國立成功大學

113學年度碩士班招生考試試題

編　號：107

系　所：工程科學系

科　目：通信系統

日　期：0202

節　次：第 1 節

備　註：不可使用計算機

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1) **Problem 1 (20%)**

a) (10%) Given an output signal from an AM modulator as

$$u(t) = 4\cos(160\pi t) + 8\cos(200\pi t) + 4\cos(240\pi t),$$

determine the message signal $m(t)$ and the carrier $c(t)$.

b) (10%) Assume a DSB-SC modulator has a carrier signal as

$$c(t) = 20\cos(2\pi f_c t).$$

If the message signal is

$$m(t) = \text{sinc}^2(2t),$$

determine the spectrum and the bandwidth B_T of $u(t)$.

2) **Problem 2 (30%)**

a) If carrier signal is $c(t) = 10\cos(2\pi f_c t)$, message signal is $m(t) = 20\cos(20\pi t)$, and the message signal is used to frequency modulate the carrier with a frequency deviation constant $k_f = 100$.

(10%) Determine modulated signal $u(t)$ and modulation index β_f.

(5%) Determine average power P_c of carrier signal $c(t)$.

(5%) Determine the bandwidth of modulated signal B_c.

b) (10%) Given that a superheterodyne FM radio receiver operates in a frequency range of 88 MHz to 108 MHz. Assume required IF frequency is $f_{\text{IF}} = 10$ MHz. What is the range of local oscillator frequency f_{LO} at the receiver?

3) **Problem 3 (20%)**

Consider a phase-modulated signal as

$$u(t) = 10\cos\left[2\pi f_c t + 4\cos(200\pi t)\right],$$

where carrier frequency is $f_c = 1$ MHz and phase deviation constant is $k_p = 10$.

(5%) Determine the message signal $m(t)$.

(5%) Determine the modulation index β_p.

(5%) Determine the average power P_c of the carrier signal $c(t)$.

(5%) What is the bandwidth of modulated signal B_c?

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4) **Problem 4 (15%)**

Given a FM modulated signal with frequency deviation constant k_f and message signal $m(t)$ as

$$u(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau\right].$$

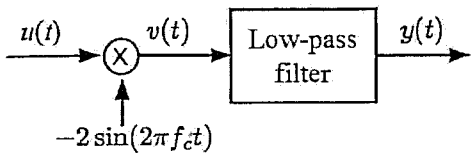
a) (10%) If $\left|2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau\right| \ll 1$, show that the FM modulated signal can be approximated by

$$A_c \cos(2\pi f_c t) - A_c 2\pi k_f \sin(2\pi f_c t) \int_{-\infty}^{t} m(\tau)d\tau.$$

b) (5%) The FM modulated signal can be rewritten as

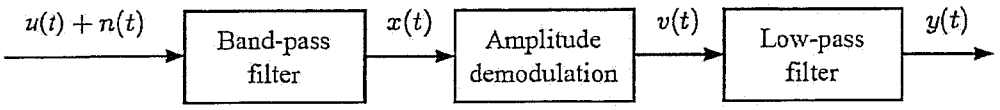
$$u(t) = A_c \cos(2\pi f_c t) - A_c m(t) \sin(2\pi f_c t).$$

If it passes through a mixer demodulator with its local carrier $-2\sin(2\pi f_c t)$, as shown in the figure below. What is the output signal $y(t)$?



5) **Problem 5 (15%)**

Assume that DSB-SC modulated signal is $u(t) = A_c m(t)\cos(2\pi f_c t)$ and a coherent receiver is shown as follows:



where the bandwidth of received bandpass signal $u(t)+n(t)$ is $2W$, the bandwidth of bandpass filter is B_T and that of the low-pass filter is B_L. Assume $B_T > 2W$ and $B_L > W$, the power of the baseband signal is P_M, and the noise is a white Gaussian noise with power spectral density $\frac{N_0}{2}$.

(5%) Determine the signal after AM demodulation $v(t)$.

(5%) Determine the output signal $y(t)$.

(5%) Determine the output SNR.