XMUT310 Communication Engineering

Tutorial 3: Angle Modulation (FM + PM)

Answers are provided for your convenience.

Most solutions can be found here Bilibili
https://www.bilibili.com/video/BV1jy4y1q79h/

Q1. Determine the percentage modulation of an FM wave with a frequency deviation of 10 kHz if the maximum deviation allowed is 25 kHz.

(Answer: 40%)

Q2. In an FM system, if the maximum value of deviation is 75 kHz and the maximum modulating frequency is 10 kHz, calculate the deviation ratio and bandwidth of the system using Carson's rule.

(Answer: deviation ratio = 7.5, bandwidth = 170 kHz)

Q3. The equation of an angle voltage is $e(t) = 10\sin(10^8t + 3\sin 10^3t)$. What form of angle modulation is this? Calculate the carrier and modulating frequencies, the modulation index, and deviation, and the power dissipated in a 100 ohm resistor.

(Answer: carrier = 15.91MHz, modulating = 159 Hz, deviation = 477 Hz, power = 0.5 W)

Q4. Compare the bandwidth that would be required to transmit a baseband signal with a frequency range from 300 Hz to 3 kHz using (a) NBFM with a maximum deviation of 5 kHz, (b) WBFM with maximum deviation of 75 kHz.

(Answer: (a) 6 kHz , (b) 156 kHz)

Q5. The carrier frequency of an FM broadcast station transmitter is 100 MHz and the maximum frequency deviation is 75 kHz. If the highest audio frequency modulating signal is 15 kHz, what is he approximate bandwidth of the FM signal?

(Answer: 180 kHz)

Q6. A single tone FM signal is given by $v(t) = 10 \sin(16\pi \times 10^8t + 3\sin 2\pi \times 10^3t)$ volt. Find the modulation index, modulating frequency, deviation, carrier frequency and power of the FM signal.

(Answer: modulation index = 3, modulating = 1 kHz, carrier = 8×10^8 Hz, deviation = 3×10^3 Hz, power = 50/R W)

Q7. A FM wave is represented by the following equation $v(t) = 10 \sin(5 \times 10^8t + 4\sin 1250t)$. Find

a. Carrier and modulaing frequencies
b. Modulation index and maxmum deviation
c. The power dissipated by this FM wave in a 5 ohm resistor.

(Answer: (a) Modulating = 199 Hz, carrier = 79.57 MHz (b) modulation index = 4, maximum deviation = 796 Hz (c) power = 10 W)

Q8. In a FM system, the modulating frequencies fm = 1 kHz, the modulating voltage Em = 2 v and the deviation is 6 kHz. If the modulating volatge is raised to 4 volt than what is the new deviation? If the modulating volatge is raised to 8 volt and modulating freuqency is reduced to 500 Hz what will the deviaton be?

(Answer: 1st new deviation = 12 kHz, 2nd new deviation = 24 kHz)

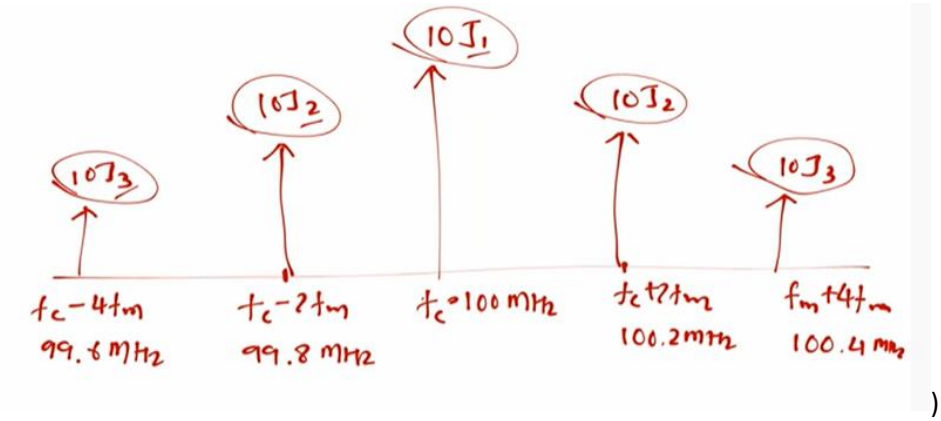
Q9. What is the bandwidth required for a FM signal is the modulating frequency is 1 kHz and the maximum deviation is 10 kHz? What is the BW required for a DSB-SC transmission for the same modulating signal?

