

**MSc Examination**

**Friday 16th May 2014      10:00 - 12:30**

**ECS702P Mobile and WLAN Technologies      Duration: 2 hours 30 minutes**

**YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL  
INSTRUCTED TO DO SO BY AN INVIGILATOR**

**Answer TWO questions of PART A AND TWO questions of  
PART B.**

**If you answer more questions than specified (in each part), only the first two questions (in the order they appear on your answer script) will be marked unless you have crossed out any answers you do not wish to be marked.**

Calculators are permitted in this examination. Please state on your answer book the name and type of machine used.

Complete all rough workings in the answer book and cross through any work that is not to be assessed.

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**EXAM PAPERS MUST NOT BE REMOVED FROM THE EXAM ROOM**

**Examiners: Prof. Xiaodong Chen and Dr Eliane L. Bodanese**

**PART A**

**Question 1**

a) Explain Flat fading and frequency selective fading. Describe their impacts on the wireless channel, with the help of a sketch of BER vs  $E_b/N_0$  curves.

**[6 marks]**

b) With the help of diagrams, explain how the Direct Sequence Spread Spectrum (DSSS) works and the processing gain.

**[6 marks]**

c) Describe the operation of CSMA/CA, with the help of a diagram if necessary.

**[6 marks]**

d) Explain why the RTS/CTS Protocol is devised in the IEEE802.11 standard.

**[7 marks]**

**Question 2**

a) Describe three options of the Physical layer in the IEEE802.11 standard.

**[6 marks]**

b) Describe in detail the power management in IEEE802.11.

**[7 marks]**

c) Describe the main features in the IEEE802.11ac proposal.

**[6 marks]**

d) Describe the main features of three operation modes in IEEE802.11n standards.

**[6 marks]**

**Question 3**

a) Describe the Radio Specification of Bluetooth 2.0.

**[6 marks]**

b) With the help of a diagram, explain how data transaction is done in the Bluetooth Low Energy standard (4.0).

**[7 marks]**

c) Describe the network topology used in WiMedia.

**[6 marks]**

d) Explain the attributes of Zigbee system.

**[6 marks]**

## PART B

## Question 4

- a) Considering the basic cellular operation for mobile initialisation, i.e. when the mobile station is turned on by the user, briefly describe the general steps that occur from the moment the mobile station is turned on up to the stage the mobile station enters the *idle* state, if there is cellular service available. (Tip: base your answer on the first generation steps that are the simplest to explain.)

[4 marks]

- b) **Error! Reference source not found.** shows a section of the Erlang B Table. Assume a cell receives on average 390 calls per hour, the mean holding time of a call is 120 seconds and the grade of service is 0.02. Consider Table 1 to answer the following questions appropriately:

- Calculate the offered traffic in the cell.
- How many channels does the cell need if an omni directional antenna is used?
- Considering the offered traffic is uniformly distributed inside the cell, how many channels does the cell need if six 60 degree directional antennas are used?
- Calculate the trunking efficiency for both cases (i.e. items ii) and iii) ).

[11 marks]

<b>Blocked-Calls-Cleared (Erlang B)</b>													
N	A, erlangs												
	B												
	1.0%	1.2%	1.5%	2%	3%	5%	7%	10%	15%	20%	30%	40%	50%
1	.0101	.0121	.0152	.0204	.0309	.0526	.0753	.111	.176	.250	.429	.667	1.00
2	.153	.168	.190	.223	.282	.381	.470	.595	.796	1.00	1.45	2.00	2.73
3	.455	.489	.535	.602	.715	.899	1.06	1.27	1.60	1.93	2.63	3.48	4.59
4	.869	.922	.992	1.09	1.26	1.52	1.75	2.05	2.50	2.95	3.9	5.02	6.50
5	1.36	1.43	1.52	1.66	1.88	2.22	2.50	2.88	3.45	4.01	5.19	6.60	8.44
6	1.91	2.00	2.11	2.28	2.54	2.96	3.30	3.76	4.44	5.11	6.51	8.19	10.4
7	2.50	2.60	2.74	2.94	3.25	3.74	4.14	4.67	5.46	6.23	7.86	9.80	12.4
8	3.13	3.25	3.40	3.63	3.99	4.54	5.00	5.60	6.50	7.37	9.21	11.4	14.3
9	3.78	3.92	4.09	4.34	4.75	5.37	5.88	6.55	7.55	8.52	10.6	13.0	16.3
10	4.46	4.61	4.81	5.08	5.53	6.22	6.78	7.51	8.62	9.68	12.0	14.7	18.3
11	5.16	5.32	5.54	5.84	6.33	7.08	7.69	8.49	9.69	10.9	13.3	16.3	20.3
12	5.88	6.05	6.29	6.61	7.14	7.95	8.61	9.47	10.8	12.0	14.7	18.0	22.2
13	6.61	6.80	7.05	7.40	7.97	8.83	9.54	10.5	11.9	13.2	16.1	19.6	24.2
14	7.35	7.56	7.82	8.20	8.80	9.73	10.5	11.5	13.0	14.4	17.5	21.2	26.2
15	8.11	8.33	8.61	9.01	9.65	10.6	11.4	12.5	14.1	15.6	18.9	22.9	28.2
16	8.88	9.11	9.41	9.83	10.5	11.5	12.4	13.5	15.2	16.8	20.3	24.5	30.2
17	9.65	9.89	10.2	10.7	11.4	12.5	13.4	14.5	16.3	18.0	21.7	26.2	32.2
18	10.4	10.7	11.0	11.5	12.2	13.4	14.3	15.5	17.4	19.2	23.1	27.8	34.2
19	11.2	11.5	11.8	12.3	13.1	14.3	15.3	16.6	18.5	20.4	24.5	29.5	36.2
20	12.0	12.3	12.7	13.2	14.0	15.2	16.3	17.6	19.6	21.6	25.9	31.2	38.2

