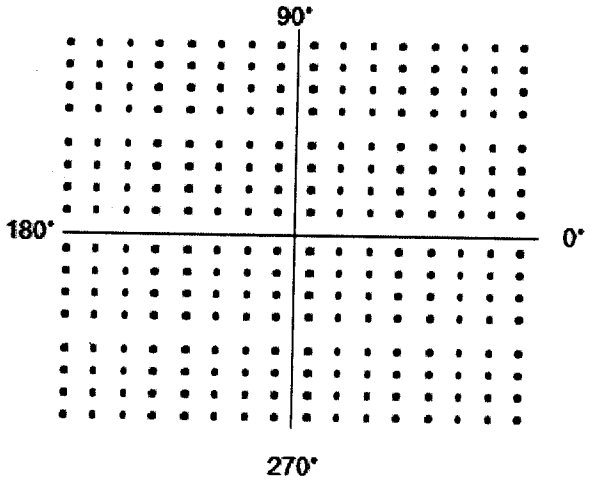


16-PSK, 16 symbols
(4 bits, symbol)



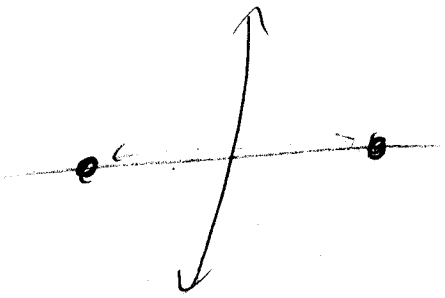
8-QAM, 8 SYMBOLS

(3 bits per SYMBOL)



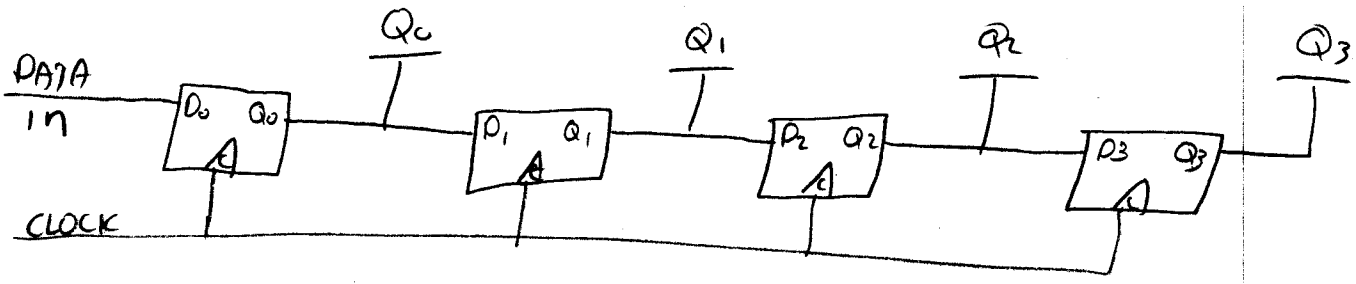
256-QAM, 256 SYMBOLS

8 bits per SYMBOL



Given:

