

东南大学考试卷 (A 卷)

课程名称 通信原理 考试学期 07-08-3 得分
适用专业 信息工程 考试形式 闭卷 考试时间长度 120 分钟
(开卷、半开卷请在此写明考试可带哪些资料)

Section A(30%): True or False (Give your reason if False, 3% for each question)

1. If a Gaussian process is stationary, then the process is also strictly stationary. ()
2. Compared to a uniform quantizer, a nonuniform quantizer following the μ -law has a larger SNR for low-level signals and the same SNR for high-level signals, thus the overall SNR is increased by using the nonuniform μ -law quantizer. ()
3. Correlative-level coding uses a partial-response signaling method to avoid ISI. ()
4. An FDM-based ADSL system uses the same frequency band for both downstream and upstream data transmissions, and a different frequency band for telephone service. ()
5. If two random variables are uncorrelated, they are also statistically independent. ()
6. Considering DSB modulation, its figure of merit is determined by bandwidth. ()
7. A PLL can be used for frequency demodulation in an FM system. ()
8. In coherent detection of signal in additive white Gaussian noise, the maximum likelihood (ML) rule always equals the maximum a posteriori probability (MAP) rule. ()
9. DM requires a sampling rate much higher than the Nyquist Rate. ()
10. In a QPSK system, bit error rate equals symbol error rate. ()

Section B(30%): Fill in the Blanks (3% for each question)

1. Suppose the highest frequency component of a message signal $m(t)$ is 200 Hz, the Nyquist rate of this signal is _____ samples per second.
2. The matched filter of $g(t) = \cos(\frac{\pi t}{2T})$, $0 \leq t \leq T$ is $h(t) =$ _____.
3. A random process $X(t)$ is applied to a linear time-invariant filter of frequency response $H(f)$, the output process is $Y(t)$. If the power spectral density of $X(t)$ is $S_X(f)$, then the power spectral density of $Y(t)$ is _____.
4. 12 different message signals, each with a bandwidth of 10 kHz, are to be multiplexed and transmitted. If the multiplexing and modulation methods are FDM and SSB, respectively, then the minimum bandwidth required is _____ kHz; if the multiplexing and modulation methods are TDM and PAM, then the minimum bandwidth required is _____ kHz.
5. A signal $s(t) = 2 \cos(10\pi t)$ V is quantized by a uniform quantizer, the step size of the quantizer is 0.1V, then the minimal number of quantization level is $L_{\min} =$ _____, the number of bits per sample is at least $R_{\min} =$ _____, and the variance of the quantization error is _____.
6. A narrowband signal is $X(t) = 10 \cos(2\pi f_c t + 0.5)$, where f_c is carrier frequency and $f_c = 10$ MHz, the in-phase component of $X(t)$ is _____.
7. The basic data rate of a digital hierarchy is _____ kb/s.
8. Basic operations performed in the transmitter of a PCM system are _____, _____, and _____.
9. Bandwidth efficiency of QPSK is _____ bits/s/Hz, bandwidth efficiency of BFSK (Sunde's FSK) is _____ bits/s/Hz, and bandwidth efficiency of 16-QAM is _____ bits/s/Hz.
10. A carrier wave of frequency 1 MHz is frequency modulated by a message signal $m(t) = 2 \cos(20\pi t)$ (V), the frequency sensitivity of the modulator is 10 Hz/V, by using Carson's rule, bandwidth of the modulated wave is _____ Hz.

Section C(40%): Calculations (10% for each question)

1. (a) Compare the bandwidth efficiency of 16-QAM and 16-PSK;
(b) If the maximum power is the same, compare the noise performance of 16-QAM and 16-PSK schemes;
(c) If the average power is the same, compare the noise performance of 16-QAM and 16-PSK schemes again.

2. In an MSK system, the modulated signal is

$$\begin{aligned} s(t) &= \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t + \theta(t)) \\ &= \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t + \theta(0) \pm \frac{\pi h}{T_b} t), 0 \leq t \leq T_b \end{aligned} \quad (C-1)$$

where $T_b = 10^{-3}$ sec., $E_b = 10^{-3}$ J, and $f_c = 2000$ Hz.

- (a) Determine the value of h ;
- (b) Give a set of orthonormal basis functions to represent the message signals in (C-1);
- (c) If $\theta(t) = \theta(0) + \frac{\pi h}{T_b} t$ and $\theta(t) = \theta(0) - \frac{\pi h}{T_b} t$ represent symbols "1" and "0",

respectively, and assuming $\theta(0) = 0$, plot the phase trellis representing the sequence 11101101;

- (d) Plot waveform of the modulated MSK signal corresponding to the transmitted sequence 11101101.

3. Consider the signal $s(t)$ shown in Fig. C-1,
 (a) Assuming $h(t)$ is the matched filter of $s(t)$, plot the impulse response of $h(t)$;
 (b) When $s(t)$ is applied to $h(t)$, plot the matched filter output in the time domain.

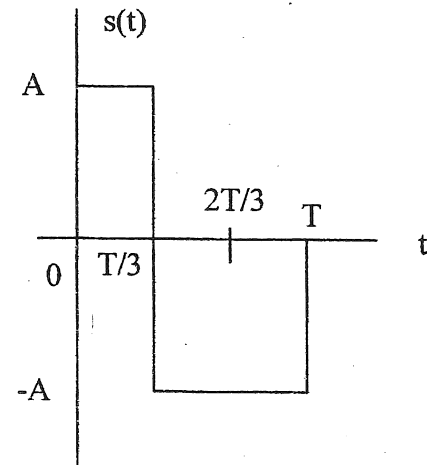


Fig. C-1

4. A communication system has three message signals

$$\begin{cases} s_1(t) = \cos(2\pi \times 9.9 \times 10^6 \times t) \\ s_2(t) = -\cos(2\pi \times 9.9 \times 10^6 \times t) \quad 0 \leq t \leq 5 \times 10^{-3} \text{ sec} \\ s_3(t) = \cos(2\pi \times 10.1 \times 10^6 \times t) \end{cases} \quad (\text{C-2})$$

They are transmitted with equal probability. Assume the communication channel is an AWGN channel.

- (a) Give a set of orthonormal basis functions to represent the message signals in (C-2);
 (b) Plot the signal-space diagram of the message signals in (C-2);
 (c) If a coherent receiver is used, determine the average probability of symbol error P_e . (Express the result using complementary error function $\text{erfc}(\cdot)$ and the ratio of symbol energy to noise power spectral density (E_s/N_0)).