Principles of Communication (BEC-28)

Unit-2

Angle Modulation

DR. DHARMENDRA KUMAR

ASSISTANT PROFESSOR

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MMM UNIVERSITY OF TECHNOLOGY, GORAKHPUR–273010.

NUMERICAL EXAMPLES

Example 4

For an FM modulator with a modulation index $\beta = 1$, a modulating signal

$v_m(t) = V_m \sin(2\pi 1000t)$ and unmodulated carrier

$v_c(t) = 10\sin(2\pi 500kt)$, determine

d) Number of sets of significant sideband
e) Their amplitude
f) Then draw the frequency spectrum showing their relative amplitudes

Example 5

For an FM modulator with a peak freq deviation $\Delta f = 10kHz$, a modulating signal freq $f_m = 10kHz$, $V_c = 10V$ and 500kHz carrier, determine

b) Actual minimum bandwidth from the Bessel function table

c) Approximate minimum bandwidth using Carson's rule

d) Plot the output freq spectrum for the Bessel approximation

DEVIATION RATIO (DR)

- Minimum bandwidth is greatest when maximum freq deviation is obtained with the maximum modulating signal frequency
- Worst case modulation index and is equal to the maximum peak frequency deviation divided by the maximum modulating signal frequency
- Worst case modulation index produces the widest output frequency spectrum
- Mathematically,

$$DR = \frac{\text{max peak freq deviation}}{\text{max mod signal freq}} = \frac{\Delta f_{max}}{f_{m(max)}}$$

Example 6

- Determine the deviation ratio and bandwidth for the worst case (widest bandwidth) modulation index for an FM broadcast band transmitter with a maximum frequency deviation of 75kHz and a maximum modulating signal frequency of 15kHz
- Determine the deviation ratio and maximum bandwidth for an equal modulation index with only half the peak frequency deviation and modulating signal frequency

POWER IN ANGLE-MODULATED SIGNAL

- The power in an angle-modulated signal is easily computed

$$P = V_C^2/2R \text{ W}$$

- Thus the power contained in the FM signal is independent of the message signal. This is an important difference between FM and AM.
- The time-average power of an FM signal may also be obtained from

$$v_{FM}(t) = V_c \cos(2\pi f_c t + \theta(t))$$

Example 7

An FM signal is given as $v_{FM}(t) = 12\cos[(6\pi 10^6 t) + 5\sin(2\pi \times 1250t)]$ V. Determine

a. freq of the carrier signal
b. freq of the modulating signal
c. modulation index
d. freq deviation
e. power dissipated in 10 ohm resistor.

Example 8

Determine the unmodulated carrier power for the FM modulator given that $\beta = 1$, $V_c = 10$ V, R = 50 Ω. Then, determine the total power in the angle-modulated wave.

Solution:

→ not exactly equal because values in Bessel table have been rounded off.

Example 9

An FM signal expressed as

$$v_{FM}(t) = 1000\cos(2\pi 10^{7} t + 0.5\sin 2\pi 10^{4} t)$$

is measured in a 50 ohm antenna. Determine the following :-

a. total power
b. modulation index
c. peak freq deviation
d. modulation sensitivity if 200 mV is required to achieve part c
e. amplitude spectrum
f. bandwidth (99%) and approximate bandwidth by Carson's rule
g. power in the smallest sideband of the 99% BW
h. total information power

Example 10

An FM signal with 5W carrier power is fluctuating at the rate of 10000 times per second from 99.96 MHz to 100.04 MHz. Find

a. carrier freq
b. carrier swing
c. freq deviation
d. modulation index
e. power spectrum

Example 11

In an FM transmitter, the freq is changing between 100 MHz to 99.98 MHz, 400 times per seconds. The amplitude of the FM signal is 5 V, determine :-

1. carrier and modulating freq
2. carrier freq swing
3. amplitude spectrum
4. bandwidth by using Bessel Table and Carson's rule
5. average power at the transmitter if the modulator carrier power is 5 W.


Thank You