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Mid ExamI.

Q.1 (12 Points, ABET Question) $\circlearrowright$ NT   Area
Design a Digital Cellular system for an area of 40000Km², if the total
number of available channels is 315 and 30 subscribers are **active per**
Km² at busy hour. If the average call duration is **2 min one control**
channel per cell, γ=3 and **BP=1%**. Then Find (you **must** use all
channels): $\lambda = 2$ ✗ · $Q_q = 30 \times 40K = 1.2M$

(10)

Configuration	3x3	7x1
	↑×n	↑×n
No of Ch. Per sector	3̶5̶ ✗	44
No of control Ch.	3 1ch/cell	7
Total No of **Cells**	592 ✗	~~2468~~ 1341
Actual C/I	11.303 dB	12.05 dB

3×3

$\frac{C}{I} = \frac{3}{6}(q)^8$

$q = 3$

$= \frac{3}{6}(3)^3$

$q = \sqrt{3K}$
$= \sqrt{3 \times 7}$

$\frac{C}{I} = \frac{1}{6}(\sqrt{21})^3$

Repeat for BP=2%.

Configuration	3x3	7x1
Total No of **Cells**	563 ✗	1283 ✓
Actual C/I	11.303 dB	12.05 dB

Write down the frequency plan for the 3x3 system:

cells
sectors

A			B			C		
f₁	f₂	f₃	f₄	f₅	f₆	f₇	f₈	f₉
f₁₀	f₁₁	f₁₂	f₁₃	f₁₄	f₁₅	f₁₆	f₁₇	f₁₈
f₁₉	f₂₀	f₂₁	f₂₂	f₂₃	f₂₄	f₂₅	f₂₆	f₂₇
f₂₈	f₂₉	f₃₀	f₃₁	f₃₂	f₃₃	f₃₄	f₃₅	f₃₆
f₃₇	f₃₈	f₃₉	f₄₀	f₄₁	f₄₂	f₄₃	f₄₄	f₄₅
f₄₆	f₄₇	f₄₈	f₄₉	f₅₀				f₅₄
~~f₅₅~~ 298	219	390	391	302	303	304	305	~~f₆₃~~ 306
~~f₃₀₄~~ f₃₀₇	f₃₀₈	f₃₃₅	f₃₀₉	f₃₁₀	~~f₃~~	f₃₁₁	f₃₁₂	~~f₃₃₂~~ → f₃₁₅

3×3

7×1 f₃₁₄

315 chan

$N_c = \frac{315 - 3}{3} = 102 \lessgtr \frac{35}{34} = 34.66 = 35$

$N_c = \frac{315 - 7}{7} = 44$

1%   2%
$A_{sect} = A(35) = 22.55$ 23.71
× 3   × 3
$A_c = 67.65$ 78.43

1%   2%
$A_c(44) = 29.84$ 31.19

$A_T = \frac{Q_q \lambda}{60} = \frac{1.2M \times 2}{60} = 40K$

No. of cells = $\frac{40K}{29.84}$ $\frac{40K}{31.19}$

No. of cells = $\frac{40K}{67.65}$ $\frac{40K}{71.13}$

1

Scanned by CamScanner

Q.2 **(5 Points)**

Design a Digital Cellular system for an area of 10000Km², if the total number of available channels is 138 and 300K subscribers are **active** at busy hour. If the average call duration is <u>3 min one control channel per cell</u>, γ=3, min C/I is 8.5dB and BP=1%.

$$\lambda = 3$$

$$\text{Area} = 10000$$

$$N_T = 138$$

$$Q_a = 300K \qquad \lambda = 3$$

cell configuration of 3×3

$$\frac{C}{I} = \frac{3}{6} \times (3)^3 = 11.303 \, dB \; > \; 8.5 \, dB$$

$$N_C = \frac{138 - 3}{3} = 45 \begin{cases} 15 \; - \; \text{Number of channels/sector} \\ 15 \\ 15 \end{cases}$$

$$A_{sect} = 7.39$$
$$A(15)$$

$$A_C = 7.39 \times 3 = 22.17$$

$$A_T = \frac{Q_a \lambda}{60} = \frac{300K \times 3}{60} = 15K$$

$$\text{No. of cells} = \frac{15K}{22.17} = 676.59$$
$$\frac{A_T}{A_C} \qquad\qquad = 677 \; cell$$

Q.3 (5 Points 1,2,2)

1- A 3x3 configuration system at C/I=7dB. Down tilting increases the home signal by 1.5dB and reduces the interference by 1dB each. Find the new C/I.

C/I= 9.5 dB.

2- If a user at 800m from base station has C/I=11dB. What is the C/I for a user at 500m in the same cell (assume that the interference on both locations is the same).

