American University of Beirut

Faculty of Engineering and Architecture

Department of Electrical and Computer Engineering

EECE200 – Introduction to Engineering– Fall 2014

Homework 1 Solution

Problem 1 [30 points]

a. The amplitude of x is 1.5V [1]
   The amplitude of y is 2.5V [1]
   The amplitude of z is 3V [1]

b. For x
   T= 4-0 = 4 sec [1]
   F= 1/T = 0.25 Hz [1]
   $\omega = 2\pi F = 1.57$ rad/sec [1]

   For y
   T= 5-0 = 5 sec [1]
   F= 1/T = 0.2 Hz [1]
   $\omega = 2\pi F = 1.256$ rad/sec [1]

   For z
   T= 2-0 = 2 sec [1]
   F= 1/T = 0.5 Hz [1]
   $\omega = 2\pi F = 3.14$ rad/sec [1]

c. Signal z has the highest frequency (0.5Hz) [1]

d. For x:
   $x=1.5\sin(1.57t+\varphi_x)$
   At t = 1sec, x=1.5 => $1.5=1.5\sin(1.57+\varphi_x)$; $\sin(1.57+\varphi_x)=1$; $1.57+\varphi_x=\pi/2$ [1]
   ⇨ $\varphi_x = 0$ rad/s [1]
   and $\varphi_x = 0$ deg [1]
   On the graph at t=0 sec , x=0.5. Substituting in the equation verifies the calculated results [1]

   For y
   $y= 2.5\sin(1.256t+\varphi_y)$
   At t = 1.25sec, y=0 => $0=2.5\sin(1.256*1.25+\varphi_y)$; $\sin(1.25*1.25+\varphi_y)=0$ => $1.57+\varphi_y=0+k\prod$ [1]
   ⇨ $\varphi_y = +/ -1.57$ rad/s [1]
   and $\varphi_y = +/- 90$ deg [1]
   On the graph at t=0 sec, y=2.5. Substituting in the equation:
   $2.5=2.5\sin(+/- 1.57)$=> $\varphi_y = 1.57$ rad/s verifies the calculated results [1]

For z

$z = 3\sin(3.14t+\varphi_z)$

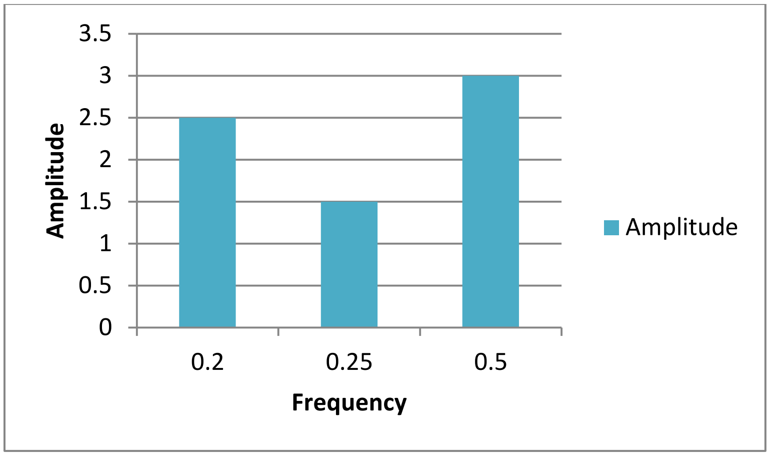
At t = 2.25sec, z=3 => $3=3\sin(3.14t+\varphi_z)$; $\sin(3.14*2.25+\varphi_z)=1$; $7.065+\varphi_z=\pi/2$ [1]

⇨ $\varphi_z = 0.785$ rad/s [1]

and φ_z =45 deg [1]

On the graph at t=0 sec , z=2.2. Substituting in the equation verifies the calculated results [1]

e. 1 point for each correct column (total 3) and one point for labeling each axis (total 2) [5 points].



