國立台灣科技大學九十五學年度碩士班招生試題

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. Let $x(t) \leftrightarrow X(f)$ be a Fourier transform pair. Please find the Fourier transform of

$$y(t) = x^*(t - t_0)\cos 2\pi f_0 t$$

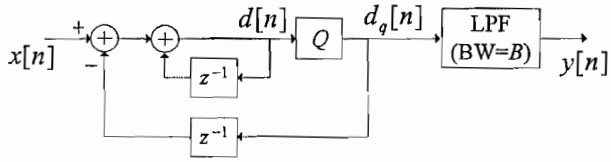
where $x^*$ denotes the complex conjugate of $x$. (10%)

2. Let $x(t) = m(t)\cos 2\pi f_0 t - \hat{m}(t)\sin 2\pi f_0 t$ represent a bandpass signal where $\hat{m}(t)$ is the Hilbert transform of $m(t)$ and

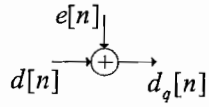
$$m(t) = \frac{\sin(\pi t)}{\pi t}.$$

Assume that $f_0$ >> the bandwidth of $m(t)$. Please Find the pre-envelope, lowpass equivalent signal, and bandwidth of $x(t)$. (20%)

3. Consider the following discrete-time system:




where LPF is a lowpass filter with bandwidth = $B$ and $Q$ is a quantizer. We can model the quantizer as




where $e[n]$ is the quantization error introduced by $Q$. $e[n]$ is assumed to be white with variance $\sigma_e^2$. Suppose that the sampling rate $f_s$ of the system is much greater than the bandthwith $B$ of the LPF. Please derive the variance of the quantization noise in the output signal $y[n]$. (20%)

4. Suppose that $s_0(t) = \sin(t)$ and $s_1(t) = \cos(t)$. A sample function $v(t)$ of a zero-mean, white noise process is crosscorrelated with $s_0(t)$ and $s_1(t)$, to yield

$$v_1 = \int_0^{2\pi} s_0(t)v(t)dt \text{ and } v_2 = \int_0^{2\pi} s_1(t)v(t)dt.$$

Derive $E(v_1 v_2)$. (10%)

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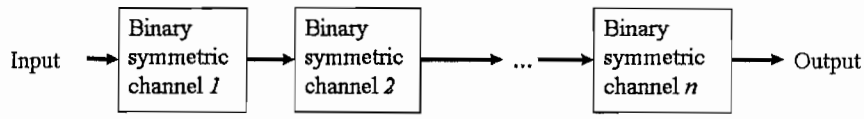
5. Prove that the probability of error for the maximum-likelihood detector on the AWGN channel with an $M$-point signal constellation with minimum distance $d_{\min}$ is bounded by

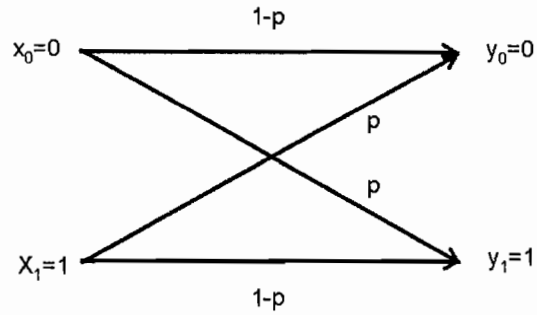
$$p_e \le (M-1)Q\left(\frac{d_{\min}}{2\sigma}\right).$$

Assume that the variance of the white Gaussian noise in the AWGN channel is $\sigma^2$. (20%)

6. Find the overall channel capacity of the n cascaded identical binary symmetric channel (0<p<1). (20%)




The $n$ cascaded identical binary symmetric channel




Transition probability diagram of each binary symmetric channel