COMPLETE The TIMING DIAGRAM



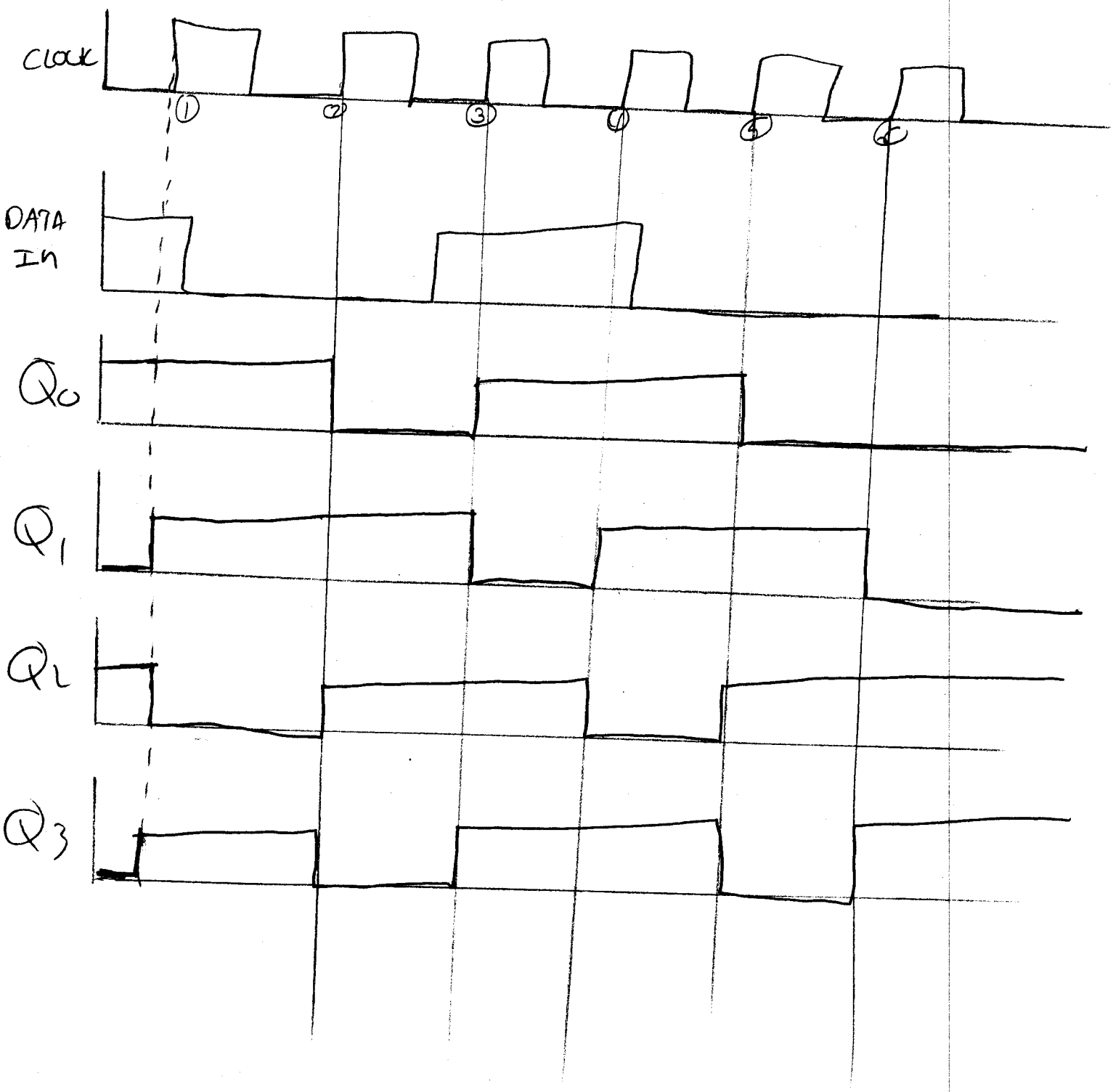
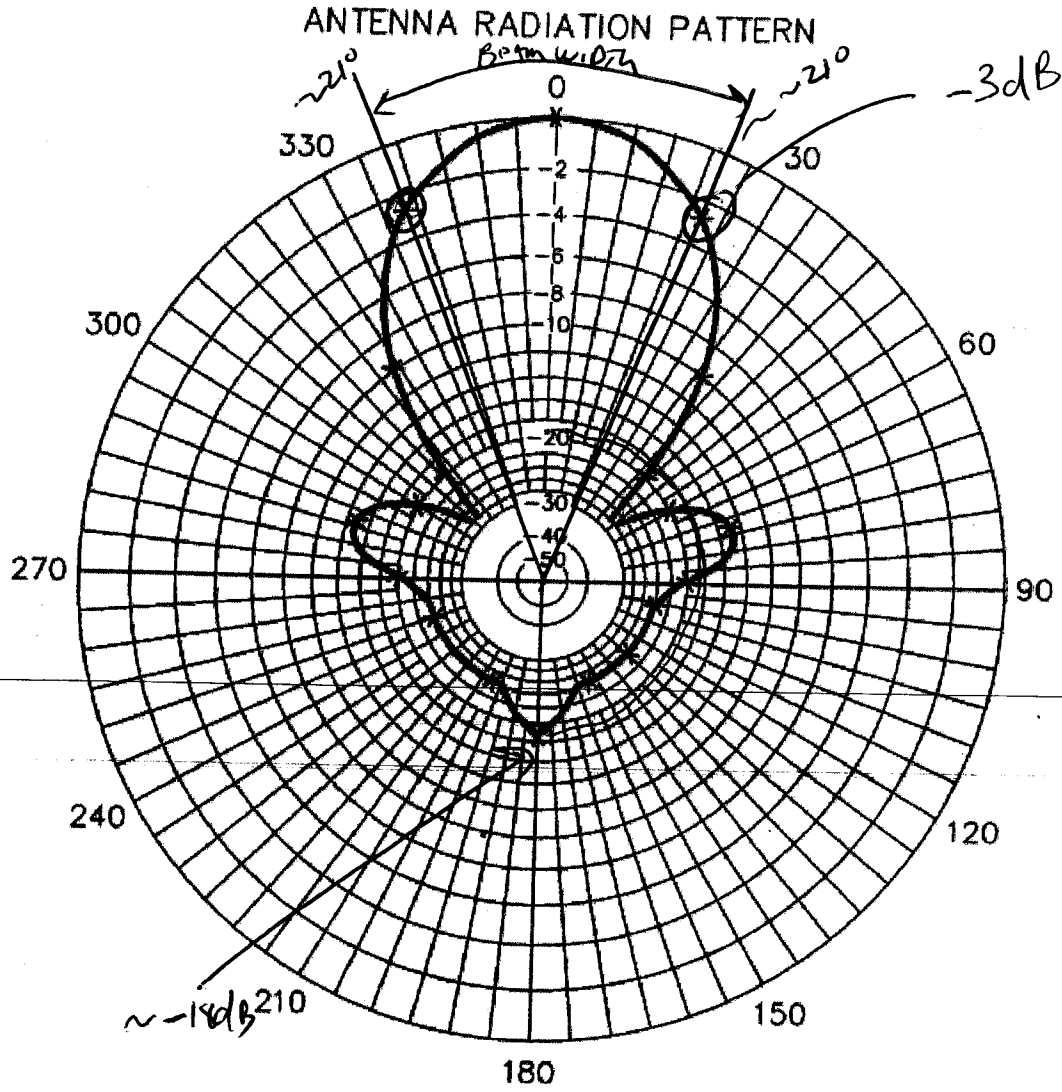


