The University Of Sheffield.

Data Provided: None EEE6430

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2011-2012 (2 hours)

EEE6430 Mobile Networks and Low Level Protocols

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 or abbreviation is not defined it can be assumed to have its usual meaning, with which candidates should be familiar**.

1. **a.** Describe the following logical control channels in the GSM protocol and the bursts they map on to:

(i) Frequency Correction Channel (FCCH),

(ii) Synchronisation Channel (SCH),

(iii) Broadcast Control Channel (BCCH),

(iv) Common Control Channels (CCCH). **(8)**

b. Hence sketch (i) a downlink and (ii) an uplink control channel multiframe involving these channels. **(4)**

c. If the BCCH is transmitted in frames 2 – 5 of a multiframe using timeslot 0, what is the elapsed time between the end of the frame 5 burst in multiframe *n* and the beginning of the frame 2 burst in the next multiframe *n+1*? What would this elapsed time be if timeslot 5 were used in multiframe *n+1* instead? **(4)**

d. Explain the Cell Broadcast Channel in GSM, and how its implementation differs from the Short Message Service. **(4)**

2. **a.** A BTS array antenna comprises 5 half wave dipoles oriented vertically and co-axially one above the other spaced by $d = 0.7\lambda$ between centres, and is mounted on a mast so that the centre of the antenna is 10m above the ground. Calculate

(i) The antenna gain

(ii) The position of the 1st sidelobe

(iii) The height of the 1st sidelobe with respect to the main lobe

(iv) The power density incident on a pedestrian's head from the first sidelobe assuming a constant BTS transmit power of 20W, and that the pedestrian is 2m tall.

The following formula may be of use:

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

(12)

b. Hence draw calibrated sketches of the azimuth and elevation radiation patterns up to the first sidelobes. **(3)**

c. If the mast is sited on the pavement in a residential neighbourhood, what are the safety implications with regard to

(i) Pedestrians walking along the street close to the mast

(ii) Residents of nearby buildings?

Your answer in (ii) should include calculation of a minimum 'safe' distance from the antenna. **(5)**

3. **a.** Explain how the Dedicated Channel is transmitted in both the uplink and downlink directions in a 3G WCDMA FDD cellular system. Your answer should include descriptions of timeslot, frame structure and modulation of the DPDCH, DPCCH and DPCH together with the type of bits they contain. **(10)**

b. If a spreading factor of 16 is used and data is being transmitted continuously, estimate

(i) The uplink DPDCH symbol rate,

(ii) The uplink DPDCH bit rate,

(iii) The uplink DPDCH user data rate assuming half rate coding,

(iv) The downlink DPCH symbol rate,

(v) The downlink DPCH bit rate,

(vi) The downlink user data rate assuming half rate coding and that the DPCCH occupies 10% of the DPCH. **(8)**

c. Estimate the uplink DPDCH user data rate if each frame contains 5ms of DTX. **(2)**

4. a. Describe with the aid of a diagram the operation of a RAKE receiver. **(8)**

b. Explain the terms *softer* and *soft handovers* in the context of a mobile network. **(4)**

c. The signal from a mobile handset arrives at a BTS from two different directions, ϕ_A and ϕ_B where $\phi_A - \phi_B = 180^o$, and is received by two antennas *A* and *B* pointing in these directions respectively, with a delay of $2.6\mu s$ between each path:

(i) What is the difference between the two signal path lengths?

(ii) What might cause such multi-path propagation?

(iii) How could the two antennas be optimally combined to yield the largest net signal strength?

(iv) What would happen if antenna *A* received some of the ϕ_B signal off its back lobe?

(v) What would be the consequences if the ϕ_B signal was due to reflection off an aircraft? **(8)**