(Answer: FM = 22 kHz, DSB-SC = 2 kHz)

Q10. A 20 MHz carrier is modulated by a 400 Hz modulating signal. The carrier voltage is 5 V and maximum deviation is 10 kHz. Write down the mathematical expression for the FM waves.

[Answer: FM = $5 \sin(2\pi \times 20 \times 10^6 t + 25 \sin 800\pi t)$]

Q11. A carrier wave of amplitude 10 V and frequencyy 100 MHz is frequency modulated by a sinusoidal voltage. The modulating voltage hasan amplitude of 5 V and frequency fm = 20 kHz. The freuqnecy deviation is 2 kHz/V. Draw the frequency spectrum of the FM wave.

(Answer: 

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Q12. When the modulating frequency in an FM system is 400 Hz and the modulating voltage s 2.4 V, themodulation index is 60. Calculate the maximm deviation. What is the modulation index when modulating frequency is reduced to 250 Hz and the modulating voltage is simultaneously raised to 3.2 V.

(Answer: maximum deviation = 24 kHz, modulation index = 128)

Q13. In an FM system, the audio frequency (AF) is 1 kHz and audio voltage is 2 V. The deviation is 4 kHz. If the AF voltage is now increased to 8 V and its frequency dropped to 500 Hz, find the modulating index in each case and the corresponding bandwidth using Carson's rule.

(Answer: modulation index = 4, bandwidth = 10 kHz; modulation index = 32, bandwidth = 1032 kHz)

Q14. (MCQ) A message signal $m(t) = A_m \sin(2\pi f_m t)$ is used to modulate the phase of a carrier $A_c \cos(2\pi f_c t)$ to get the mdulated signal $y(t) = A_c \cos(2\pi f_c t + m(t))$. The bandwidth of y(t)

a. Depends on A_m but not on f_m

b. Depends on f_m but not on A_m
c. Depends on both A_m and f_m
d. does not depend on A_m or f_m

(Answer: c)

Q15. (MCQ) Consider an FM signal $f(t) = \cos\left[2\pi f_c t + \beta_1 \sin 2\pi f_1 t + \beta_2 \sin 2\pi f_2 t\right]$. The maximum deviation of instantaneous freuqnecy from the carrier frequency f_c is

(A) $\beta_1 f_1 + \beta_2 f_2$ (B) $\beta_1 f_2 + \beta_2 f_1$
(C) $\beta_1 + \beta_2$ (D) $f_1 + f_2$

(Answer: A)

Q16. (MCQ) Consider the frequenct modulated signal $10\cos[2\pi \times 10^5 t + 5\sin(2\pi \times 1500t) + 7.5\sin(2\pi \times 1000t)]$ with carrier frequency of 10^5 Hz. The modulation index is

a. 12.5
b. 10
c. 7.5
d. 5

(Answer: b)

Q17. (MCQ) The signal $\cos\omega_c t + 0.5\cos\omega_m t \sin\omega_c t$ is

a. FM only
b. AM only
c. Both AM and FM
d. Neither AM nor FM

(Answer: c)

Q18. (MCQ) Match the relationship between group 1and group 2:

	Group 1		Group 2
P.	$\{1 + km(t)\, A\sin(\omega_c t)\}$	W.	Phase modulation
Q.	$km(t)\, A\sin(\omega_c t)$	X.	Frequency modulation
R.	$A\sin\{\omega_c t + km(t)\}$	Y.	Amplitude modulation
S.	$A\sin\left[\omega_c t + k\int_{-\infty}^{t} m(t)\, dt\right]$	Z.	DSB-SC modulation

(A) P – Z, Q – Y, R – X, S – W
(B) P – W, Q – X, R – Y, S – Z
(C) P – X, Q – W, R – Z, S – Y
(D) P – Y, Q – Z, R – W, S – X

(Answer: D)

Q19. (MCQ) An anlge-modulated signal is given by $s(t) = \cos 2\pi(2 \times 10^6 t + 30\sin 150t + 40\cos 150t)$. The maximum frequency and phase deviation are:

(A) 10.5 kHz, 140π rad (B) 6 kHz, 80π rad
(C) 10.5 kHz, 100π rad (D) 7.5 kHz, 100π rad

(Answer: D)