The University Of Sheffield.

Data Provided: None

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2007-2008 (2 hours)

Mobile Networks and Low Level Protocols 6

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.** *Where a symbol is not defined it can be assumed to have its usual meaning, with which candidates should be familiar.*

1. a. Using a series of synchronized bit sequence diagrams, explain how two data streams can modulate the same carrier simultaneously in the *CDMA* protocol and be independently recovered at the receiver. **(9)**

1. b. Calculate the processing gain of a typical *12.2kbps 3G WCDMA* speech service, and explain its significance. **(3)**

1. c. If a spreading factor of *128* is used in a *3G WCDMA* system, calculate the downlink *DPCH* channel symbol and bit rates and estimate the *DPDCH* user data rate. How do these compare with the uplink *DPDCH* if the same spreading factor is used? **(5)**

1. d. Estimate the maximum user data rate for a *3G WCDMA* link, and explain how this could be achieved. **(3)**

2. a. The array factor for a *BTS* antenna comprising a co-linear array of half wave dipoles can be written

$$P(\theta) = I_o \frac{sin\left(\frac{kNd}{2}cos(\theta)\right)}{sin\left(\frac{kd}{2}cos(\theta)\right)}$$

Calculate the gain in *dBi* of an *11* element array, and the position and height of the first side lobes, assuming $d = 0.8\lambda$. **(7)**

2. b. Explain how (i) polarization diversity, (ii) space diversity and (iii) time diversity can be used to enhance the signal received at a *BTS*. **(6)**

2. c. A tri-sectored *BTS* serving three cells is situated in the middle of a field. Explain why the signal received at the *BTS* from a mobile phone user may vary as he walks around the perimeter of the field. **(5)**

2. d. If the engineering menu item *BTS Test* is invoked on the handset for one of the cells, how might this affect the signal received in (c)? **(2)**

3. a. Briefly explain the following techniques for digitally modulating an *RF* carrier, and say whether they are used in *GSM* or *WCDMA* cellular systems: (i) *QPSK* (ii) *FSK* (iii) *MSK* (iv) *GMSK*. What is the bandwidth efficiency for *GSM*? **(9)**

3. b. Explain mathematically why an audio amplifier makes a buzzing noise when a *GSM* handset is held close to it. Are there any possible health implications? **(8)**

3. c. Would you expect a *WCDMA* handset to cause similar interference? Why? **(3)**

4. a. Sketch the typical *GSM* downlink traffic multi-frames used for (i) half rate and (ii) full rate speech channels, and show how these multi-frames combine with signalling multi-frames into a super-frame. **(6)**

4. b. Describe how the *456* bits of a *20ms* speech block are loaded onto a full rate traffic channel, and give the speech data and traffic channel bit rates. Why is it done this way? **(6)**

4. c. Briefly explain the technologies used to transmit computer type data over a *GSM* network. Your answer should include, but not be limited to, a comparison of *GPRS* and *EGPRS* systems. **(6)**

4. d. Suggest a method of making a mobile phone call that does not involve using a conventional speech traffic channel. **(2)**