國立中正大學 104 學年度碩士班招生考試試題

系所別：電機工程學系-信號與媒體通訊組

通訊工程學系-通訊甲組

科目：通訊原理

第 1 節

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一、單選題（共 30 分）：每題有五個選項，選擇一個最適當的答案，每題答對得 5 分；未作答、答錯或答多於一個選項者，該題以 0 分計算。

1. Which of the following statements is false?

(a) Random signals are signals that take on random values at any given time instant and must be modeled probabilistically.

(b) The unit impulse function $\delta(t)$ is defined in terms of the integral

$$\int_{-\infty}^{\infty} x(t)\delta(t)dt = x(0)$$

where $x(t)$ is any test function that is continuous at $t = 0$.

(c) The unit step function $u(t)$ is defined to be the integral of the unit impulse function.

(d) The continuous-time Fourier transform of a real even signal is complex and even.

(e) The continuous-time Fourier series representation of a signal is unique.

2. Let the notation $x(t) \leftrightarrow X(f)$ be a continuous-time Fourier transform pair; therefore, $x(t)$, $x_1(t)$, and $x_2(t)$ are signals with their Fourier transforms $X(f)$, $X_1(f)$, and $X_2(f)$, respectively. Additionally, $a, a_1, a_2, t_0,$ and f_0 are constants. Which of the following statements is false?

(a) $a_1 x_1(t) + a_2 x_2(t) \leftrightarrow a_1 X_1(f) + a_2 X_2(f)$.

(b) $x(t - t_0) \leftrightarrow X(f)e^{j2\pi f t_0}$.

(c) $x(at) \leftrightarrow \frac{1}{|a|}X\left(\frac{f}{a}\right)$.

(d) $X(t) \leftrightarrow x(-f)$.

(e) $x(t)e^{j2\pi f_0 t} \leftrightarrow X(f - f_0)$.

3. Which of the following statements is false?

(a) DSB is 100% power efficient.

(b) Demodulation utilizing a coherent reference is known as synchronous or coherent demodulation.

(c) Amplitude modulations results when a DC bias is added to the message signal $m(t)$ prior to the modulation process.

(d) A lower-sideband SSB signal can be generated by passing a DSB signal through an ideal filter that passes the LSB and rejects the USB.

(e) The process of frequency translation can be accomplished by summation of a bandpass signal by a periodic signal and is referred to as mixing.

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4. Suppose that wide-sense stationary Gaussian random process $X(t)$ has mean function 0 and autocorrelation function $R_X(\tau) = \cos\left(\dfrac{\tau}{T_0}\right)$, where T_0 is a constant. Which of the following statements is false?

   (a) The process $X(t)$ is not necessarily strictly sense stationary.

   (b) At a particular time instant t_0, $X(t_0)$ is a random variable with probability density function $f(x) = \dfrac{1}{\sqrt{2\pi}}\exp\left[-\dfrac{x^2}{2}\right]$.

   (c) The process $X(t)$ is a colored process.

   (d) At two particular time instants t_0 and $t_0 + T_0$, the two random variables $X(t_0)$ and $X(t_0 + 2\pi T_0)$ are jointly Gaussian with correlation coefficient 1.

   (e) Input $X(t)$ to a filter with impulse response $h(t) = \delta(t) - \delta(t - T_0)$ produces a Gaussian process.

5. Let $\{\phi_1(t), \phi_2(t), \phi_3(t)\}$ be a set of orthonormal signals over the interval $[0, T]$. Suppose we want to design a system to transmit a binary information over an additive white Gaussian noise channel. If the logic 0 is represented by $x(t) = \dfrac{1}{\sqrt{3}}\phi_1(t) - \dfrac{1}{\sqrt{3}}\phi_2(t) - \dfrac{1}{\sqrt{3}}\phi_3(t)$, which of the following signals is the best candidate for logic 1?

   (a) $-\dfrac{1}{\sqrt{3}}\phi_1(t) + \dfrac{1}{\sqrt{3}}\phi_2(t) - \dfrac{1}{\sqrt{3}}\phi_3(t)$.

   (b) $-\dfrac{1}{\sqrt{3}}\phi_1(t) + \dfrac{1}{\sqrt{3}}\phi_2(t) + \dfrac{1}{\sqrt{3}}\phi_3(t)$

   (c) $-\dfrac{1}{\sqrt{3}}\phi_1(t) - \dfrac{1}{\sqrt{3}}\phi_2(t) - \dfrac{1}{\sqrt{3}}\phi_3(t)$

   (d) $\dfrac{1}{\sqrt{3}}\phi_1(t) + \dfrac{1}{\sqrt{3}}\phi_2(t) - \dfrac{1}{\sqrt{3}}\phi_3(t)$

   (e) $\dfrac{1}{\sqrt{3}}\phi_1(t) - \dfrac{1}{\sqrt{3}}\phi_2(t) + \dfrac{1}{\sqrt{3}}\phi_3(t)$

6. Consider a set of binary codewords $c_1 = [1,1,1,1]$, $c_2 = [1,-1,1,1]$ $c_3 = [1,-1,-1,-1]$, $c_4 = [1,1,-1,-1]$, and $c_5 = [1,-1,-1,1]$. Assume that the received signal is $r = \alpha c_m + w$, where $\alpha = -0.4$ is the known channel gain and w is the additive white Gaussian noise whose entries are of zero mean and variance σ^2. Suppose that $r = [0.2, 0.3, -0.1, -0.2]$ is received, the maximum likelihood detector determines the received codeword to be

(a) c_1

(b) c_2

(c) c_3

(d) c_4

(e) c_5

二、計算題（共 40 分）：

1. (10 分) Determine whether the following signals are energy signals or power signals. Note that A and $\alpha > 0$ are constants.

(a) $x_1(t) = Ae^{-\alpha t}u(t)$.

(b) $x_2(t) = Au(t)$.

2. (10 分) Consider an FM system operating with the message signal

$$m(t) = A\cos(2\pi f_m t).$$

Find the frequency-modulated signal $x_c(t)$.

3. (10 分) Assume that A and f_0 are constants, and random variable θ is uniformly distributed over $[0, 2\pi]$. Is random process $X(t) = A\cos(2\pi f_0 t + \theta)$ ergodic?
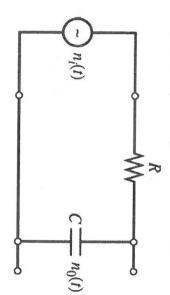
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4. (10 分) A noisy random process $n_i(t)$ with autocorrelation function $R_n(\tau) = \frac{N_0}{2}\delta(\tau)$ is passed through the following filter

What is the average power of the output process $n_0(t)$?

三、名詞解釋(共 30 分)：請以下列兩名詞為標題，利用數學符號、數學式、圖、表格或其他專業術語寫兩篇短文(每篇至多 500 字)，從該名詞的定義、用途、特性等，分別解釋下列的名詞。

1. (15 分) Linear Modulation
2. (15 分) Pulse shaping filter at the transmitter side