TABLE method

CLOCK	DATA IN	Q_0	Q_1	Q_2	Q_3
0	1	1	0	1	0
1	0	1	1	0	1
2	1	0	1	1	0
3	1	1	0	1	1
4	0	1	1	0	1
5	0	0	1	1	0
6	0	0	0	1	1



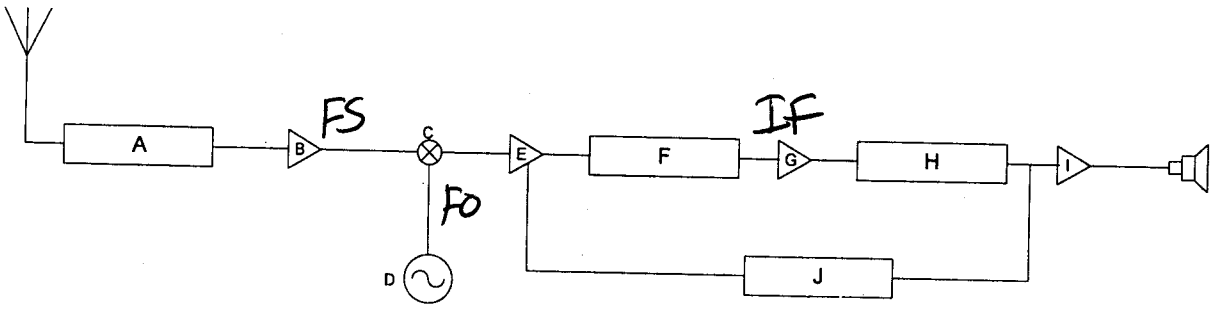
(1) What is the beam width ? = 42°

(2) What is the Front to Back Ratio?

$$Fb = 0dB - (-18dB)$$

$$= 18dB$$

15. Given the following Superheterodyning block diagram, write the letter next to the description of the stages below



Local Oscillator D

Mixer C

Selective Filter F

Preselector A

Demodulator H

16. On the above diagram, write in where the Input signal is (Fs), where the local oscillator signal is (Fo) and where the IF signal is.

17. True or false in a Superheterodyning, the IF changes depending on the "channel" we are trying to receive.

18. Suppose I have a Superheterodyning with NO preselector. Suppose I want to tune in 200MHZ and my IF is 500KHz:

a. Would the Fo of my local oscillator be 200.5MHZ or 205MHz? $Fo - 200MHz = IF$; $Fo = 200MHz + 500KHz$

b. Would a station that is transmitting at 201MHz present a problem and why? Could it be corrected?

Yes, Because $201MHz - 200.5MHz = 500KHz$ And you would get Imaging. A preselector would correct This

