53 (EC 712) SSCM

2014

SPREAD SPECTRUM COMMUNICATION

Paper : EC 712

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Show that the error probability for a PSK signal is given by $Pe\big|_{PSK} = \frac{1}{2} erfc\left(\sqrt{\frac{E_b}{\eta}}\right)$; where the symbols have their usual meaning. 10

(b) Consider a binary optimum system with source probabilities $P_1 \triangleq P(m_1)$ and $P_2 \triangleq P(m_2)$ for messages m_1 & m_2 respectively. Show that for such a system, the threshold voltage in calculating the system BER will be given by

$$V_T = \frac{E_2 - E_1}{2} + \frac{N_0}{2} ln\left(\frac{P_1}{P_2}\right),$$

where 'E_i' is the signal energy and 'N_0' is the two-sided power spectral density. 10

2. (a) Consider a BPSK Communication system using spread spectrum technique. Show that the system noise $n(t)$ because of the interfering signal only will be suppressed by the system. 10

(b) Find an expression for the maximum error probability in case of pulse-noise jamming. Hence show that the optimised pulse noise jammer causes a degradation of approximately $31{\cdot}5dB$ relative to continuous jamming at a BER of 10^{-5}. 10

3. Calculate the power spectrum of the direct sequence spread spectrum transmitter signal when BPSK is used for both the data modulation and the spreading code modulation. Assume that the spreading code is 100 times the data rate and the period of the spreading code is infinite. 20

4. *(a)* Suppose that BPSK is used for both the data modulation and the spreading modulation and that the interference is a single tone having power 'J'. Also assume that the jammer places the jamming tone directly in the center of the modem's transmission bandwidth. Show that the magnitude of the jammer power passed by an IF filter with transfer function $H(f)$ will be given by $J_0 = J \cdot \frac{T_C}{T}$; where the symbols have their usual meaning. 10

(b) Consider a random PAM pulse train. Show that the *psd* of such a random pulse train is given by 10

$$Sy(f) = \frac{|P(f)|^2}{T_b} \cdot \sum_{n=-\infty}^{\infty} R_n \cdot e^{-j2\pi nf \cdot T_b}$$

where 'T_b' is the bit period and 'R_n' is the correlation of the RV's of the amplitudes.

5. An FHSS/BFSK is used for transmitting binary data coming at a rate of $20kbps$. The unspread BFSK signal occupies a bandwidth of $25kHz$. The received signal power is $-15dBm$. A jammer which can produce a received power of at the most $-20dBm$ either has a narrowband signal of $25kHz$ bandwidth, or as a broadband signal occupying the full bandwidth of the FHSS system, is trying to jam the FHSS signal. If the spreading factor 'L' of the FHSS/BFSK system is 25, find the improvement in the SNR (dB) under broadband jamming as compared to narrowband jamming. Assume the one-sided *psd* of the AWGN channel to be $10^{-11} W/Hz$. 20

6. *(a)* Explain the operation of a FH/MFSK (frequency hopped/min. frequency shift keying) system. 10

(b) Explain how ranging is performed using a DS-spread spectrum system. 10

7. Write short notes on ***any two*** of the following : 10+10

(a) Polynomial multiplication circuit

(b) Power calculation in a single channel system using binary phase modulation

(c) RAKE receiver

(d) Low probability of detection (LPD).
