國立中正大學 101 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-通訊系統組、網路通訊甲組

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<u>最適當</u>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. Let $X(f)$ be the Fourier transform of $x(t)$, i.e., $\mathscr{F}(x(t)) = X(f)$. Which of the following statements is true?

   (a) $\mathscr{F}(x(t-t_0)) = e^{j2\pi f t_0} X(f)$

   (b) $\mathscr{F}(X(t)) = x(f)$

   (c) $\mathscr{F}(\sin(2\pi\alpha t)) = -\frac{1}{2j}\delta(f-\alpha) + \frac{1}{2j}\delta(f+\alpha)$

   (d) $\mathscr{F}(\cos(2\pi\alpha t)x(t)) = X(f-\alpha)$

   (e) $\mathscr{F}(\frac{d}{dt}x(t)) = j2\pi f\, X(f)$

2. Which of the following analog modulations has the best bandwidth efficiency?
   (a) The double sideband suppressed carrier (DSB-SC) AM
   (b) The conventional AM
   (c) FM
   (d) PM
   (e) Vestigial-Sideband AM

3. Which of the following statements is false?
   (a) The signal $x(t)$ and its Hilbert transform are orthogonal.
   (b) The power spectral density of $x(t)$ and its Hilbert transform are the same.
   (c) Let $\mathscr{F}(x(t)) = X(f)$, then the Fourier transform of $x(t)$'s Hilbert

   transform is $X^*(f)$, which is the complex conjugate of $X(f)$.

   (d) The Hilbert transform of $\sin(2\pi\alpha t + \phi) = -\cos(2\pi\alpha t + \phi)$.
   (e) If $x(t)$ is modulated by SSB, then the modulated signal can be represented

   as $Ax(t)\cos(2\pi f_c t) - A\hat{x}(t)\sin(2\pi f_c t)$, where $\hat{x}(t)$ is the Hilbert

   transform of $x(t)$.

4. Assume that real-valued random process $X(t)$ is passed throug h a linear time invariant system with impulse response $h(t)$ to produce random process $Y(t)$.

   The process $X(t)$ is stationary with mean m_X, autocorrelation function $R_X(\tau)$,

   and power spectral density $S_X(f)$. Which of the following statements is false?

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(a) The process $Y(t)$ is stationary, too.

(b) The mean of $Y(t)$ is equal to $m_X \int_{-\infty}^{\infty} h(t)\, dt$.

(c) The autocorrelation function of $Y(t)$ is equal to $R_X(\tau) * h(\tau) * h(-\tau)$,

where '*' denotes convolution integral.

(d) The processes $X(t)$ and $Y(t)$ are jointly stationary.

(e) The power spectral density of $X(t) + Y(t)$ is equal to $S_X(f) + S_Y(f)$.

5. A random process is defined by $X(t) = A\cos(2\pi f_0 t + \Theta)$, where Θ is a

random variable uniformly distributed over $[0, 2\pi)$. Which of the following statements about $X(t)$ is false?

(a) Process $X(t)$ is strictly sense stationary.

(b) Process $X(t)$ is ergodic.

(c) The power spectral density of $X(t)$ is equal to

$$\frac{A^2}{4}[\delta(f - f_0) + \delta(f + f_0)].$$

(d) A sample function of $X(t)$ is $A\cos(2\pi f_0 t)$, whose power spectral density

is $\frac{A^2}{4}[\delta(f - f_0) + \delta(f + f_0)]$.

(e) The process $X(t)$ is a bandlimited process.

6. Let $s_m(t) = \sqrt{2\dfrac{E_s}{T}}\cos\left(2\pi f_c t + 2\pi \dfrac{m}{M}\right)$, for $m = 0, 1, \cdots, M-1$, $0 \le t \le T$, and

$\dfrac{1}{T} << f_c$. Which of the following statements is false?

(a) All signals $s_m(t)$, $m = 0, 1, \cdots, M-1$, have the same energy over $0 \le t \le T$.

(b) All signals $s_m(t)$, $m = 0, 1, \cdots, M-1$, can be represented as a linear

combination of two basis functions.

(c) $\int_0^T |s_m(t) - s_n(t)|^2\, dt = 2E_s\left(1 - \cos\left(2\pi \dfrac{m-n}{M}\right)\right)$

(d) The minimum Euclidean distance of this signal set is equal to

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$$\sqrt{4E_s\left(1-\cos\left(\frac{2\pi}{M}\right)\right)}.$$

(e) Each $s_m(t)$ can be used to represent $\log_2 M$ bits of information.

二、計算題(共 40 分)：

1. (10 分) Let $X(f)$ be the Fourier transform of $x(t)$, i.e. $\mathscr{F}(x(t)) = X(f)$. Let $\mathscr{F}(y(t)) = Y(f)$ and $z(t) = x(t)y(t)$. Express $\mathscr{F}(z(t))$ in terms of $X(f)$ and $Y(f)$.

2. (10 分) The output signal from an AM modulator is
$$4\cos(1850\pi t) + 16\cos(2000\pi t) + 4\cos(2150\pi t).$$
   (a) (5 分) Determine the modulating signal $m(t)$ and the carrier $c(t)$.
   (b) (5 分) Determine the modulation index.

3. (10 分) The real-valued process $X(t)$ is stationary with mean m_X and autocorrelation function $R_X(\tau)$.
   (c) (3 分) Show that $R_X(\tau)$ is an even function;
   (d) (7 分) Show that the maximum absolute value of $R_X(\tau)$ occurs at $\tau = 0$, i.e., $|R_X(\tau)| \le R_X(0)$.

4. (10 分) Consider the signal detector with an input
$$r = \pm A + n$$
   where $+A$ and $-A$ occur with equal probability and the noise n is random with the Gaussian probability density function
$$p(n) = \frac{1}{\sqrt{2\pi\sigma^2}}\, e^{-\frac{n}{2\sigma^2}}.$$
   Determine the probability of error as a function of parameters A and σ.

三、名詞解釋(共 30 分)：請利用數學符號、數學式、圖表或其他專業術語寫兩段短文(每段至多 500 字)，分別解釋下列的名詞。

1. (15 分) Superhetrodyne receiver
2. (15 分) Non-coherent detection of binary FSK signal