Quiz #5

Name:_____

1. In a Superheterodyning system, what remains constant regardless of what channel you are trying to receive?

IF

2. What determines a receiver's ability to distinguish between the desired channel and other frequencies? (one word!)?

SELECTIVITY

3. What are the two parasitic elements used in Yagi antennas?

REFLECTOR, DIRECTOR

4. True / (False.) A Yagi antenna directs most of its energy in two directions.

5. What is the equation for wavelength?

$\lambda = \frac{c}{f}$

6. If you see an antenna has a gain *x* dBi, what does that mean?

MEANS THE ANTENNA HAS A GAIN OF X WITH RESPECT TO AN ISOTROPIC SOURCE

7. For a dipole, how much more gain does the dipole when compared to an isotropic antenna (ratio)? What is this in dB?

RATIO → 1.64

2.15 dBi

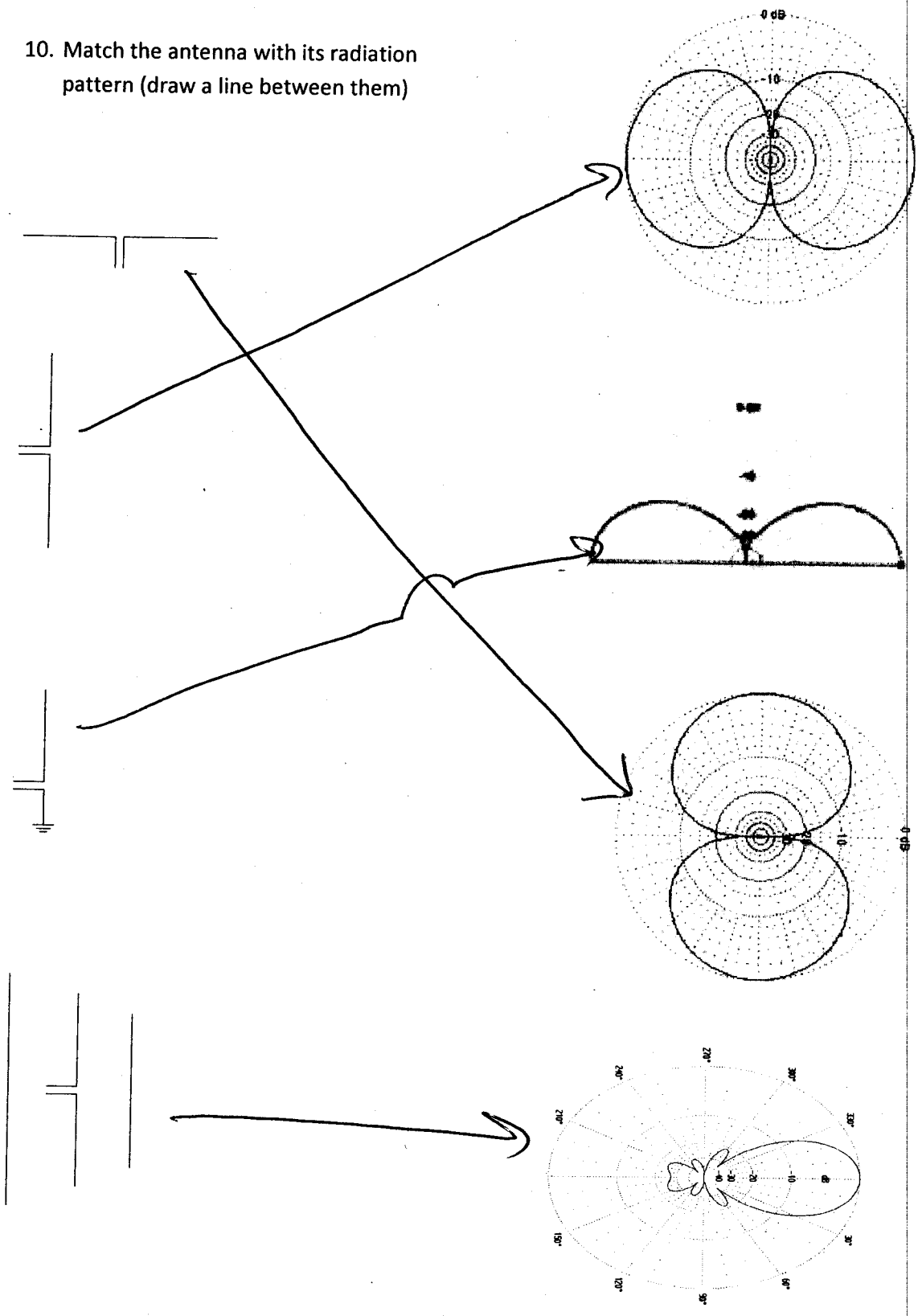
8. If an antenna has a gain of 9 dBd, what is its gain in dBi?

9 dBd + 2.15 dB = 11.15 dBi

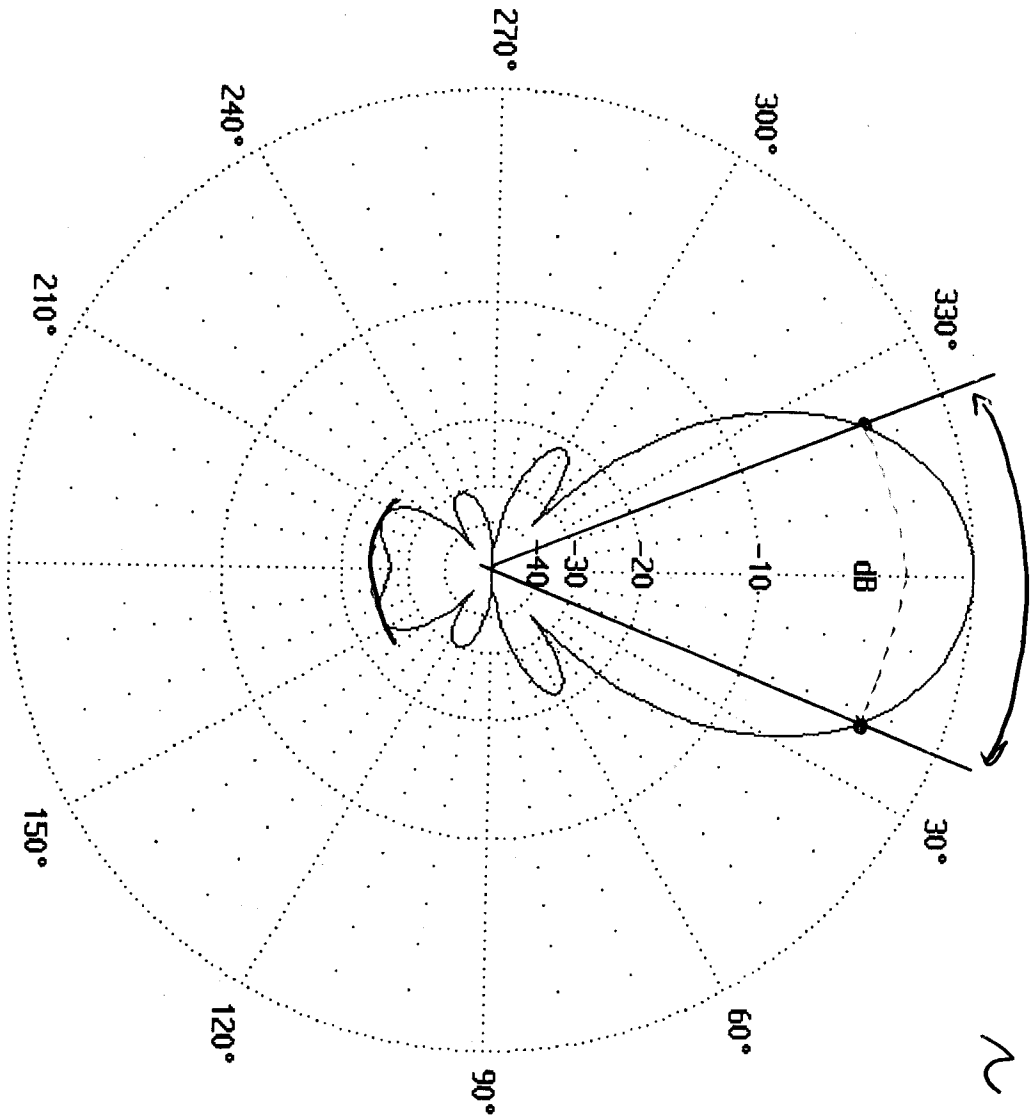
9. What is reciprocity?

