Mobile and Personal Communications

Homework Assignment – 2019

Q1-16 each is 5 points. Q17 is 20 points.

1. What is PCS?, How is it different from cellular?

2. Why do we use interleaving? What is the trade-off when using it?

3. Compare the first-generation analog and second-generation digital systems.

4. Explain the relationship between cluster size, capacity, and co-channel interference.

5. What are the possible solutions to increase capacity of cellular systems? Explain how and indicate if there are any drawbacks in your solution.

6. Is co-channel interference a function of transmitted power from cell site? Explain.

7. Discuss how to reduce CCI with sectorization.

8.
    a. Describe ACI problem and how it effects the communication signal.
    b. How can we reduce ACI?

9.
    a. If the call arriving rate is 10 calls per minute. Average call holding time is 3 minutes. Calculate traffic intensity.
    b. Define GOS. Is it better to increase or decrease it?

10. What does 3G means, what are some of the main features of 3G?

11. Why does the radio channel vary? what is the effect of this variation?

12. What is the cause of inter-symbol interference (ISI), when do we observe ISI?

13. State the difference between long term and short-term fading?

14. Describe delay spread and coherence bandwidth. Explain their relation between each other.

15. Describe coherence time and maximum Doppler spread. Explain their relation between each other.

16. Plot the GOS versus number of channels for 10 Erlang traffic intensity.

17. Following problems require MATLAB coding.

    a. AWGN signal analysis

Part (I)

Generate random bits (10000 bits) with values 1 and 0
- Plot the bit correlation values (autocorrelation of bit values)
- Apply repetition coding on these symbols (i.e. every symbol is repeated). Assume a repetition of 3 (one symbol in 3 symbols out).
- Apply block interleaving with an interleaving matrix of 300 rows and 100 columns
- Convert these bits to BPSK modulated symbols which have values +1 and -1
- Plot the symbol correlation values
- Generate complex additive white Gaussian noise (AWGN) samples of the same size as the number of symbols
- Plot the noise correlation values (autocorrelation function of noise samples)

- Normalize the noise such that we obtain SNR values of [0 2.5 5 7.5 10] dB
- Make a loop (over several SNR values) and add the signal and noise together to get the noisy received signal.
- Apply your favorite detector to detect the coded transmitted symbols
- Calculate symbol error rate
- Convert symbols to bits
- Apply de-interleaving
- Apply majority voting type (2 out of 3) of decoding to get the estimate of the transmitted bits
- Find the difference between what is transmitted and what is received to calculate bit error rate (BER)
- Plot Symbol Error Rate(SER) and BER versus SNR, x-axis shows SNR, y-axis shows SER and BER. y-axis needs to be in logarithmic domain.
- Very briefly (2 sentence) comment on the results.

- Include the figures and the matlab source codes (with a lot of comments) on the homework.

- Remove interleaving and repeat the simulations again. Compare and comment the results.

b. Rayleigh Fading

Part (II)

Generate Rayleigh fading model using Modified Jake's model.

You can find Modified Jakes Model in:

Jakes fading model revisited
Dent, P.; Bottomley, G.E.; Croft, T. Electronics Letters , Volume: 29 Issue: 13 , 24 June 1993
Page(s): 1162 -1163

Generate 30,000 samples of these generated fading waveform.

Use the following values in the simulation:

```
Samples_PerSymbol=1;
TSymbol = 1/ (13e6/48); % symbol period (in second) in GSM/EDGE
Fs=(1/TSymbol)*SamplesPerSymbol;  % Sampling frequency of the oversampled rate
No=40; % number of oscillators
initial_phases=2*pi*rand(No,1)
Ns=30000; % number of fading samples

2 different Fc values (in Hz)
Fc=900e6;      % Carrier Freq. in Hz (GSM and EDGE)
Fc=9000e6;

4 different speed values (kilometers per hour, kmph)
vs_kmph=3;
vs_kmph=30;
vs_kmph=300;
vs_kmph=3000;
```

For each combination of the values plot the amplitude and autocorrelation function of the generated waveforms. Show amplitude changes with speed and carrier frequency. Plot histogram with speed of 3000 kmph and Fc=9000 MHz.
Comment on the results.

Part (III)

Use the above generated model in your simulation for speed=300 kmph and Fc=900e6. Assume that each symbol sample you have generated corresponds to a symbol with a symbol period given above. Pass the generated symbols (Part (I)) from Rayleigh fading channel and observe the bit-error-rate and symbol error rate performances for the given SNR values. Note that at the receiver you need to remove the effect of channel in order to be able to detect the correct symbols. This can be done by multiplying the received samples with the complex conjugate of the channel

coefficients (you can also divide by the channel coefficients, but I prefer multiplication with the complex conjugate for this specific case).

Comment on the results.
Remove interleaving and repeat the simulations again.
Compare and comment the results.

- Include the figures and the Matlab source codes (with a lot of comments) on the homework.

Homework is expected to be completed individually not in groups.