國立臺灣科技大學
九十四學年度碩士班招生考試試題

系所組別：電機工程系碩士班丙二組
科　　目：通訊系統

總分 100 分

1. Consider the signal s(*t*) shown in Figure 1.
   (a) (10 points) What is the matched filter h(*t*) of the signal s(*t*)? Sketch it as a function of time.
   (b) (10 points) Plot the matched filter output as a function of time.

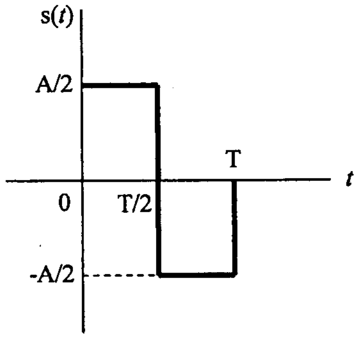

Figure 1

2. (15 points) Assume a BPSK demodulator with an additional additive noise term at the input to its decision device, as shown in Figure 2. The decision device outputs a "1" if its input r(*t*) has $\mathrm{Re}\left[r(t)\right] \geq 0$, and a "0" otherwise. Suppose the additive noise term $n(t) = 1.5 \times e^{-j\theta}$, where $\theta = \frac{n\pi}{3}$ with probability 1/6 for n = 0, 1, 2, 3, 4, 5. What is the probability of making a decision error in the decision device? Assuming $f_c \gg 1$, and that information bits corresponding to a "1" ($s(t) = \cos(2\pi f_c t)$) or a "0" ($s(t) = \cos(2\pi f_c t + \pi)$) are equal-probable.

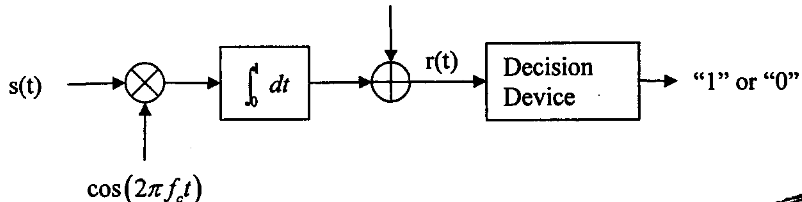

Figure 2

國立臺灣科技大學
九十四學年度碩士班招生考試試題

系所組別：電機工程系碩士班丙二組
科　　目：通訊系統

3. (15 points) The capacity of a channel with white Gaussian noise is defined by $C = B\log_2\left(1+\frac{S}{N}\right)$, where S is the received signal power, B is the channel bandwidth, and N is the received noise power. For an additive white Gaussian noise (AWGN) channels with the noise power spectral density N_0, find the channel capacity C in the limit as $B \to \infty$.

4. (20 points) Consider the following scalar communication problem: $y = x + n$, where the channel input levels 0 or 1 are equal-probable and the noise n has density $p(n) = \frac{1}{\sqrt{2\pi\sigma_1^2}} e^{\frac{-n^2}{2\sigma_1^2}}$ if $x = 1$ and $p(n) = \frac{1}{\sqrt{2\pi\sigma_0^2}} e^{\frac{-n^2}{2\sigma_0^2}}$ if $x = 0$. $\sigma_0^2 + \sigma_1^2 = 10^{-1.5}$. Determine the optimal decision regions when $\frac{\sigma_1^2}{\sigma_0^2} = 30$. Find the average probability of error for this receiver in terms of Q-functions ($Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty \exp(\frac{-\tau^2}{2}) d\tau$).

5. Twenty baseband channels, each band limited to 3.2 kHz, are to be sampled and transmitted on a PAM-TDM system.
   (a) (5 points) Find the maximum length of each flat-top sample with sampling rate 8 kHz.
   (b) (5 points) Find the theoretical minimum transmission bandwidth.

6. Consider a wave $m(t) = A_m \cos[2\pi f_m t + \phi(t)]$.
   (a) (10 points) Define the average power in $m(t)$ over an interval T to be $P_{ave} = \frac{1}{T}\int_{-T/2}^{T/2} m^2(t)dt$. What should be the size relationships between T, f_m, and the bandwidth of $\exp[j2\phi(t)]$ to have $P_{ave} = A_m^2/2$?
   (b) (10 points) Let $\phi(t) = 0$ in $m(t)$. A phase-modulated wave is described by $s(t) = A_c \cos[2\pi f_c t + k_p m(t)]$. Determine the spectrum of $s(t)$, assuming that $k_p A_m$ does not exceed 0.2 radians.

142