國立中央大學通訊工程學系 102 學年度碩士在職專班入學筆試

【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. Plot the time-domain waveforms of the following signals which are expressed in terms of the rectangular function $\Pi(x)=\begin{cases}1, & -0.5\le x\le 0.5\\ 0, & \text{otherwise}\end{cases}$: (a) $h(t)=\Pi\left(\frac{t}{2T}\right)$; (b) $x(t)=\Pi\left(\frac{t}{2T}\right)-\Pi\left(\frac{t-2T}{2T}\right)$; (c) $y(t)=\Pi(t)*\Pi(t)=\int_{-\infty}^{\infty}\Pi(t-\tau)\cdot\Pi(\tau)\,d\tau$; (15%)

2. For a sinusoidal message signal $m(t)=2\cdot\cos(2\pi\cdot f_0\cdot t)$ with $f_0=10^3$ Hz, (a) what is the period of the message signal; (b) what is the amplitude of the message signal; (c) what is the type of modulation when the transmitted signal is given by $x(t)=m(t)\cdot\cos(2\pi f_c t)$ $\left(f_c=10^5\text{ Hz}\right)$; (d) what is the type of modulation when the transmitted signal is given by $x(t)=\left(4+m(t)\right)\cdot\cos(2\pi f_c t)$; (e) what is the type of modulation when the transmitted signal is given by $x(t)=2\cdot\cos\left(2\pi f_c t+2\pi f_d\cdot\int_{-\infty}^{t}m(\tau)\,d\tau\right)$ $\left(f_d=10^3\text{ Hz}\right)$. (25%)

3. Find the correctness of the following statements or equations by answering right or wrong: (for example: 2>1, the answer is wrong) (40%)

   (a) $2\cos(2\pi f_c t)\cdot\cos(2\pi f_0 t)=\cos\left(2\pi(f_c+f_0)t\right)+\cos\left(2\pi(f_c-f_0)t\right)$;

   (b) the Gaussian probability density function with mean $m_n\neq 0$ and variance σ_n^2 is given by $f_N(n_0)=\frac{1}{\sqrt{2\pi\cdot\sigma_n^2}}\exp\left(\frac{-n_0^2}{2\sigma_n^2}\right)$;

   (c) $\frac{1}{\sqrt{2\pi\cdot\sigma_n^2}}\int_0^{\infty}\exp\left(\frac{-n_0^2}{2\sigma_n^2}\right)\cdot dn_0=0.5$;

   (d) $\int_0^{\infty}\exp\left(\frac{-n_0^2}{2\sigma_n^2}\right)\cdot dn_0>\int_{2\sigma_n^2}^{\infty}\exp\left(\frac{-n_0^2}{2\sigma_n^2}\right)\cdot dn_0$;

   (e) $\text{Re}\left\{\left(s_I(t)+j\cdot s_Q(t)\right)\cdot e^{j2\pi f_c t}\right\}=s_I(t)\cdot\cos(2\pi f_c t)+s_Q(t)\cdot\sin(2\pi f_c t)$;

   (f) the maximum data transmission rate (bps) of the Wi-Fi (802.11a) is higher than that of the USB 2.0 (Universal Serial Bus);

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(g) for a random variable X with a probability density function $f_X(x)$, the mean of X is given by $E[X]=\int_{-\infty}^{\infty} x\cdot f_X(x)\,dx$;

(h) for two signals $x_1(t)=\cos(2\pi\cdot 1000\cdot t)$ and $x_1(t)=\cos(2\pi\cdot 21000\cdot t)$, we have $x_1(n\cdot T_S)=x_2(n\cdot T_S)$ when $T_S=\frac{1}{10000}$;

(i) Mbps is the acronym（縮寫）of megabits per second;

(j) AWGN is the acronym of asynchronous window general network;

(Hint: $e^{j2\pi f_c t}=\cos(2\pi f_c t)+j\cdot\sin(2\pi f_c t)$, $\mathrm{Re}\{e^{j2\pi f_c t}\}=\cos(2\pi f_c t)$)

4. Find the wrong statement (only one) in the following statements: (4%)
   (a) 3G mobile communication system use CDMA technology;
   (b) DVB-T digital video broadcast system use OFDM technology;
   (c) 3G mobile communication system use Turbo Convolutional coding;
   (d) AGC is the acronym of Automatic Gain Control;
   (e) Bluetooth use the OFDM technology.
5. Find the wrong equation (only one) in the following equations: (4%)

   (a) $\mathrm{var}(x)=E[X^2]-(E[X])^2$ (the variance of a random variable *X*);

   (b) $X(f)=\Im\{x(t)\}=\int_{-\infty}^{\infty} x(t)\cdot e^{-j2\pi\cdot f\cdot t}dt$ (the Fourier transform);

   (c) $X(\omega)=DTFT\{x[n]\}=\sum_{n=-\infty}^{\infty} x[n]\cdot e^{j2\pi\omega\cdot n}$ (the discrete-time Fourier transform);

   (d) $y(t)=h(t)*x(t)=\int_{-\infty}^{\infty} h(t-\tau)\cdot x(\tau)\,d\tau=x(t)*h(t)$ (Linear convolution);

   (e) $Y(f)=\Im\{y(t)=h(t)*x(t)\}=\Im\{x(t)\}\cdot\Im\{h(t)\}$.

6. Explain the following terms: (12%)
   (a) Code-division multiplexing;
   (b) OFDMA;
   (c) dBm.