AN ANTENNA HAS THE SAME CHARACTERISTICS (BEAMWIDTH, PATTERN, GAIN, ETC.) FOR BOTH TRANSMIT AND RECEIVE

10. Match the antenna with its radiation pattern (draw a line between them)



11. What is the beam width of the following radiation pattern? What is the front to back ratio?



Beam width between -3dB points ≈ 44°

Note: Each dot represents either -2dB or 10°

$FB_{RATIO} = 0dB - (-24dB)$

$= 24dB$

Quiz #6

Name:_____

1. Suppose the USS Leal has a dipole antenna that is mounted 125 feet above the water line. The USS Leal wishes to communicate with the USS Korpela who has a Yagi antenna that is mounted 150 feet above the water line. What is the maximum distance that the ships can separate but still maintain communication?

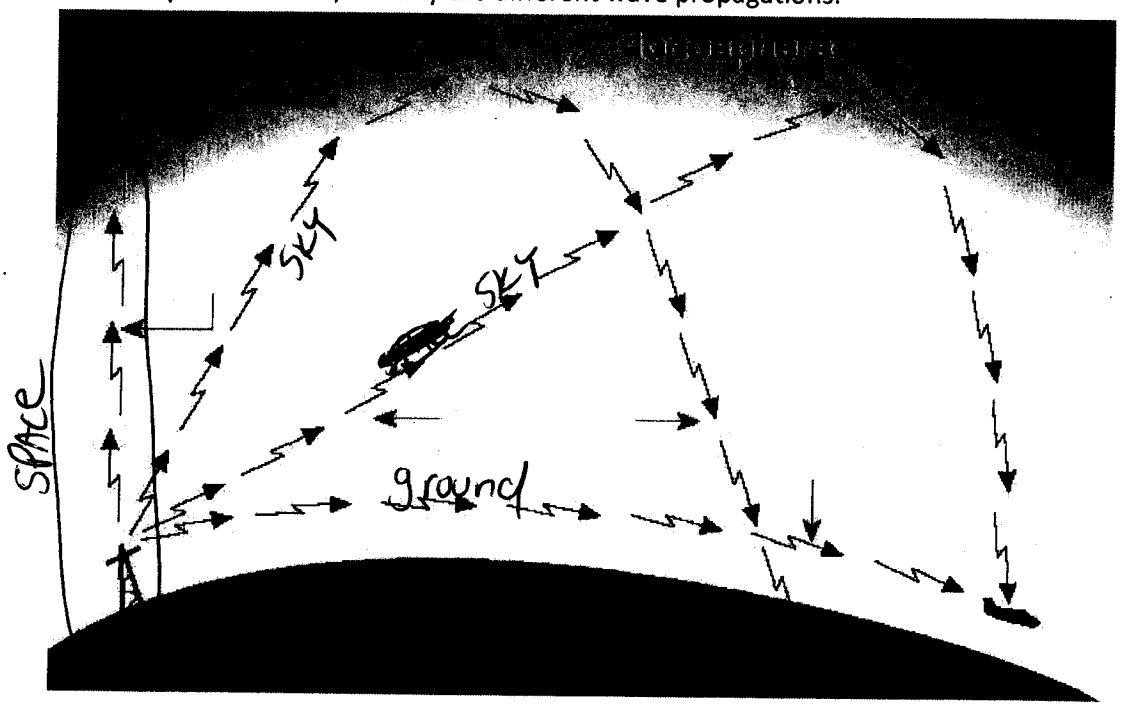
$$d = \sqrt{2(125)} + \sqrt{2(150)} = 33.13 \text{ miles}$$

2. Given your answer in #1, if the Yagi antenna on the USS Korpela has a gain of 14.5 dBd and transmits with a power of 37 watts at 100MHz, how much power is received by the USS Leal?

$$P_R = \frac{(37w)(1.64)\left(10^{\frac{(14.57+2.15)}{10}}\right)(3m)^2}{16\pi^2\left(33.13 \text{ miles} \cdot 1609 \frac{\text{miles}}{m}\right)}$$

$$= 56.26\,nW$$

3. Give the picture below, identify the different wave propagations.



4. Match the logic gate with the type of gate and the truth table (____/____ is diagram / truth table).

Gate Type

AND

C, E

OR

D, F

XOR

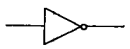
B, G

NOT

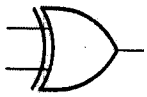
A, H

Diagram

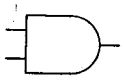
A.



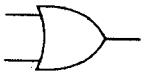
B.



C.



D.



Truth Table

E.

IN	IN	OUT
0	0	0
0	1	0
1	0	0
1	1	1

F.

