國立臺北科技大學九十六學年度碩士班招生考試

系所組別：1640 電機工程系碩士班丁組

第一節 通訊原理 試題

注意事項：

1. 本試題共 6 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. (18%, each 3%) Answer the following questions.

(a) What is the capture effect? What cause(s) may result in such an effect?

(b) What benefits can FM system obtain when pre-emphasis and de-emphasis are applied?

(c) What modulation scheme is employed in the GSM system? What advantages does this scheme have?

(d) What is the function of repeater in a PCM system?

(e) Which of the following modulation schemes: PSK, FSK, ASK and QAM, do you prefer to use in the case of passband data transmission over nonlinear channel? Describe your reason(s).

(f) Why the nonuniform μ-law (or A-law) quantization is commonly used in the PCM-based telephone network?

2. An FM modulation system has $k_f = 10^5$ Hz/volt and carrier wave $c(t) = \cos 2\pi 10^8 t$.

Assume that the input signal is $m(t) = \cos 2\pi 10^4 t$ volt

(a) Write down the equation of the resulting FM signal $s(t)$ in terms of modulation index β, f_c, and f_m. Is s(t) a wideband FM (WBFM) signal? Why? (5%)

(b) Calculate the maximum and minimum instantaneous frequencies of $s(t)$. Please illustrate your result with unit of MHz. (4%)

(c) Find $s_+(t) = s(t) + j\hat{s}(t)$, and $\tilde{s}(t) = s_I(t) + js_Q(t)$. (8%)

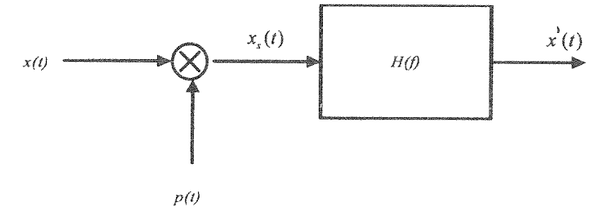
(d) Estimate bandwidth of $s(t)$ using the Carson's rule.(4%)

3. An ideal sampling system is shown below where $x(t) = \sin c(200t)$, and $p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$. (Note: $\sin c(\lambda) = \frac{\sin \pi\lambda}{\pi\lambda}$)

(a) Determine the required minimum value of f_s (sampling frequency). (3%)

(b) Sketch Fourier transform of the sampled signal $x_s(t)$ if $f_s = 150$ Hz. (6%)

(c) What phenomenon happened in (b)? How to overcome such a problem in practice? (4%)

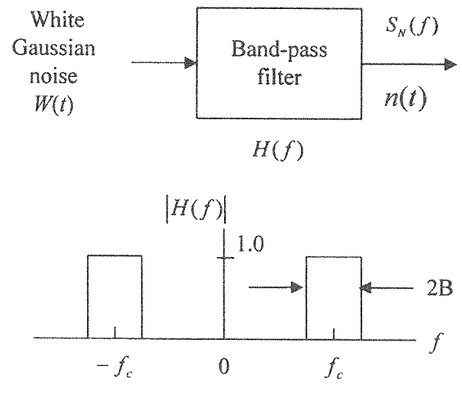


4. A white Gaussian noise with zero mean and PSD of $N_0/2$ is applied to the BPF shown below where $f_c >> 2B$.

(a) Find $\overline{n(t)}$ (average value of $n(t)$). (3%)

(b) Find the average power of n(t) delivered to a $1-\Omega$ resistor. (4%)

(c) Find the average power of $n_I(t)$ (in phase component of n(t)) to a $1-\Omega$ resistor. (5%)



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5. An analog signal is sampled, quantized, and encoded into a binary PCM wave. The number of representation levels used is 128. A synchronizing pulse is added at the end of each code word representing a sample of the analog signal. The resulting PCM wave is transmitted over a channel of bandwidth 10 kHz using a M-ary PAM system with raised-cosine spectrum. The rolloff factor $\alpha = 1$.

(a) Find the symbol rate and bit rate of the information transmitted through the channel when M=2 and M=16. (6%)

(b) For the case of M=16, find the rate at which the analog signal is sampled. What is the maximum possible value for the highest frequency component of the analog signal? (6%)

6. A pair of sinusoidal waves of a coherent BFSK system is represented by

$$s_i(t) = \begin{cases} \sqrt{\frac{2E_b}{T_b}}\cos(2\pi f_i t), & 0 \le t \le T_b \\ 0, & \textit{elsewhere} \end{cases}$$

where $f_i = \frac{n_c + i}{T_b}$ for some fixed integer n_c, $i = 1, 2$, ($s_1(t)$ for symbol 1 and $s_2(t)$ for symbol 0) and E_b is the transmitted signal energy per bit.

(a) Plot their signal constellation and decision regions for optimum detection in the signal space. Simply describe your decision rule. (6%)

(b) Plot block diagrams of transmitter and receiver of this system. (6%)

(c) Show that for the case of equiprobable symbols, the bit error rate for coherent BFSK over AWGN channel with PSD of $\frac{N_0}{2}$ is $p_e = \frac{1}{2}erfc(\sqrt{\frac{E_b}{2N_0}})$. (8%)

(d) Describe advantage(s) and disadvantage(s) of this system. (4%)

Note: $erfc(x) = \frac{2}{\sqrt{\pi}}\int_x^\infty e^{-t^2}dt = 1 - erf(x) = 2Q(\sqrt{2}x)$