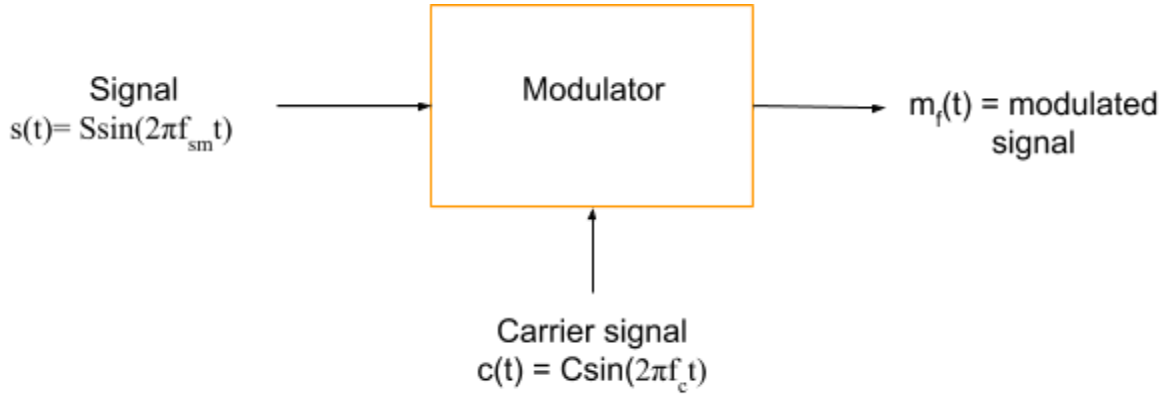
Satellite & Mobile Communication Network

04.09.2020

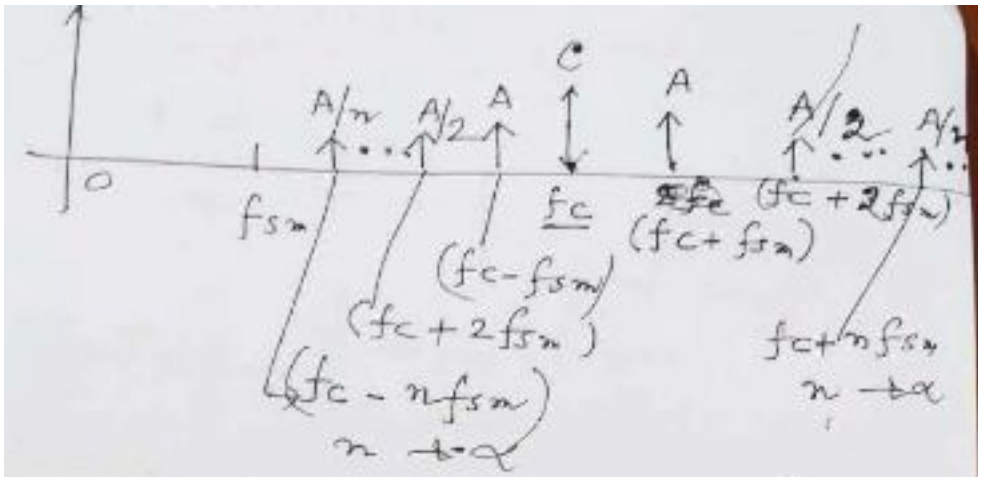
1. Frequency Modulation



$$m_f(t) = Csin(2\pi(f_c + k_f s(t))t)$$
$$= Csin(2\pi(f_c + k_f Ssin(2\pi f_{sm} t))t)$$

- A sin function within a sine function, so analysis can be done by simple trigonometric process.
- Solution for m(t) in time domain done through very complicated higher engineering mathematics whose result is being presented in the following diagram in frequency domain.

2.



3. A = Amplitude of the first frequency above $f_{sm} + f_c$ (or below)

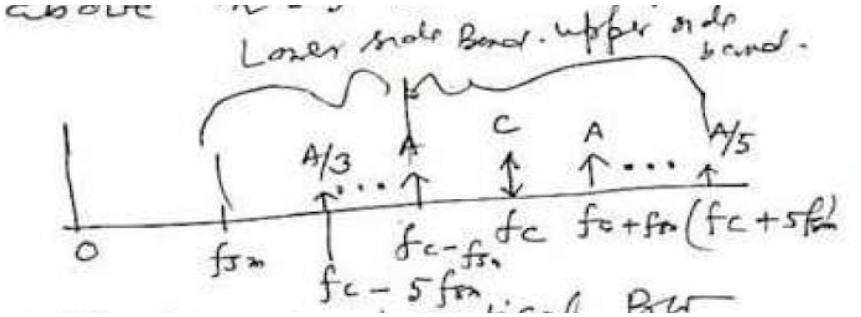
Ideal BW of m(t) ⇒ Frequency modulated signal

$= (f_c + nf_{sm}) - (f_c - nf_{sm})$

$= 2nf_{sm}$ $[n \rightarrow \infty]$

$= \infty$

4. But we see as n increases, the amplitude decreases. Inverse as n increases, power decreases inversely as n^2.
5. It has been practically overserved that with n > 5 , the power is so small that frequency above $n = 5$ can be neglected .

