國立臺北大學109學年度碩士班一般入學考試試題

系（所）組別：通訊工程學系

科　　　目：通訊原理

□可 ☑不可使用計算機

1. An AM modulator has output

   $x_c(t) = A\cos 2\pi(200)t + B\cos 2\pi(180)t + B\cos 2\pi(220)t$

   The carrier power is 200W, and the efficiency is 20%.

   (a) (10%) Determine A and B.

   (b) (10%) Determine the modulation index.

2. An angle-modulated signal is described by

   $x_c(t) = 10\cos[2\pi(10^6)t + 0.1\sin(10^3)\pi t]$

   (a) (10%) Consider $x_c(t)$ as a PM signal with its phase deviation constant $k_p = 10$. Find modulating signal $m(t)$.

   (b) (10%) Consider $x_c(t)$ as an FM signal with its frequency deviation constant $k_f = 10\pi$. Find modulating signal $m(t)$.

   (c) (10%) Estimate the bandwidth of $x_c(t)$.

3. Consider the BPSK system whose transmitted signal is given by

   $$x(t) = \begin{cases} A\cos(2\pi f_c t), & m = 0, \\ -A\cos(2\pi f_c t), & m = 1, \quad 0 \le t \le T, \quad f_c >> \frac{1}{T}, \end{cases}$$

   The message m has the distribution of $\mathbb{P}(m=0) = 2/9$ and $\mathbb{P}(m=1) = 7/9$. The received signal is given by $y(t) = x(t) + n(t)$ where $n(t)$ is a zero mean white Gaussian noise with power spectral density $N_0/2$ for all f.

   (a) (10%) Use coherent demodulation to demodulate the received signal and formulate the detection problem as hypothesis testing. You must derive the probability density function for each hypothesis.

   (b) (10%) Derive the detection threshold η_{ML} of maximum likelihood detection for the hypothesis testing problem derived in part a). Also, derive the detection threshold η_{MAP} of maximum a posterior detection.

   (c) (10%) Derive the average probability of error based on η_{MAP} in part b). (Hint: $Q(x) \triangleq \int_x^\infty \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} \mathrm{d}y$ and

   $Q(-x) = \int_{-\infty}^x \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} \mathrm{d}y$.)

4. Consider a baseband communication system with $s_1(t)$ and $s_2(t)$ depicted in Fig. 1.

   (a) (7%) Determine the corresponding optimal receive filter $h^*(t)$.

   (b) (7%) Evaluate $s_1(t) * h^*(t)$ and $s_2(t) * h^*(t)$ at $t = T$ and compute the optimal ML detection threshold.

   (c) (6%)Suppose now $s_1(t)$ is fixed as that in Fig. 1 but we are allowed to design $s_2(t)$. Find the optimal $s_2(t)$ such that the probability of error is minimized.

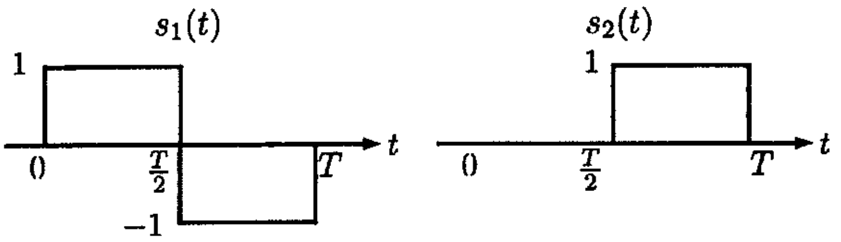

Fig. 1 $s_1(t)$ and $s_2(t)$.

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