UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2017

Module Number: EE6207 **Module Name: Wireless and Mobile Communication**

[Three Hours]

[Answer **all questions**, each question carries **10 marks**]

Q1 a) What are the advantages and the disadvantages of Fixed Channel Assignment (FCA) and Dynamic Channel Assignment (DCA) strategies?

[1.5 Marks]

b) 10.2 MHz of total spectrum is used by an operator for a duplex cellular mobile system. Assume that the channel bandwidth is 25 kHz and a 200 kHz total guard band is used to separate each subscriber of the system.

i) If a cluster size of 4 is used, determine the total number of channels that can be assigned for each cell using FCA strategy.

ii) "It is decided to increase the capacity of the system by using the cell splitting technique." Explain the validity of the aforesaid sentence by considering that the new cell radius is half of the original cell radius.

[4.0 Marks]

c) Using an illustration, explain how to select a proper threshold when a call in operation is handed over from the serving base station to a neighbouring base station.

[2.5 Marks]

d) What is meant by the cell dragging predicament in cellular mobile systems? Suggest a possible solution for this.

[2.0 Marks]

Q2 a) Explain where a directional antenna can be practically used to obtain distinct advantages over an omni-directional antenna.

[2.0 Marks]

b) Derive an expression for co-channel interference ratio of a cellular mobile system in terms of the cluster size, the number of co-channel cells in the first tier and the path loss exponent of free space.
State all the assumptions used for the above derivation.

Hint:
The average received power (P_r) at any point of the forward channel, a distance d away from the transmitting antenna is

$$P_r = P_0\left(\frac{d}{d_0}\right)^{-n}$$

where n is the path loss exponent and P_0 is the receiving power at a distance d_0 away from the transmitting antenna.

[5.0 Marks]

c) Hence, show that co-channel interference can be reduced in cell sectoring.

[3.0 Marks]

Q3 a) Explain how GSM has used both Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) techniques for channel formation.

[2 Marks]

b) A cellular mobile operator is asked to design a mobile network for a city of population 50,000. However, only 60% of the total population will become subscribers of the network and less than 25 base stations are allowed to be installed by the Municipal Council of the city since it requires to control EMF radiation levels within the city. The operator has a license for a 4 MHz spectrum in the 900 MHz frequency band to implement the GSM cellular network.

i) The desired co-channel interfering ratio (C/I) of the cell based system is 15 dB. Considering only the first tier interfering cells for your calculations, determine the cluster size for maximum capacity. Assume that path loss exponent of free space is four.

ii) If one user will make an average of 5 calls per day, determine the maximum possible average call duration in minutes that makes the probability of call blocking in the network to less than or equal 2%.

Note:
Assume that the GSM channel bandwidth is 200 kHz. Use the provided Erlang-B table entries in Table 1 for your calculations and state all the assumptions you use in the design.

[8 Marks]

Q4 a) Is it possible to transmit a digital signal (e.g. coded as square waves used in computers) using radio transmission without any loss? Why?

[2 Marks]

b) What are the main benefits of a spread spectrum system? How can spreading be achieved and what is the reason for using the word "spread" in such systems?

[2 Marks]

c) Why is frequency planning not needed in a CDMA cell/sector?

[1 Mark]

d) Why is the transmitter and the receiver need to be precisely synchronised in TDMA systems?

[1 Mark]

e) What limits the number of simultaneous users in a TDMA or FDMA system compared with a CDMA system? What happens to the transmission quality of connections if the load gets higher in a cell, i.e. how does an additional user affect the other users in the cell in each of the system?

[2 Marks]

f) What is CDMA2000? What is WCDMA? What is the main difference between them?

[1 Mark]

g) Which factors limit the size of the UMTS FDD cell and why?

[1 Mark]

Q5 a) State the main difference between handover and roaming.

[1 Mark]

b) Explain two reasons for handover.

[1 Mark]

c) State the four types of handovers used in GSM.

[1 Mark]

d) When a mobile station sends a Channel Request, RACH, is used and mapped into Access-burst. Why is the Access-burst different from the other bursts in the GSM radio interface?

[2 Marks]

e) Explain why RIL3-RR algorithm is used in "Channel Request" procedure.

[1 Mark]

f) State the purpose of using the "Timing Advance" functionality in the GSM radio interface.

[1 Mark]

g) Compared with other bursts, "Access-burst" consists of a 68.25 bit large guard period. Briefly explain the reasons for this.

[1 Mark]

h) In the frame structure of a normal burst, what is the purpose of using a 26-bit field?

[1 Mark]

i) Explain the functionality of A3 and A8 algorithms.

[1 Mark]

Blocked-Calls-Cleared (Erlang *B*)

	A, erlangs												
	B												
N	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	1.76	2.05	2.50	2.95	3.99	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	7.09	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	14.6	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	17.8	19.6	21.6	25.9	31.2	38.2
21	12.8	13.1	13.5	14.0	14.9	16.2	17.3	18.7	20.8	22.8	27.3	32.8	40.2
22	13.7	14.0	14.3	14.9	15.8	17.1	18.2	19.7	21.9	24.1	28.7	34.5	42.1
23	14.5	14.8	15.2	15.8	16.7	18.1	19.2	20.7	23.0	25.3	30.1	36.1	44.1
24	15.3	15.6	16.0	16.6	17.6	19.0	20.2	21.8	24.2	26.5	31.6	37.8	46.1
25	16.1	16.5	16.9	17.5	18.5	20.0	21.2	22.8	25.3	27.7	33.0	39.4	48.1
26	17.0	17.3	17.8	18.4	19.4	20.9	22.2	23.9	26.4	28.9	34.4	41.1	50.1
27	17.8	18.2	18.6	19.3	20.3	21.9	23.2	24.9	27.6	30.2	35.8	42.8	52.1
28	18.6	19.0	19.5	20.2	21.3	22.9	24.2	26.0	28.7	31.4	37.2	44.4	54.1
29	19.5	19.9	20.4	21.0	22.1	23.8	25.2	27.1	29.9	32.6	38.6	46.1	56.1
30	20.3	20.7	21.2	21.9	23.1	24.8	26.2	28.1	31.0	33.8	40.0	47.7	58.1
31	21.2	21.6	22.1	22.8	24.0	25.8	27.2	29.2	32.1	35.1	41.5	49.4	60.1
32	22.0	22.5	23.0	23.7	24.9	26.7	28.2	30.2	33.3	36.3	42.9	51.1	62.1
33	22.9	23.3	23.9	24.6	25.8	27.7	29.3	31.3	34.4	37.5	44.3	52.7	64.1
34	23.8	24.2	24.8	25.5	26.8	28.7	30.3	32.4	35.6	38.8	45.7	54.4	66.1
35	24.6	25.1	25.6	26.4	27.7	29.7	31.3	33.4	36.7	40.0	47.1	56.0	68.1
36	25.5	26.0	26.5	27.3	28.6	30.7	32.3	34.5	37.9	41.2	48.6	57.7	70.1
37	26.4	26.8	27.4	28.3	29.6	31.6	33.3	35.6	39.0	42.4	50.0	59.4	72.1
38	27.3	27.7	28.3	29.2	30.5	32.6	34.4	36.6	40.2	43.7	51.4	61.0	74.1
39	28.1	28.6	29.2	30.1	31.5	33.6	35.4	37.7	41.3	44.9	52.8	62.7	76.1
40	29.0	29.5	30.1	31.0	32.4	34.6	36.4	38.8	42.5	46.1	54.2	64.4	78.1