Problem 2 [10 points]

a. Analogue: black and white TV, video tape, volume control of old radio, LANDLINE TELEPHONE, microphone.
Digital: HDMI, electric guitar amplification board, USB connection, image processing MRI scanning modem, CPU signals, DVB TV, serial connection cable. [0.5point each]

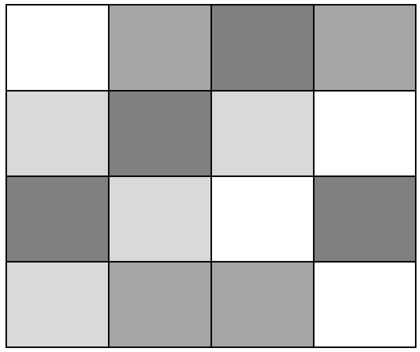
b. Total bandwidth of FM radio is 87.5 to 108.0 MHz , 400kHz being allocated to each station.(please consider the answer of 88-108MHZ and bandwidth of 200KHz to be correct as well) [0.5 each]

c. Any 3 of the below [1 point each, total 3points]:

1. The amplitude of an FM wave remains constant. This provides the system designers an opportunity to remove the noise from the received signal. This is not possible in AM systems because the baseband signal is carried by the amplitude variations it self and the envelope of the AM signal cannot be altered.
2. Most of the power in an FM signal is carried by the side bands. For higher values of the modulation index, mc, the major portion of the total power is contained is side bands, and the carrier signal contains less power. In contrast, in an AM system, only one third of the total power is carried by the side bands and two thirds of the total power is lost in the form of carrier power.
3. In FM systems, the power of the transmitted signal depends on the amplitude of the unmodulated carrier signal, and hence it is constant. In contrast, in AM systems, the power depends on the modulation index ma. Therefore, the power usage is optimum in an FM system.
4. In an AM system, the only method of reducing noise is to increase the transmitted power of the signal. This operation increases the cost of the AM system. In an FM system, you can increase the frequency deviation in the carrier signal to reduce the noise.
5. In an FM signal, the adjacent FM channels are separated by guard bands. In an FM system there is no signal transmission through the spectrum space or the guard band. Therefore, there is hardly any interference of adjacent FM channels.

However, in an AM system, there is no guard band provided between the two adjacent channels. Therefore, there is always interference of AM radio stations unless the received signalis strong enough to suppress the signal of the adjacent channel.

Problem 3 [25 points]



a. 4x4 = 16 pixels [2]

b. 2 bits are needed to represent the pixel because we have 4 levels of gray which are represented with 2 bits (2^2=4 levels) [1] for the number of bits and [1] for verification
Very Dark grey: 00 [2]
Dark grey: 01 [2]
Light grey: 10 [2]
White: 11 [2]

c. [0.5] for each correct element in the matrix

3	1	0	1
2	0	2	3
0	2	3	0
2	1	1	3

d. 16 (elements)x2(bits for each element)x30 (frames per second)x60 (sec per minute)x5 (minutes)/8 (bits per byte)= 36000 bytes. 36000/1024= 35.156 Kbytes. 35.156/1024= 0.034 Mbytes [5]

Problem 4 [35 points]

a. $100110.101_2 = 1x2^5+0x2^4 +0x2^3+1x2^2+1x2^1+0x2^0+1x2^{-1}+0x2^{-2}+1x2^{-3}$ = 38.625 [9]

b. 250.25_{10} = 11 11 1010.01 [4] on the answer and [5] on the steps

250/2	125	0
125/2	62	1
62/2	31	0
31/2	15	1
15/2	7	1
7/2	3	1
3/2	1	1
1/2	0	1

0.25x2=0.5 ; 0.5x2=1

c. $135_8 = 1x8^2+3x8^1+5x8^0 = 93_{10} = 1011101_2$[2] for the answer and [2] for the steps

93/2	46	1
46/2	23	0
23/2	11	1
11/2	5	1
5/2	2	1
2/2	1	0
1/2	0	1

d. $11010110_2 = D6_{HEX}$ [4]

$1101_2=D_{HEX}$; $0110_2=6_{HEX}$

e. $D32_{16} = 13x16^2+3x16^1+2x16^0 = 3378$ [9]