國立中正大學
113學年度碩士班招生考試
試 題

[第 1 節]

科目名稱	通訊原理
系所組別	通訊工程學系-通訊甲組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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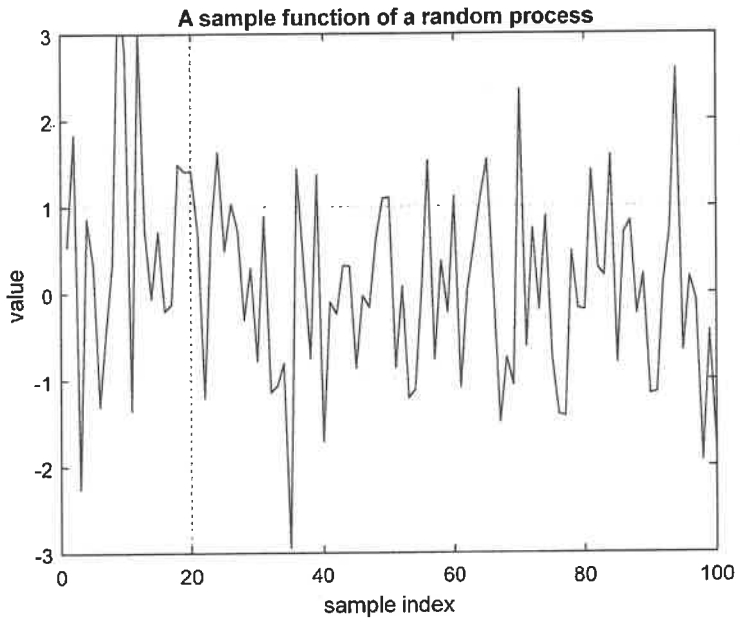
科目名稱：通訊原理　　本科目共 2 頁　第 1 頁

系所組別：通訊工程學系-通訊甲組

1. (20 %) The additive white Gaussian noise (AWGN) $n(t)$ appears in communication system.
   (a) (10 %) Please give a mathematical definition for the AWGN $n(t)$.
   (b) (10 %) Suppose now you are given a sample function $n(t)$, $t = 0,1,\cdots,N-1$, depicted below. Is it a sample function of an AWGN $n(t)$? Please address the steps and methods that you use to justify your answer.



2. (20 %) Consider a periodic signal $x(t)$ with period T_0. Over one period, the

$$x(t) = \Pi\left(\frac{2t}{T_0}\right) - \frac{1}{2}, \quad -\frac{T_0}{2} < t < \frac{T_0}{2},$$

where $\Pi(\bullet)$ is the unit rectangular pulse. The signal $x(t)$ is filtered by an ideal lowpass filter with cutoff frequency $\frac{3}{2T_0}$ to produce output signal $y(t)$.

   (a) (2 %) Plot $x(t)$ for $T_0 = 1$.
   (b) (5 %) What is the output signal $y(t)$?
   (c) (10 %) What is the autocorrelation of the output signal $y(t)$?
   (d) (3 %) What is the power spectral density of the output signal $y(t)$?

3. (20 %) The frequency modulated signal is denoted by $x(t) = A_c \cos\left(2\pi f_c t + 2\pi f_d \int^{t} m(\tau) d\tau\right)$, where f_c is the carrier frequency, f_d is the frequency deviation constant, and $m(t)$ is the message signal.

Consider now $m(t) = A_m \cos(2\pi f_m t)$.

(a) (2 %) Show that the modulated signal may be expressed as $x(t) = A_c \cos\left(2\pi f_c t + \beta \sin(2\pi f_m t)\right)$. Please give the value of β.

(b) (3 %) What is the complex envelope of $x(t) = A_c \cos\left(2\pi f_c t + \beta \sin(2\pi f_m t)\right)$?

(c) (10 %) What is the continuous-time Fourier transform of $x(t) = A_c \cos\left(2\pi f_c t + \beta \sin(2\pi f_m t)\right)$? You may use Bessel function to express your result.

(d) (5 %) What is the time average power of $x(t) = A_c \cos\left(2\pi f_c t + \beta \sin(2\pi f_m t)\right)$?

4. (20 %) The received (complex-valued) baseband signal is $x = hs + w$, where h is the known channel gain, w is the additive white Gaussian noise with zero mean and variance σ^2. The transmitted symbol s comes from the 8-PSK constellation set $S = \left\{e^{j2\pi k/8} : k = 0,1,\cdots,7\right\}$.

(a) (2 %) What is the constellation diagram for S?
(b) (3 %) What is the likelihood function for detecting transmitted s from received x?
(c) (5 %) What is the decision rule for the maximum likelihood detector (MLD) to detect transmitted s? Please reduce to the simplest form as possible as you can.
(d) (5 %) What are the decision regions for the MLD?
(e) (5 %) What is the symbol error probability for the MLD?

5. (20 %) A stereo frequency modulation (FM) broadcasting is to transmit a left channel signal $m_1(t)$, a pilot $p(t) = \cos(2\pi f_p t)$, and a right channel signal $m_2(t)$ at a time through frequency division multiplexing and frequency modulation. Assume that $m_1(t)$ and $m_2(t)$ are of the same bandwidth 15 kHz and pilot frequency is $f_p = 19$ kHz.

(a) (10 %) Give your design for the stereo FM transmitter using a block diagram. You may give spectra of signals in the block diagram if necessary.
(b) (10 %) Give your design for the stereo FM receiver using a block diagram. You may give spectra of signals in the block diagram if necessary.