IN	IN	OUT
0	0	0
0	1	1
1	0	1
1	1	1

G.

IN	IN	OUT
0	0	0
0	1	1
1	0	1
1	1	0

H.

IN	OUT
0	1
1	0

5. Convert the decimal value of 32730 to a hexadecimal value.

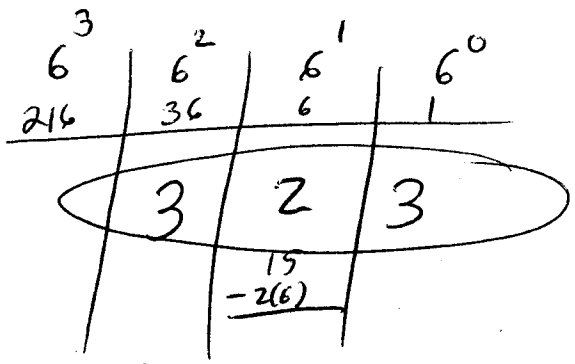
7FDA

6. Convert your answer from #5 to a binary number.

0111 1111 1101 1010

7. Brownie points question!!!!!!!

Convert the decimal number 123 to a Base 6 number (that is use 6 as the base, not 2, 10, or 16!!!)



123
− 3(36)
15

Quiz #7

Name:_____

1. Name 2 reasons why digital is superior to analog.

   NOISE IMMUNITY
   COMPRESSION
   MULTIPLEXING

2. In a superheterdyning system, what frequency never changes? What frequency does change when you want to tune say 102.7 FM?

   IF never changes

   – you change the LOCAL OSC. TO TUNE IN 102.7FM

3. If an antenna has a gain of 32.1 dBd, what is its gain in dBi?

   32.1 + 2.15 = 34.25 dBi

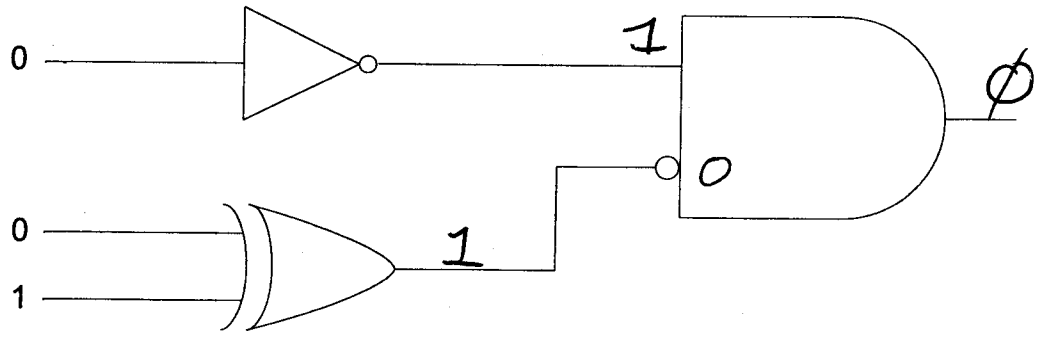
4. How many bits in a byte

   8

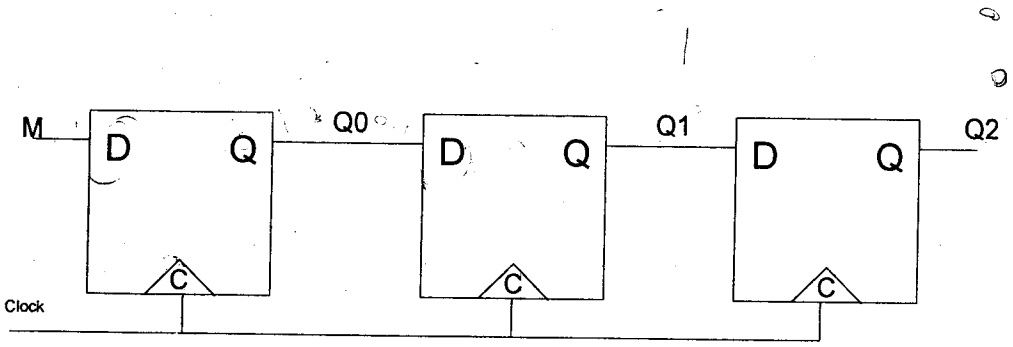
5. What is the Hexadecimal equivalent of 1011 1100?