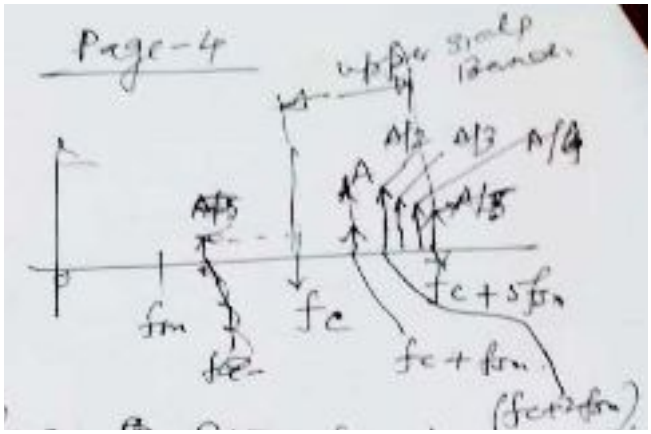


Effective or practical BW

$BW_e = (f_c + 5f_{sm}) - (f_c - 5f_{sm})$

$= 10f_{sm}$

6. Now with very insignificant loss of quality either the lower or upper side band can be transmitted , like amplitude modulation.
7. Assume that we shall transmit the upper side band for FDM (Frequency Division Multiplexing) to create many channels.
8.



9. Therefore, BW_e for transmission purpose

$= (f_c + 5f_{sm}) - (f_c)$

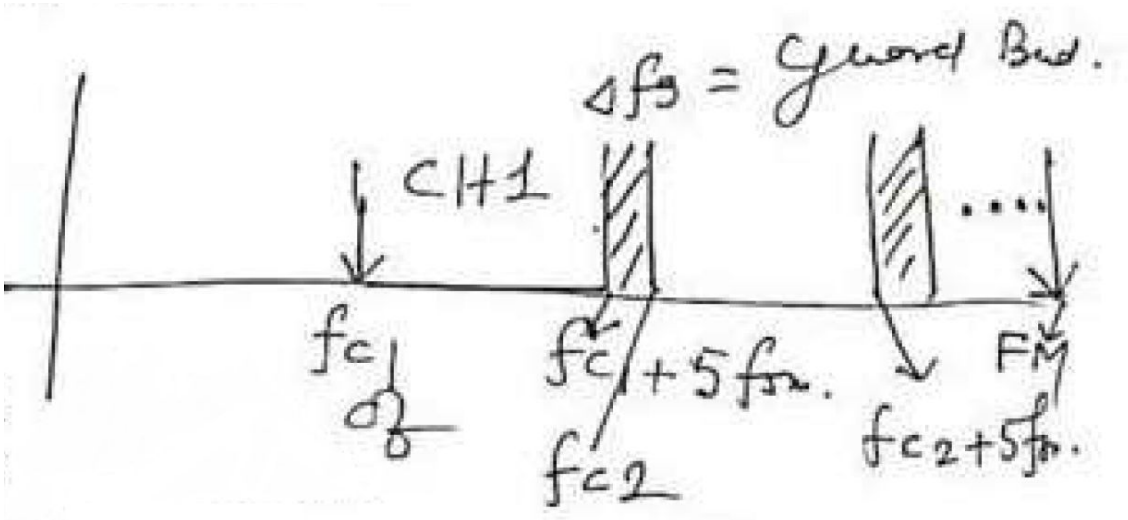
$= 5f_{sm}$

10. For music f_{sm} = 20 kHz. Therefore, the bandwidth of the music channel for FM = 100 kHz.
11. For AM transmission, bandwidth for AM channel = 20 kHz.
12. Then why do we go for FM with 5 times channel Bandwidth?
    Because the total number of channels over a given bandwidth of space will be very lesser.

13. We shall still choose FM music for quality.
    In AM, both signal s(t) and noise signal changes the amplitude of the carrier but frequency of carrier is not changed.
14. After demodulation at receiver noise will come along with the noise signal s(t) which cannot be separated.
15. In FM, the noise will change the amplitude of the carrier but signal s(t) will change the frequency.
16. So after demodulation, the noise can be filtered out from the signal.
17. So, the quality of music signals is very good in FM.
18. The Transmission range of AM music is in medium wave range.
19. Transmission of FM music is from 90 MHz to 108 MHz (in High Frequency or HF range).

PROBLEM : FDM in FM

1. Lowest Carrier = 400 kHz
2. Bandwidth of music signal = 20 kHz
3. Guard band = 2 kHz
4. Highest frequency allocated FM = 2 MHz
5. Upper sideband is used



Let n be the no. of channels.

FM - $f_{c1} = n * 5f_m + (n-1) \Delta f_g$

Calculate n and take its floor value.