

**Written Exam – September 12, 2017**

<b>Surname</b>	
<b>Name</b>	
<b>ID</b>	

**Time available for the exam: 1:45 hours**

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>A</b>

**Question 1 (6 points)**

- a) Describe the difference between Static Frequency Allocation and Dynamic Channel Assignment. What is the approach used by Geometric DCA to ensure interference control?
- b) Consider a mobile radio network with Geometric DCA. The system has 6 channels and the compatibility matrix reported below. To the system, completely empty at the beginning, a sequence of calls arrives according to the arrival order indicated in vector S (indices in S indicate the cell of call arrival). Assuming no call termination in the considered interval, indicate for each call if it is accepted and which channel is assigned (among available channels always select that with minimum index).

$$C = \begin{bmatrix} 2 & 2 & 0 & 1 & 0 \\ 2 & 2 & 1 & 1 & 0 \\ 0 & 1 & 2 & 0 & 1 \\ 1 & 1 & 0 & 2 & 1 \\ 0 & 0 & 1 & 1 & 2 \end{bmatrix}$$

$$S = \{2, 2, 2, 3, 4, 5, 1, 1, 2, 2, 3, 4, 5\}$$

**Question 2 (6 points)**

- a) Describe the logical to physical channel mapping in GSM and the TDMA scheme used.
- b) Design the multiplexing scheme of a TDMA mobile radio system similar to GSM. The system has radio carriers with a net rate of 256 Kb/s and it requires the following logical channels: Traffic channels TCH (uplink and downlink) with rate 30 Kb/s; Associated control channels SACCH (uplink and downlink) with rate 2 Kb/s; Broadcast channel BCCH (only downlink) with rate 16 Kb/s; Frequency channel FCCH (only downlink) with rate 12 Kb/s; Synchronization channel SCH (only downlink) with rate 8 Kb/s; Paging channel PCH (only downlink) with rate 16 Kb/s; Access grant channel AGCH (only downlink) with rate 8 Kb/s; Random access channel RACH (only uplink) with rate 60 Kb/s. On the carrier, you have to multiplex 6 TCHs and their 6 SACCHs and one signaling channel for each of the types indicated above. Design the multiplexing scheme indicating the frame and multi-frame structure for both uplink and downlink (solutions similar to GSM will get a higher score).

**Question 3 (6 points)**

Define the maximum cell size of a TDMA system in order to guarantee coverage (power above minimum threshold) and a maximum call blocking probability of 2%. Assume: hexagonal cells, minimum threshold for received power  $P_{th}$  equal to -90 dBm, minimum SIR equal to 13 dB, propagation factor equal to 4, number of carriers equal to 9 with 5 time slots per TDMA frame (one call per time slot), received power at reference distance  $d_0=10$  m equal to -20 dBm, shadowing margin 5.9 dB. Consider the two cases:

- a) rural area with traffic density of 5 Erlang/km<sup>2</sup>,  
 b) dense urban area with traffic density of 35 Erlang/km<sup>2</sup>.

**Question 4 (6 points)**

Describe into detail the signaling procedure for a call setup when the caller and the called users are subscribers of the same operator, and the called user is in international roaming.

**Question 5 (6 points)**

Describe the main characteristics of data service in terms of multiple access scheme resource management strategies in UMTS R.99, and HSPA (considering separately HSDPA and HSUPA).

**Additional topics (2 points)**

It is possible to present here topics directly related to those of the course but not discussed during lectures, including those in the suggested readings available on the web page.