自觉遵守考场纪律　如考试作弊　此答卷无效

姓名＿＿＿＿＿＿　学号＿＿＿＿＿＿

封　线　密

东 南 大 学 考 试 卷（ A卷）

课程名称　通信原理　考试学期　10-11-3　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 it is also strictly stationary. ( )
2. Differentially encoded signal may be inverted without affecting its interpretation. ( )
3. For both $\mu-law$ and $A-law$ quantization, the signal-to-noise ratios (SNR) of the quantizer for low-level and high-level signals improve with the increasing of parameters μ and A. ( )
4. A minimum shift keying (MSK) signal can be detected with or without memory between consecutive bits, and performance of the two detection methods are different. ( )
5. Correlative-level coding (also known as partial-response signaling) can achieve the Nyquist rate of 2W symbols per second over a channel of bandwidth of W Hz using realizable and perturbation-tolerant filters. ( )
6. For binary continuous phase frequency-shift keying (FSK) modulation scheme, the minimum frequency spacing that allows the two FSK signals representing bits 1 and 0 not to interfere with one another is $1/T_b$, where T_b is the bit duration. ( )
7. Performance of differential phase-shift keying (DPSK) is 3 dB worse than that of coherent binary phase-shift keying (BPSK). ( )
8. In a baseband transmission, if only additive white Gaussian noise (AWGN) is considered, a matched filter at the receiver has the maximized output average SNR. ( )
9. 10 different message signals, each with a bandwidth of 20 kHz, are to be multiplexed and transmitted. If the multiplexing and modulation methods are frequency-division multiplexing (FDM) and double sideband-suppressed carrier (DSB-SC) modulation, respectively, then the minimum bandwidth required is 200 kHz. ( )
10. Let $\{\phi_j(t), j = 1, 2, \ldots, N, 0 \le t \le T\}$ be the orthonormal basis functions of a transmission signal set, the channel is an AWGN channel, if a received signal x(t) is projected onto $\{\phi_j(t), j = 1, 2, \ldots, N, 0 \le t \le T\}$, then the projections can fully describe x(t) and can be used to estimate the transmitted signal. ( )

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

1. Two primary resources employed in communication systems are _____ and _____.
2. Basic operations performed in the transmitter of a PCM system include _____, _____, and _____.
3. A stationary Gaussian process X(t) has zero mean and power spectral density S(f). The probability density function of a random variable X(t0) obtained by observing the process at some time t0 is _____.
4. A PCM system uses a uniform quantizer followed by an L-bit binary encoder. The bit rate of the system is equal to R_b b/s. The maximum message bandwidth for which the system operate is _____.
5. Assuming the bit duration of an M-ary PSK signal is T_b, the bandwidth required to transmit the signal is _____.
6. An single tone FM signal with carrier frequency f_c=1MHz is described by the equation $s(t)=30\cos(2\pi f_c t+8\sin(4000\pi t))$. The frequency deviation Δf is _____, the modulation index β is _____, and calculating by Carson's rule, the approximate value of the transmission bandwidth is_____.
7. The matched filter of $g(t)=\cos(\frac{\pi t}{2T}), 0 \le t \le T$ is $h(t)$ = _____.
8. In a differential encoding system, a transition denotes symbol 0 and no transition denotes symbol 1. Symbol 1 is used as reference bit. If an binary data sequence {0 1 1 1 0 1 0 0 1} is the input to this system, the output sequence is {1_____}.
9. The bit error rate (BER) of a coherent binary frequency-shift keying FSK system over AWGN channel is 10^{-6}. A coherent binary phase-shift keying (BPSK) system has the same received signal and noise powers with the binary FSK system, but the bit rate of the BPSK system is twice as that of the binary FSK system. BER of the BPSK system is _____.
10. Sampling rate and step size of a delta modulator are f_s = 100 KHz and Δ = 0.1 V, respectively. If the modulating wave is a single tone sinusoidal signal with f_m = 1 KHz, to avoid slope-overload distortion, the maximum allowed amplitude of this modulating wave is _____.

