Indian Institute of Engineering Science and Technology, Shibpur

M.E. (E&TCE) 2nd SEMESTER FINAL EXAMINATION, 2014

Wireless Communication (ETC-1041)

Time: 3 hours **Full marks: 70**

Answer any **FIVE** questions

1. Write down three advantages and three disadvantages of wireless communication systems. Plot typical variation of the ratio of received-to-transmit power (in dB scale) versus log distance in a wireless fading channel. Explain the variation. Under the free-space path loss model, find the transmit power required to obtain a received power of 1dBm for a wireless system with isotropic antennas (gain equals to one) and a carrier frequency f = 5 GHz, assuming a distance d = 10 m.

[5+5+4]

2. Using the baseband equivalent model of a wireless channel having a bandwidth of W around a centre frequency of f_c , determine an input-output relationship of the wireless system in the discrete-time domain. Explain the importance of rms delay spread and coherence bandwidth in characterizing any wireless fading channel. Show that minimum value of $f_c\tau_n$ for a wireless multipath channel at f_c = 1GHz with a fixed transmitter and a receiver separated by more than 10 m from the transmitter is much greater than 1. τ_n represents propagation delay of the nth multipath component.

[6+4+4]

3. Show that for a narrowband fading model of wireless channel, in-phase and quadrature components of the received signal are wide sense stationary random processes. Find the auto-correlation function of the received signal under same model. Mention the necessary assumptions. Also plot the power spectral density of the in-phase and quadrature components.

[7+4+3]

4. Justify the use of exponential distribution for modeling the signal-to-noise ratio of received signal in narrowband fading channel. Plot and compare *bit error rate* (BER) performance of a point-to-point wireless communication system in a Rayleigh fading channel using BPSK modulation with that of a AWGN channel. Explain the concept of coherence time of a wireless fading channel and its relation with Doppler spread.

[7+3+4]

5. Discuss briefly the importance and diversity, equalization and coding in wireless communication. Derive an expression for the average SNR of the received signal when selection diversity is used at the receiver. Can OFDM technique be used to realize frequency diversity?

[6+6+2]

6. Discuss the types of transmit diversity and its advantages. In this context, summarize Alamouti's contribution. Mention application(s) of antenna diversity in current wireless communication technologies and standards. Discuss the application of time diversity in GSM systems.

[4+3+3+4]

7. Explain the concepts of ergodic capacaity and outage probability in the context of a wireless fading channel. Show that upper bound of ergodic capacity is given by the Shannon capacity of an AWGN channel with same average SNR. Prove that at small SNR and for a small value of outage probability ϵ, the ϵ-outage capacity is ϵ times that of the capacity of AWGN channel with same signal to noise ratio.

[5+3+6]

8. Write short notes on (**any two**)

   a. Rake receiver and diversity
   b. Cell coverage , path loss and shadowing
   c. Smart antennas in wireless communication systems

2×7