C/I= ~~16.575~~ 17.125 dB.

$$\frac{c}{I}_{old} = K \left(\frac{D}{R}\right)^{\gamma} \quad, R = 800$$

$$\frac{c}{I}_{new} = K \left(\frac{D}{0.625 R}\right)^{\gamma} \quad 500 = 0.625 R$$

3- Discuss briefly (in points) the call setup procedure.

power on

network search

Authentication

→Idle   send phone number (called)

call end   ②

④

$$\frac{10^{0.1}}{C/I_{new}} = \frac{1}{\left(\frac{1}{0.625}\right)^{\gamma}} \quad 3$$

let $\gamma = 3$

$$\frac{10^{1.1}}{C/I_{new}} = 0.244$$

$$C/I_{new} = \cancel{58.58}$$
$$= \cancel{16.575 dB}$$
$$= 17.125 dB$$

$$\frac{K \quad \frac{D^{\gamma}}{R^{\gamma}}}{K \quad \frac{D^{\gamma}}{(0.625)^{\gamma} R^{\gamma}}}$$

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①

$$\frac{c}{I}_{old} = 7dB = \frac{c}{6I}$$

$$\frac{c}{I}_{new} = \frac{c}{6\left(\frac{I}{10^{0.1}}\right)} \times 10^{0.15} = \frac{c}{6I} \times \frac{10^{0.15}}{\frac{1}{3}\,10^{0.1}} = \left(\frac{c}{6I}\right) \times 1.77$$

$$= 7 + 2.5 = 9.5 dB$$

Q.4   (8 Points 1 each)

No.	Statement	T	F
1.	Frequency plan reduces the effect of both co-channel and adjacent-channel interference	T	(F)
2.	Frequency reuse is implemented by creating a full spatial orthogonality.	T	(F)
3.	Frequency hopping increases the C/I for all active users.	T	(F)
4.	The propagation constant γ depends on the multi-paths in the channel.	(T)	F
5.	Control data is transmitted over the control channel while the user is active. *voice*	T	(F)
6.	Control Channels are used to update only active users data.	T	(F)
7.	Near End Far End problem happens at the cell center.	T	(F)
8.	Hand over failure is only due to no available channels in the interred cell.	T	(F)

N	1%	2%	N	1%	2%	N	1%	2%
1	0.01	0.02	36	23.33	24.53	71	52.56	54.37
2	0.15	0.21	37	24.15	25.35	72	53.41	55.25
3	0.43	0.55	38	24.96	26.18	73	54.27	56.12
4	0.81	0.99	39	25.76	27.01	74	55.14	57.00
5	1.28	1.50	40	26.58	27.84	75	56.00	57.87
6	1.75	2.05	41	27.38	28.68	76	56.87	58.76
7	2.30	2.63	42	28.23	29.51	77	57.75	59.63
8	2.87	3.25	43	29.02	30.35	78	58.60	60.52
9	3.46	3.88	44	29.84	31.19	79	59.47	61.39
10	4.09	4.54	45	30.67	32.03	80	60.33	62.28
11	4.77	5.21	46	31.49	32.87	81	61.19	63.10
12	5.39	5.90	47	32.31	33.72	82	62.06	64.05
13	6.03	6.60	48	33.14	34.57	83	62.94	64.93
14	6.71	7.31	49	33.97	35.41	84	63.81	65.81
15	7.38	8.04	50	34.81	36.26	85	64.68	66.70
16	8.09	8.77	51	35.55	37.08	86	65.55	67.58
17	8.80	9.51	52	36.42	37.93	87	66.42	68.47
18	9.52	10.22	53	37.26	38.79	88	67.29	69.36
19	10.24	11.01	54	38.10	39.64	89	68.17	70.25
20	10.87	11.77	55	38.94	40.50	90	69.05	71.13
21	11.74	12.53	56	39.78	41.36	91	69.92	72.02
22	12.45	13.30	57	40.63	42.22	92	70.79	72.91
23	13.21	14.08	58	41.47	43.06	93	71.67	73.80
24	13.80	14.86	59	42.32	43.86	94	72.55	74.68
25	14.72	15.65	60	43.16	44.80	95	73.42	75.58
26	15.42	16.44	61	44.01	45.67	96	74.31	76.47
27	16.22	17.22	62	44.86	46.54	97	75.18	77.36
28	17.03	18.00	63	45.71	47.40	98	76.06	78.26
29	17.81	18.83	64	46.56	48.27	99	76.95	79.16
30	18.52	19.64	65	47.41	49.14	100	77.83	80.04
31	19.37	20.45	66	48.27	50.01	101	78.71	80.94
32	20.16	21.26	67	49.13	50.88	102	79.60	81.84
33	20.88	22.07	68	49.98	51.75	103	80.48	82.73
34	21.75	22.86	69	50.84	52.03	104	81.35	83.62
35	22.56	23.71	70	51.66	53.50	105	82.25	84.52