

## 國立台灣科技大學九十六學年度碩士班招生試題

系所組別：電子工程系碩士班乙一組

科目：通信系統

總分 100 分

1. (20%) Fig. 1 shows the regenerated clock source  $x(t)$  of constant amplitude  $A$ , period  $T_0$ , and delay  $t_d$ , which represents a sample function of a random process  $X(t)$ . The delay is random, described by the probability density function

$$f_{T_d}(t_d) = \begin{cases} \frac{1}{T_0}, & -\frac{1}{2}T_0 \leq t_d \leq \frac{1}{2}T_0 \\ 0, & \text{otherwise} \end{cases}$$

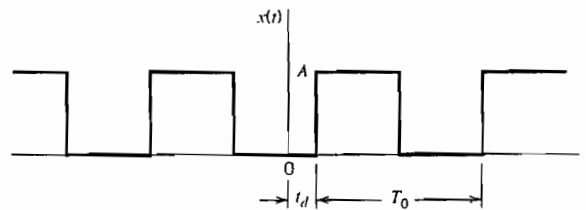
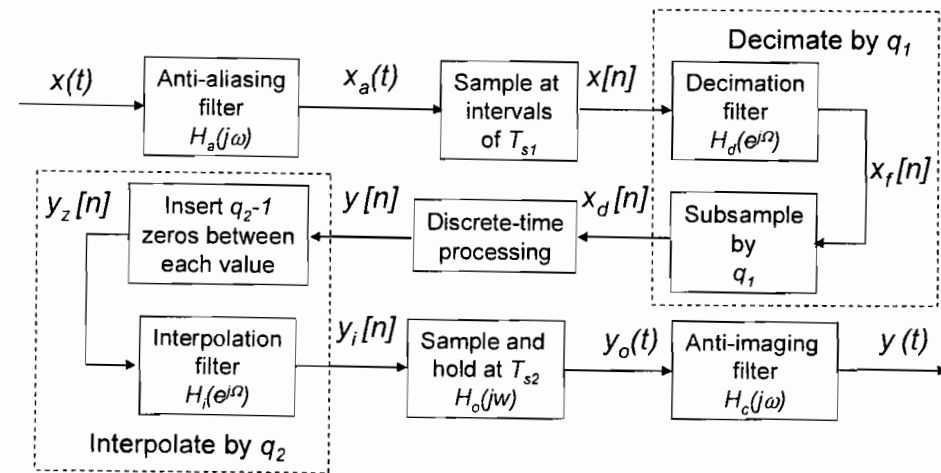


Fig. 1

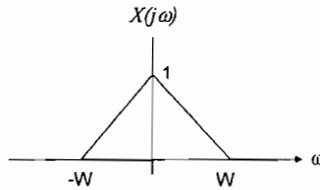
- (a) (5%) Determine the probability density function of the random variable  $X(t_k)$  obtained by observing the random process  $X(t)$  at time  $t_k$ .
- (b) (5%) Determine the mean and autocorrelation function of  $X(t)$  using ensemble-averaging.
- (c) (5%) Determine the mean and autocorrelation function of  $X(t)$  using time-averaging.
- (d) (5%) Determine whether  $X(t)$  is stationary or not. In what sense is it ergodic?
2. (20%) In the following system, we assume that sampling theorem is always satisfied and the system is noiseless.



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- (a) (5%) Plot  $X(e^{j\Omega})$  (i.e. the frequency domain representation of  $x[n]$ )
- (b) (10%) Plot  $Y_z(e^{j\Omega})$  and  $Y_i(e^{j\Omega})$  (i.e. the frequency domain representation of  $y_z[n]$  and  $y_i[n]$ )
- (c) (5%) In this system, which filter(s) could be removed? Why?
3. Let  $s_k, k=1..16$  and  $x$  be the transmitted and received signal of 16-QAM. Please answer following questions:
- (a) (20%) Please prove maximum a posteriori probability (MAP) rule is the optimum decision rule to minimize error probability of 16 QAM .
- (b) (20%) Suppose  $s_k, k=1..16$  are equal probability, based on (a) please prove MAP rule for AWGN channel is choose  $s_j$  such that  $\|x-s_j\| \leq \|x-s_k\|$  for all  $k=1..16$ .
- (c) (10%) Based on (b) , please evaluate minimum error probability of 16 QAM.
4. (10%) Explain Inter-symbol-interference (ISI) and Nyquist's criterion.