Principles of Communications

Chapter III: Analog Modulation System – Homework

November 15, 2013

1 Assume a expression of a carrier is $c(t) = 5\cos(1000\pi t)$, and the expression of baseband modulation signal is $m(t) = 1 + \cos(200\pi t)$. Find the frequency spectrum of amplitude modulated signal, and plot frequency spectrum diagram.

2 In the above exercises, what are the amplitudes of carrier component and each sideband component respectively?

3 Assume the carrier frequency of a frequency modulated signal is 10 kHz, baseband modulating signal is a single sinusoidal wave with frequency 2 kHz, and modulation frequency deviation is 5 kHz. Find modulation index and the bandwidth of the modulated signal.

4 Prove that if a baseband cosinusoidal wave is used for amplitude modulation, then the maximum power of the sum of two

sidebands of amplitude modulated signal equals one half of the carrier power.

5 Prove that if two time functions are multiplied:$z(t) = x(t)y(t)$, then their fourier transforms have convolution relationship:$Z(\omega) = X(\omega) * Y(\omega)$.

6 Let a baseband modulating signal be a sinusoidal wave with the frequency 10 kHz, and the amplitude 1 V. It modulates the phase of a carrier with frequency 10 MHz, and the maximum phase deviation of modulation is 10 rad. Calculate the approximate bandwidth of phase modulated signal. If the frequency of the modulating signal is changed to 5 kHz, find its bandwidth.

7 If the modulating signal modulates the frequency of the carrier in the above exercise, and the maximum frequency deviation is 1 MHz, find the approximate bandwidth of the frequency modulated

signal.

8 Let the expression of an angular modulated signal be

$$s(t) = 10\cos(2 \times 10^6 \pi t + 10\cos 2000\pi t)$$

Find:(1) the maximum frequency deviation of the modulated signal;

(2) the maximum phase deviation of the modulated signal;

(3) the bandwidth of the modulated signal.

9 已知调制信号$m(t) = \cos(2000\pi t)$, 载波为$2\cos(10^4\pi t)$，分别写出AM, DSB, USB, LSB 信号的表达式，并画出频谱图。

10 对抑制载波的双边带信号进行相干解调，设接收信号功率为$2mW$，载波为$100kHz$，并设调制信号$m(t)$ 的频带限制在$4kHz$，信道噪声双边功率谱密度$P_n(f) = 2 \times 10^{-9} W/Hz$ 。

(1) 画出该理想带通滤波器的传输特性；

(2) 求解调器输入端的信噪功率比；

(3) 求解调器输出端的信噪功率比；

(4) 求解调器输出端的噪声功率谱密度，并用图形表示出来。

11 若对某一信号用DSB进行传输，设加至接收机的调制信号$m(t)$的功率谱密度为

$$P_{m(f)}=\begin{cases}\frac{n_m}{2}\cdot\frac{|f|}{f_m}, & |f|\le f_m\\ 0, & |f|>f_m\end{cases}$$

(1) 求接收机的输入信号功率；

(2) 求接收机的输出信号功率；

(3) 叠加于DSB信号的白噪声具有双边功率谱密度$n_0/2$，设解调器的输出端接有截止频率为f_m 的理想低通滤波器，那么，输出信噪功率比为多少？

12 证明AM信号采用相干解调时，其制度增益G与下式相同

$$G_{AM}=\frac{S_o/N_o}{S_i/N_i}=\frac{2\overline{m^2(t)}}{A_o^2+\overline{m^2(t)}}$$

13 用包络检波器解调AM信号，设接收机中理想带通滤波器的带宽为$10kHz$，载频为$100kHz$，并设AM 信号的载波功率为$80mW$，边带功率为每边带$10mW$，信道噪声双边功率谱密度$P_n(f)=0.5\times10^{-8}W/Hz$ ，试求：

(1) 解调器输入端的信噪功率比；

(2) 解调器输出端的信噪功率比；

(3) 制度增益G。

14 已知某单频调频波的振幅是$10V$ ，瞬时频率为

$$f(t)=10^6+10^4\cos(2\pi\times10^3t(Hz)$$

(1) 求此调频波的表达式；

(2) 求此调频波的频率偏移、调频指数和频带宽度；

(3) 若调制信号频率提高到$2 \times 10^3 Hz$，则调频波的频偏、调频指数和频带宽度如何变化？

15 已知调频信号

$$S_m(t) = 10\cos[(10^6\pi t) + 8\cos(10^3\pi t)]$$

调制器的频偏常数$K_f = 200Hz/V$，试求：

(1) 载频f_c、调频指数和最大频偏；

(2) 调制信号$m(t)$。