Table 1: Erlang B table

c) Considering the frequency planning of a FDMA/TDMA cellular network, answer the following questions.

- i) Calculate the *cochannel reuse ratio* ( $D/R$ ) for a cellular network with 12 cells per cluster.
- ii) Explain the steps to assemble the frequency reuse layout and the values of the *shift parameters* for these 12 cells per cluster cellular network.

[7 marks]

d) Considering the basic cellular operation for the mobile initialisation, i.e. when the mobile station is turned on by the user, briefly describe the general steps that occur from the moment the mobile station is turned on up to the stage the mobile station enters in the *idle* state, if there is cellular service available. (Tip: base your answer in the first generation steps that are the simplest to explain)

[3 marks]

### Question 5

a) **Error! Reference source not found.** shows the *Registration Procedure* in GSM. Some of the steps will use different GSM channels.

- i) For each step that uses a GSM channel, identify the step and the respective GSM channel used.
- ii) Briefly describe the functionality of each different identified GSM channel (Note: describe the functionality of each different GSM channel only once, even if it is used in more than one step).

[ 7 marks]

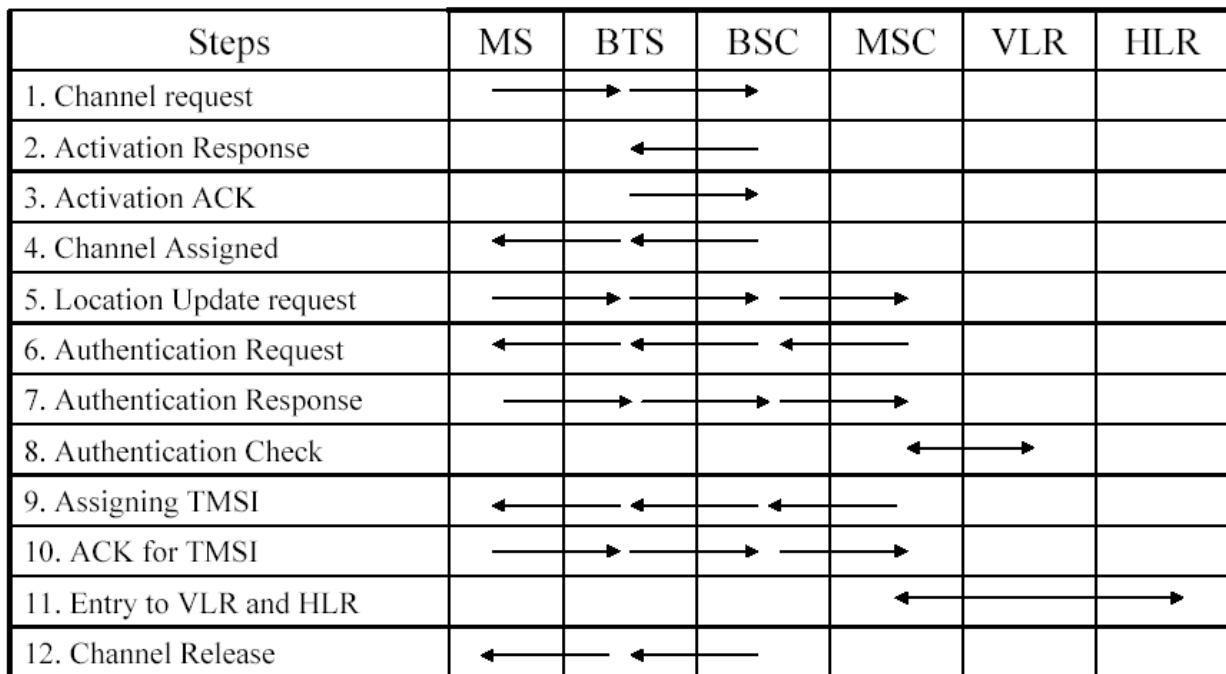


Figure 1: Registration Procedure in GSM

- b) Describe the concept of **Soft Handoff** and also describe the characteristics of the *special receiver* that makes soft handoff possible.