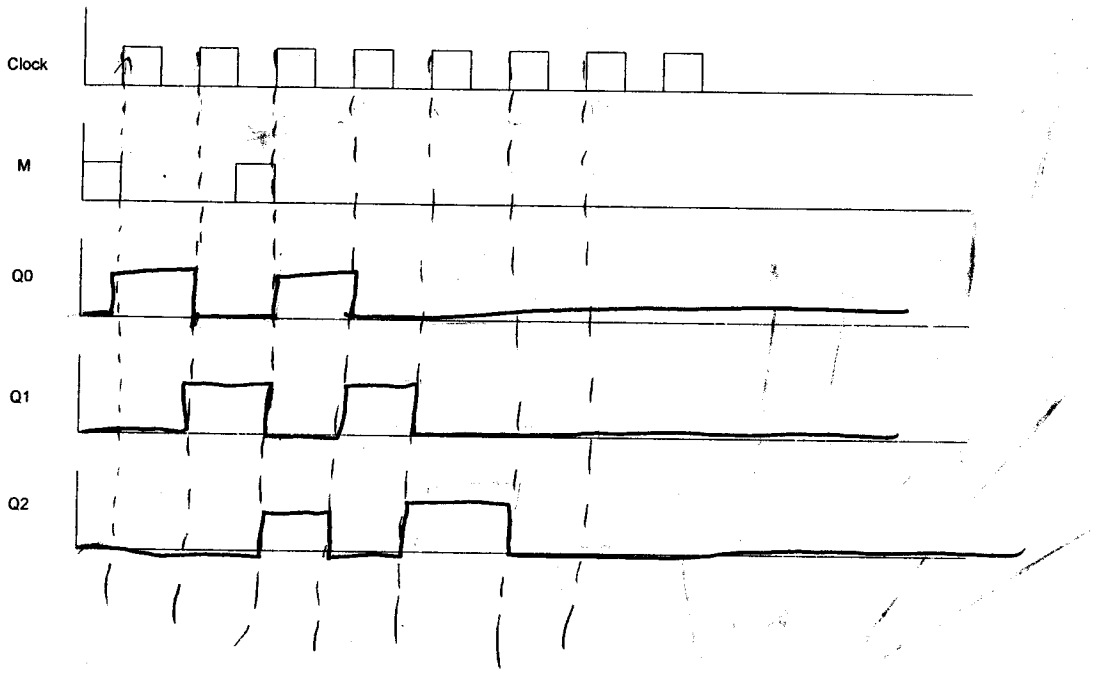
   B C

6. Given the following logic circuit, what is the output?



7. Given the following diagram and the fact that initially Q0=Q1=Q2=0, complete the timing diagram for the first 5 cycles only!!!!





8. How do you win a Nascar race?

Press the gas and turn LEFT

9. True or false, a Yagi antenna's radiation pattern resembles a circle.

10. True or false, you multiply dB's and add ratios.

11. True or false, space waves travel in a line-of-site fashion.

12. If a signal has a frequency range of 100 to 5000 hertz, what is the minimum frequency that this signal should be sampled?

2 X 5KHz = 10KHz

13. Given the following analog signal and assuming that the voltage range is 0 to 4 volts:

a. What is the quantization level if this is quantized with 4 bits?

$2^4 = 16$

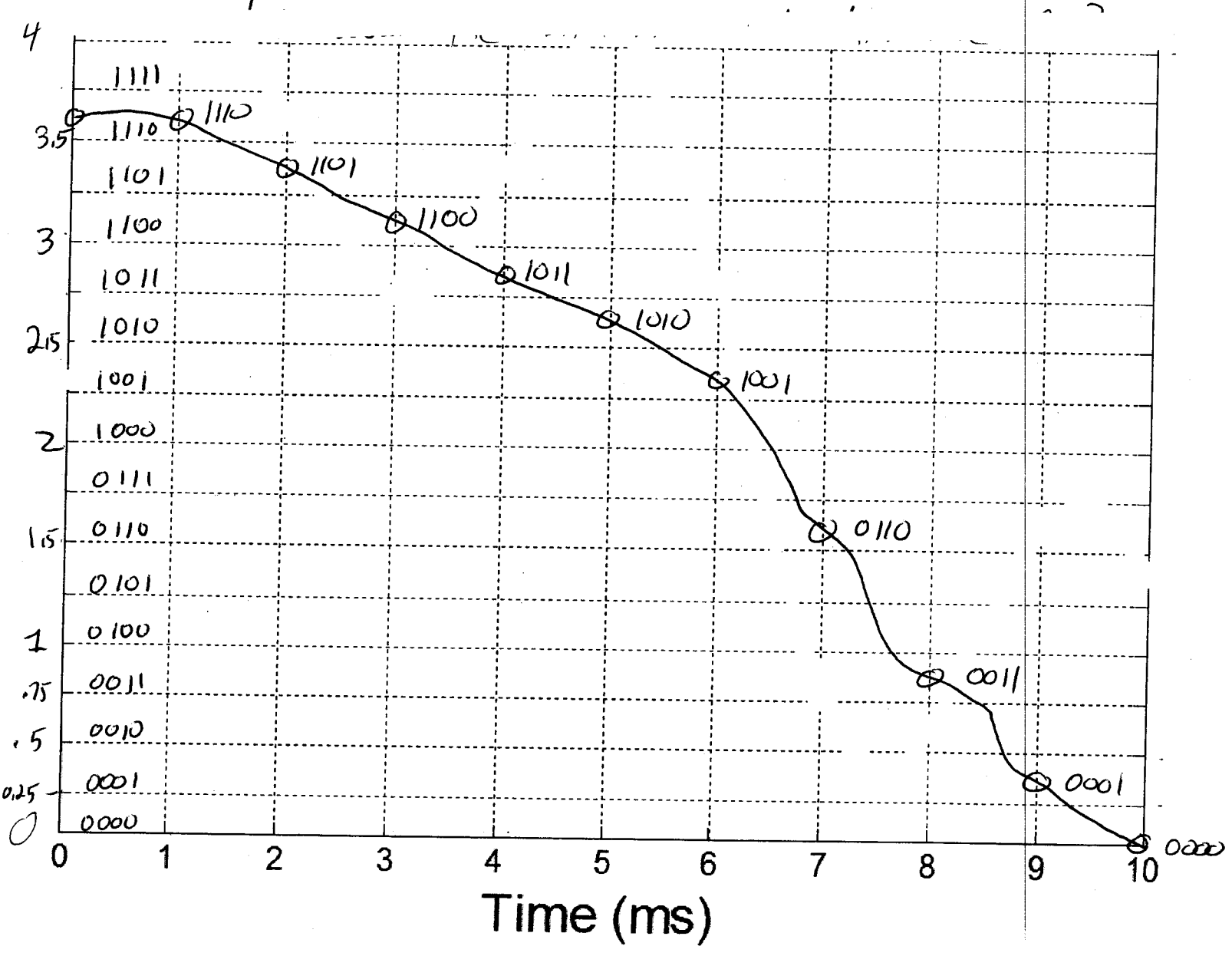
b. What is the resolution?