自觉遵守考场纪律 如考试作弊 此答卷无效

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

1. Frequency error can be defined as $\Delta f = f_c' - f_c$, where f_c and f_c' are the carrier frequencies of the sender and receiver, respectively. Frequency error affects performance of a coherent detector.

(a) For the case of a DSB-SC system, evaluate the effect of a frequency error Δf on the demodulator output;

(b) For the case of a BPSK system, determine the effect of a frequency error Δf on the average error probability of the system.

2. As illustrated in Fig. C-2, a low pass filter $H(f) = \frac{R}{R + j2\pi fL}$ is excited by an input signal Y(t) = U(t) + X(t), where U(t) = 10 is a DC signal and X(t) is a whiten Gaussian noise signal with a power spectrum density (PSD) $S_x(f)=N_0/2$ for all frequency f. Please determine the PSD $S_z(f)$ of the output process Z(t).

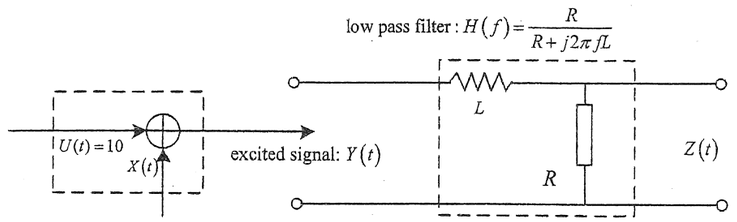

Fig. C-2

3. Consider a special ternary PSK system, where the massage signals m_1, m_2 and m_3 are mapping into the transmitted signals $s_1(t)$, $s_2(t)$, and $s_3(t)$, respectively. The transmitted signals are defined as:

$$s_1(t) = 20\sqrt{2}\sin\frac{2\pi t}{T}$$

$$s_2(t) = 20\cos\frac{2\pi t}{T}$$

$$s_3(t) = -20\cos\frac{2\pi t}{T}$$

where the signal duration is $0 \le t \le T$, T=0.05 seconds.

(a) If $\phi_1(t) = A_1\cos\frac{2\pi t}{T}$ and $\phi_2(t) = A_2\sin\frac{2\pi t}{T}$, $0 \le t \le T$ are used as the orthonormal basis functions to represent signals $s_1(t)$, $s_2(t)$, and $s_3(t)$, please determine the parameters A_1 and A_2;

(b) Determine the signal constellation $\{s_1, s_2, s_3\}$ and the average energy E of this signal constellation; Draw the signal-space diagram of this system;

(c) Find the minimum distance of the signal constellation and give the union bound of the symbol error rate P_e under an AWGN channel;

(d) The signal constellation $\{s_1, s_2, s_3\}$ can be translated to a signal constellation $\{\hat{s}_1, \hat{s}_2, \hat{s}_3\}$ which has minimal average energy $\hat{E}$, please give the time functions $\hat{s}_1(t)$, $\hat{s}_2(t)$, and $\hat{s}_3(t)$ corresponding to $\hat{s}_1$, $\hat{s}_2$, and $\hat{s}_3$, respectively, and give the minimal average energy $\hat{E}$.

4. A binary symbol sequence is transmitted using unipolar NRZ signaling. Symbol 1 is represented by a rectangular pulse of amplitude A and duration T_b, and symbol 0 is represented by switching off the pulse. The channel noise is modeled as additive, white, and Gaussian with zero mean and power spectral density $N_0/2$. Symbols 1 and 0 occur with equal probability.

(a) Plot the optimal receiver structure using a matched filter;

(b) Plot the impulse response of the matched filter;

(c) Calculate the average probability of error at the receiver output;

(d) If the symbol rate is 1 Mb/s, and the NRZ wave is modulated onto a carrier with frequency f_c = 100 MHz to transmission, calculate the bandwidth efficiency of this scheme (bandwidth here is define as the null-to-null bandwidth of the power spectrum density of a signal).