[10 marks]

- c) Supply the appropriate words to complete the blanks (1 to 12) in the following sentences about the GSM system (**Note: write your answers in the answer book and NOT on this page**).

GSM uses \_\_\_\_\_(1) as multiple access technique. The GSM spectrum provides \_\_\_\_\_(2) different frequency carriers, because a guard band is left between the first and the last carrier. Each frequency carrier in GSM occupies a frequency band of \_\_\_\_\_(3) accommodating \_\_\_\_\_(4) logical channels in it. Each logical channel is defined by the repetitive occurrence of \_\_\_\_\_(5) each one of them has an approximate duration of 0.577ms. In a GSM full rate traffic channel, the payload data is encrypted in blocks of \_\_\_\_\_(6) bits. The capacity in kbps of a full rate traffic channel is \_\_\_\_\_(7), this value takes in consideration that in \_\_\_\_\_(8) frames occurring in a \_\_\_\_\_(9) ms multi-frame, \_\_\_\_\_(10) slots are used for other purposes which are: \_\_\_\_\_(11) and the \_\_\_\_\_(12) logical channel.

[6 marks]

- e) Cite two of the different logical channels that can be used to transmit **Short Messaging Services (SMS)** messages.

[2 marks]

**Question 6**

a) Explain inner/closed (fast) power control as used in UMTS.

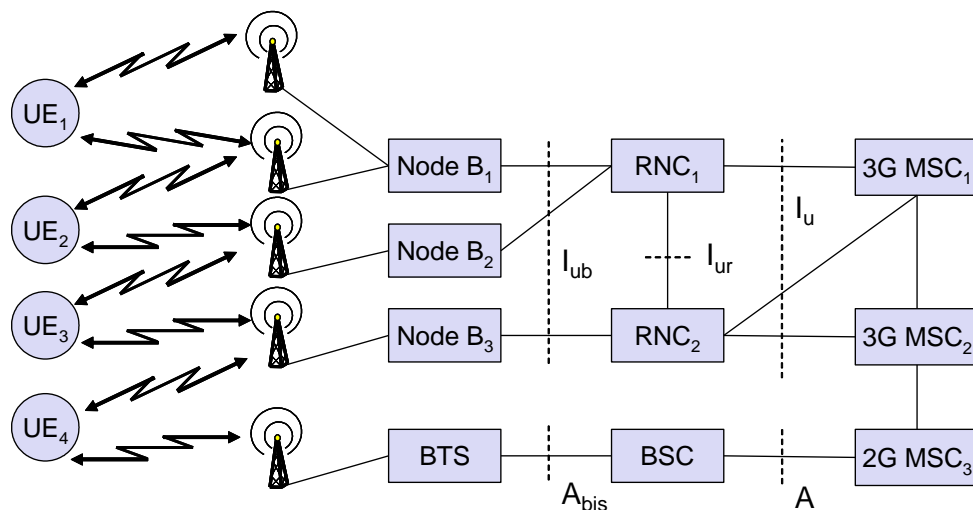
[4 marks]

b) Sketch the GPRS network architecture and describe in detail the GPRS supporting nodes.

[6 marks]

c) Figure 3 gives an overview of several types of handover in a combined UMTS/GSM network. Indicate what type of handover UE2 is performing and describe this type of handover.

[4 marks]



**Figure 3: Handovers in UMTS**

d) Answer the following questions about HSDPA:

- State the changes made in layer 1 (L1) that make the HSDPA increase the downlink packet data throughput.
- What architectural component is responsible for the actions you answered in item i) and also for the fast link adaptation?
- In UMTS, the transport channel carrying the user data with HSDPA operation, which is called High Speed Downlink Shared Channel (HS-DSCH), behaves differently than a Dedicated Channel (DCH) in terms of power control, variable spread coding and handoff. Explain these differences.

[6 marks]

- e) Supply the appropriate words to fill the blanks in the following sentences about HSUPA concepts and general functionality (**Note: write your answer in the answer book and NOT on this page**):

The technologies applied with HSUPA improve the \_\_\_\_\_ (1) packet data performance by means of fast physical layer (L1) \_\_\_\_\_ (2) and transmission \_\_\_\_\_ (3), as well as fast Node B \_\_\_\_\_ (4). HSUPA general functionality: The \_\_\_\_\_ (5) estimates the data rate transmission needs of each active HSUPA user based on the device-specific \_\_\_\_\_ (6); The scheduler in the \_\_\_\_\_ (7) then provides instruction to devices on the \_\_\_\_\_ (8) link data rate to be used at a fast pace depending on the \_\_\_\_\_ (9) received before, the scheduling algorithm and the \_\_\_\_\_ (10) prioritisation scheme.

**[5 marks]**

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