

國立中央大學通訊工程學系 98 學年度碩士在職專班入學筆試

【基本通訊概論】試卷

考試地點：通訊館一樓 E1-109 室

考試時間：100 分鐘

試題總分：100 分

1. [10 %] Please determine the following statement whether it is true or false: If  $X_1, X_2, \dots, X_N$  are

random variables, then  $\text{var} \left\{ \sum_{i=1}^N a_i X_i \right\} = \sum_{i=1}^N a_i^2 \text{var} \{X_i\}$ .  $\text{var} \{X\}$  is the variance of the random variable  $X$ . Please explain for your answer.

2. [10 %] Please determine the following statement whether it is true or false: If  $X_1, X_2, \dots, X_N$  are

random variables, then  $E \left\{ \sum_{i=1}^N a_i X_i \right\} = \sum_{i=1}^N a_i E \{X_i\}$ .  $E \{X\}$  is the expectation of the random variable  $X$ . Please explain for your answer.

3. [10 %] Sketch the double-sided spectra of  $x_a(t) = 5 \cos(4\pi t - \pi/3)$ .

4. [10%] Please determine the probability of the first error occurring at the 1000<sup>th</sup> transmission in a digital data transmission system where the probability of error is  $p = 10^{-6}$ .

5. [10 %] A random signal has the autocorrelation function  $R(\tau) = 5 + 2\Lambda(\tau/10)$

where  $\Lambda(x)$  is the unit-area triangular function defined as  $\Lambda(t/\tau) = \begin{cases} 1 - (|t|/\tau) & |t| < \tau \\ 0, & \text{otherwise} \end{cases}$ .

Please determine (a) The total power. (b) The ac power.

6. [10 %] (a)  $X_1$  and  $X_2$  are two independent Gaussian random variables. Each has zero mean and unit variance.  $Y = X_1 + X_2$ .

(a) Please determine the mean of  $Y$ .

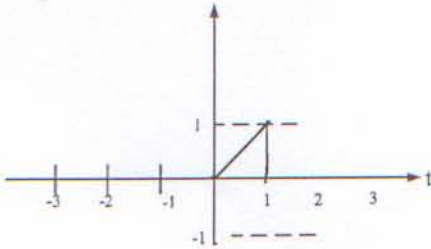
(b) Please write the expression of the probability density function (pdf) of  $Y$ ,  $f_Y(y)$ .

(Gaussian pdf:  $f_X(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-m)^2/2\sigma^2}$ ,  $-\infty < x < \infty$ , where  $m$  is the mean and  $\sigma^2$  is the variance.)

7. [10 %] A signal with a waveform shown in the following figure is fed into the system with the impulse response:

$$h(t) = \delta(t) - 3\delta(t-5) + 5\delta(t-10).$$

Please sketch the output waveform of the system output.



8. [10 %] Consider the analog signal  $x_a(t) = 3\sin(50\pi t) + 10\sin(300\pi t) - \cos(100\pi t)$ . Determine the Nyquist sampling rate for  $x_a(t)$ .

9. [10 %] Please write down two modulation schemes of (a) digital modulation (b) analog modulation, respectively.

10. [10 %] Digital binary data is to be transmitted through a baseband system with  $N_0 = 10^{-7}$  W/Hz and the received signal amplitude  $A = 20$  mV. The average probability of error  $P_E$  is given by the approximation  $P_E \cong \frac{e^{-z}}{2\sqrt{\pi z}}$  where  $z$  is " $E_b$ -over- $N_0$ ". (a) If  $10^3$  bits per second (bps) are transmitted, what is the average probability of error  $P_E$ ? (b) If  $10^5$  bps are transmitted, to what value must  $A$  be adjusted in order to attain the same  $P_E$  as in part (a)?