**College of Electronic Technology/ Tripoli**

Communication 1

Midterm Exam #2

**Date: 09/02/ 2020** **Time allowed: 1:30 hrs**

Answer **ALL** questions

**Question 1 [15 marks]**

$\beta_F = \frac{\Delta F}{F_m} = \frac{6000}{1000} = 6$ $\Delta F = K_F \cdot A_m$ $\Delta F = 3000 \times 2 = 6000$

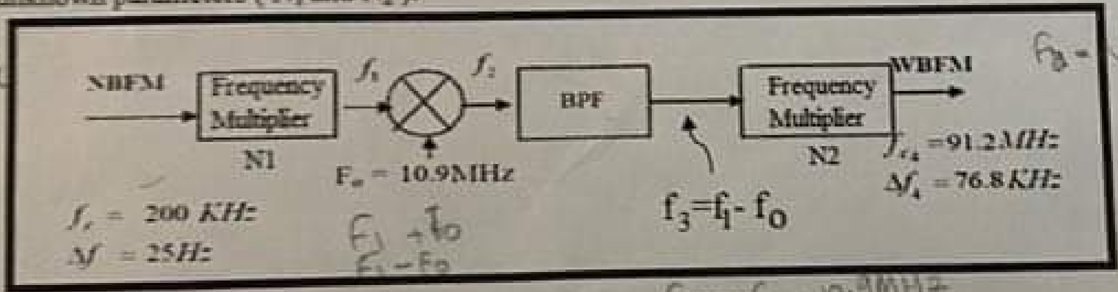
The carrier $c(t) = A \cos 2\pi 10^6 t$ is angle modulated (PM or FM) by the sinusoid signal $m(t) = 2 \cos 2000\pi t$. The deviation constants are $k_p = 1.5$ rad/V and $k_f = 3000$ Hz/V.

1. Determine $\beta f$ and $\beta p$. [4]
2. Determine the bandwidth in each case using Carson's rule. [2]
3. Plot the spectrum of the modulated signal in case of FM modulation. [5]
4. If the amplitude of m(t) is decreased by a factor of two, how would your answers to parts 1–2 change? [2]
5. If the frequency of m(t) is increased by a factor of two, how would your answers to parts 1–2 change? [2]

$B_W = 2(1+\beta) F_m =$

**Question 2 [10 marks]**

Block diagram of an indirect (Armstrong) FM transmitter is shown bellow. Compute the unknown parameters ( $N_1$ and $N_2$ ).




$\frac{\Delta F_n}{\Delta F} = n_1 \times n_2 = 3072$

$\frac{F_u}{N_2} = n_1 f_c - F_o$

**Note: Table of Bessel function**

| $J_n(\beta)$ | $\beta=1$ | $\beta=2$ | $\beta=3$ | $\beta=4$ | $\beta=5$ | $\beta=6$ |
|---|---|---|---|---|---|---|
| $n=0$ | 0.7652 | 0.2239 | −0.2601 | −0.3971 | −0.1776 | 0.1506 |
| $n=1$ | 0.4401 | 0.5767 | 0.3391 | −0.0660 | −0.3276 | −0.2767 |
| $n=2$ | 0.1149 | 0.3528 | 0.4861 | 0.3641 | 0.0466 | −0.2429 |
| $n=3$ | 0.0196 | 0.1289 | 0.3091 | 0.4302 | 0.3648 | 0.1148 |
| $n=4$ | 0.0025 | 0.0340 | 0.1320 | 0.2811 | 0.3912 | 0.3576 |
| $n=5$ | 0.0002 | 0.0070 | 0.0430 | 0.1321 | 0.2611 | 0.3621 |
| $n=6$ | 0.0000 | 0.0012 | 0.0114 | 0.0491 | 0.1310 | 0.2458 |
| $n=7$ | 0.0000 | 0.0002 | 0.0025 | 0.0152 | 0.0534 | 0.1296 |
| $n=8$ | 0.0000 | 0.0000 | 0.0005 | 0.0040 | 0.0184 | 0.0565 |
| $n=9$ | 0.0000 | 0.0000 | 0.0001 | 0.0009 | 0.0055 | 0.0212 |
| $n=10$ | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0015 | 0.0070 |

$\frac{200}{n_1} = f_1$

Answer ALL questions

**Question 1 [15 marks]**

A carrier signal Ac Cos($w_c$ t) is modulated by a signal m(t)= Am cos($w_m$ t) to form a AM modulated signal s(t)= [Ac + Am cos($w_m$ t)] cos($w_c$ t).
where Ac=10, Am=2; fc=1000Hz; fm=50Hz.

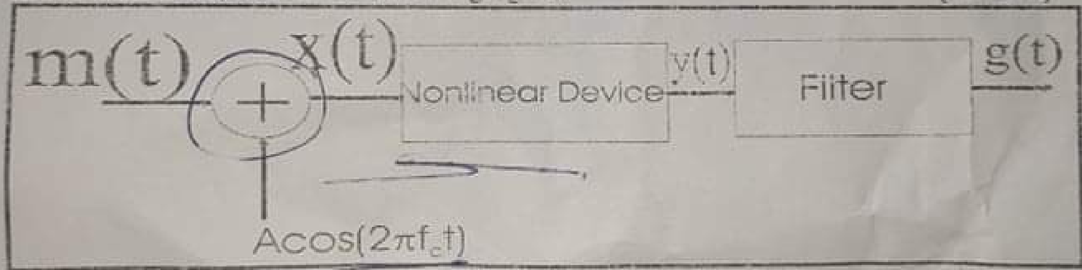
a) Obtain the expressions for the sidebands of s(t). [2 marks]
b) Sketch s(t) [3 marks]
c) Sketch the spectra M(f), C(f) and S(f) a against f. [4 marks]
d) Calculate the modulation index (μ). [2 marks]
e) What bandwidth is required to transmit AM signal? [2 marks]
f) Show that the total sideband power to the total power in the modulated wave is equal to $\mu^2/(\mu^2 + 2)$ [2 marks]

**Question 2 [10 marks]**

(1) The DSB-SC signal is **r(t)= m(t)cos($2\pi f_c t$)** is applied to the input of a coherent detector, the local oscillator used in coherent detector is defined by $c_r(t)$= **cos($2\pi f_c t+\theta$)**. The output of the coherent detector is then filtered to obtain the baseband signal.

a) Write the expression of the output waveform [3 marks]
b) Discuss the effect of this phase shift. [2 marks]

(2) Consider the system in the following figure. [5 marks]




Assume that the non linear device has the input-output relationship of the form

$$y(t)= a_1 x(t)+a_2 x^2(t)$$

And $|m(t)| \leq 1$, the bandwidth of m(t) is w

1. Write the equation for x(t)
2. . Write the equation for y(t)
3. Describe the filter that yield an AM signal for g(t)
4. Write the equation for g(t).
5. Find the condition of $a_1$ *and* $a_2$ such that the signal generated g(t) is not over-modulated

Notes

sin(x−y)=sin(x). cos(y) + cos(x). sin(y)
cos(x+y)= cos(x).cos(y) - sin(x).sin(y)
cos(x).cos(y)= ½[cos(x-y) + cos(x+y)]
sin(x).sin(y)= ½[cos(x-y) - cos(x+y)]