1. [12 分] Suppose that $z[n]=y[n+1]-y[n-1]$ and $y[n]=\sum_{k=-2}^{2}x[n+k]$.
   (a). Please determine $h[n]$ so that $z[n]$ can be as the form of $z[n] = x[n] * h[n]$, where * means the convolution.
   (b). Determine the discrete-time Fourier transform of $h[n]$.
   (c). Determine the Z transform of $h[n]$.
2. [10 分] Find the inverse Z transform of
   (a). $\dfrac{1}{2+3z^{-1}+z^{-2}}$.
   (b). $\exp(1/z)$.
3. [10 分] Suppose the bandwidth of $x(t)$ is 200 Hz and the bandwidth of $y(t)$ is 100 Hz.
   (a). What is the bandwidth of $k(t) = x(t-2)\,y(t) + 3x^2(t)\,y^3(t+3)$?
   (b). How do we sample $k(t)$ without the aliasing effect?
4. [9 分] Explain what are (a) the stationary random process, (b) the power spectral density, (c) the AWGN.
5. [9 分] Suppose that $X(z)$ and $H(z)$ are the Z transforms of $x[n]$ and $h[n]$, respectively. Express the Z transform of $y[n]$ in terms of $X(z)$ and $H(z)$ where
   $$y[n]=\sum_{\tau=-\infty}^{\infty}x\left[\frac{n}{3}-\tau\right]h[\tau](-1)^{\tau} \quad \text{when } n \text{ is a multiple of 3,}$$
   $$y[n]=0 \quad \text{otherwise.}$$
6. [10 分] In a double-sideband suppressed-carrier (DSB-SC) amplitude modulation (AM) system, the carrier is $c(t)=A\cos 2\pi f_c t$ and the message signal is given by $m(t)=\text{sinc}(t)+\text{sinc}^2(t)$. Find the frequency domain representation and the bandwidth of the modulated signal.
7. An angle modulated signal has the form $u(t)=100\cos\left[2\pi f_c t+4\sin(2000\pi t)\right]$ where $f_c=10\,\text{MHz}$.
   (a). [4 分] Determine the average transmitted power.
   (b). [4 分] Determine the peak-phase deviation.
   (c). [4 分] Determine the peak-frequency deviation.
   (d). [4 分] Is this a frequency modulation or a phase modulation signal? Explain.
8. The elements of the sequence $\{a_n\}_{n=-\infty}^{+\infty}$ are independent binary random variables taking values of ±1 with equal probability. This data sequence is used to modulate the basic pulse $g(t)$ which is rectangular spanning between [0, 2T]. The modulated signal is $X(t)=\sum_{n=-\infty}^{\infty}a_n g(t-nT)$.
   (a). [4 分] Express the power spectral density of $X(t)$ in terms of the frequency response of the pulse, denoted by $G(f)$, and the power spectral density of the data sequence, denoted by $S_a(f)$.
   (b). [8 分] Assume that we want to have a null in the spectrum of $X(t)$ at $f=\dfrac{1}{3T}$. This is done by a precoding of the form $b_n=a_n+\alpha a_{n-3}$. Find the α that provides the desired null.
9. In a broadcasting communication system the transmitter power is 40 KW, the channel attenuation is 80 dB, and the noise power-spectral density is 10^{-10} W/Hz. The message signal has a bandwidth of 10^4 Hz. Find the demodulation output SNR
   (a). [4 分] If the modulation is DSB-SC AM.
   (b). [4 分] If the modulation is single sideband (SSB) AM.
   (c). [4 分] If the modulation is conventional AM with a modulation index (or amplitude sensitivity) of 0.85 and (normalized) power of the original message signal of 0.2.

試題隨卷繳回