$q = \frac{4}{16} = 0.25\,V$

c. Mark the horizontal axis with the voltages based on the resolution.

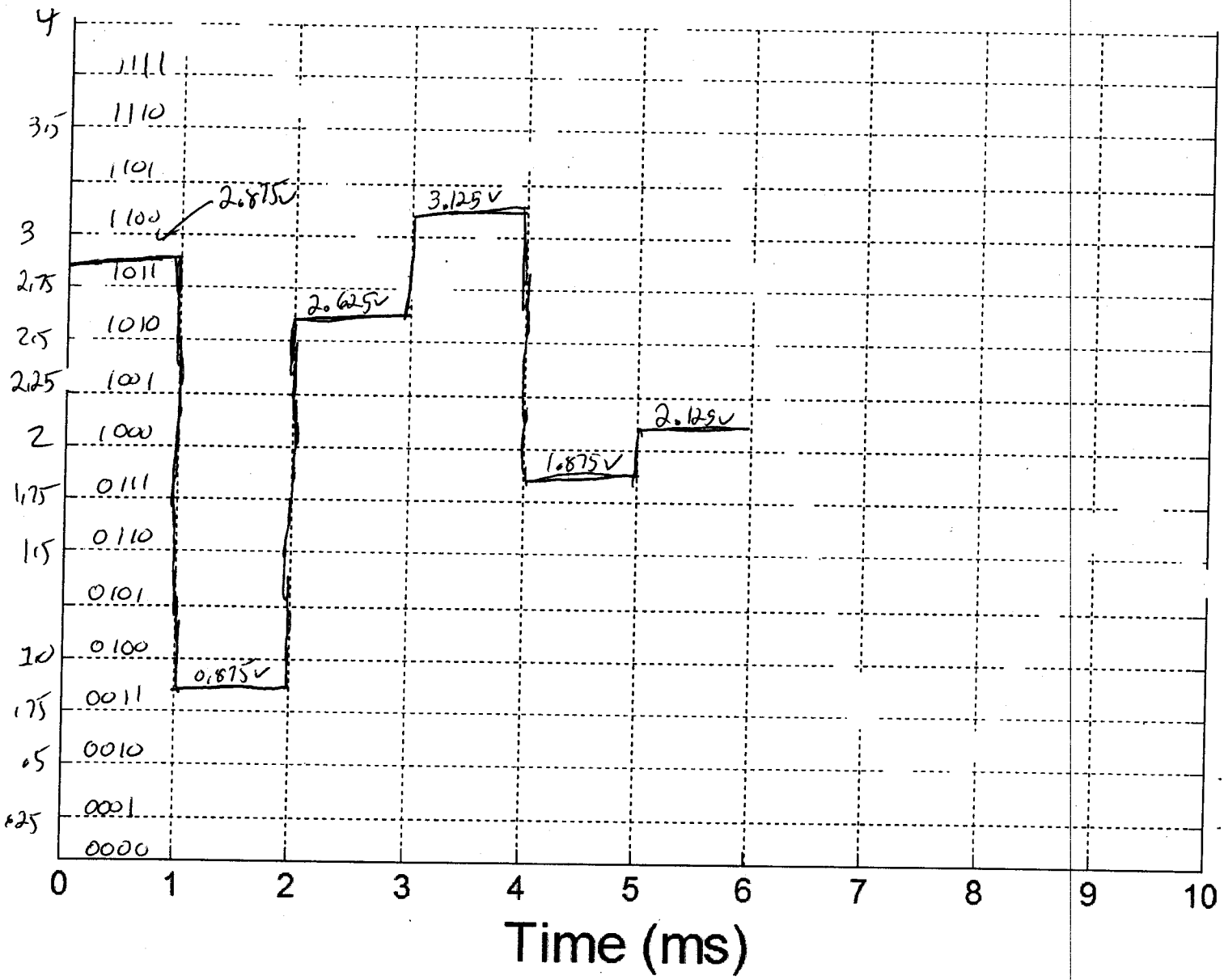
d. Label the binary numbers for the specific ranges

e. Determine the binary encoding for the samples at the 2, 5, and 9 mS marks.



14. Now assume all of the same information as from problem #8. Draw the digital to analog conversion of the bit stream received is ~~0110 1011 0011~~. Label the voltages for these ~~9~~ 6 samples only.

1101 0011 1010 1100 0111 1000



VOLTAGE IS $\frac{q}{2}$ (THEN ADD TO VOLTAGE @ A OR SUBTRACT FROM VOLTAGE @ B)