

Q.1 (13 Points, ABET Question 7x6)

Design a Digital Cellular system for an area of 20000 Km^2 , if the total number of available channels is 273 and 800K subscribers are active at busy hour. If the min C/I is 10 dB , the average call duration is 3 min one control channel per cell, (20% of customers are active at busy hour) and $\gamma=3$. Then Find:

Configuration	BP=1%	BP=2%
Cell Configuration	3×3	5×3
Total No of Cells	455 718	679
Actual C/I	11.303 dB	11.303 dB
Cell Radius (2.6 R^2)	10.35	3.365.8 m

327,3 m

If a micro cells (omni directional) is to be added to the system using 18 channels from the 273. Calculate the following for the same configuration as above:

	BP=1%	BP=2%
Total No of Cells	188 340	2360
Total No of micro Cells		
Actual C/I	11.303 dB	11.303 dB
Micro Cell Radius	1.74	1.79
Total customers	19234117	15632500

$$\rightarrow \frac{C}{I} = 10 \text{ dB}$$

$$k=3 \rightarrow q=3 \rightarrow \frac{C}{I} = \frac{q^3}{6} \rightarrow 10 \times 2 = \frac{q^3}{2} \rightarrow q = \sqrt[3]{20}$$

$$m=3 \rightarrow \frac{C}{I} = 10.303 \text{ dB}$$

$$\rightarrow A_T = \frac{Q_a \times 1}{60} \rightarrow \frac{800 \times 10^3 \times 3}{60} = 40000 E_r$$

$$A_{sec} = \frac{N_{sec}}{a} = \frac{273 - 9}{a} = 29.33$$

$$A_{cell} = 29.33 \times 3 = 88 \quad A_{sec} = 18.58 \rightarrow A_{cell} = 55.7$$

$$\# \text{ of cells} = \frac{40000}{88} = 454.5 \approx 455$$

$$\# \text{ of cells} = \frac{40000}{718} = 55.7$$

Q.2 (7 Points IXIXIX2X2)

A 3x3 configuration system contains only 7 cells as shown, $R=1.5Km$, $\gamma=3$.

1- Find the worst case C/I for each cell type.

$$\text{Type 1: } C/I = \frac{9.030}{6.02} \text{ dB.}$$

$$\text{Type 2: } C/I = \frac{6.02}{3.02} \text{ dB.}$$

$$\text{Type 3: } C/I = \frac{9.030}{6.02} \text{ dB.}$$

$$\frac{C}{I} = \frac{\left(\frac{P}{R}\right)^{\gamma}}{\frac{6}{m}} \rightarrow \left(\frac{2R}{R}\right)^2$$

2- Find the worst C/I for a user at 800m from his Base Station and 5200m from the co-channel base station.

$$C/I = \frac{24.38}{21} \text{ dB.}$$

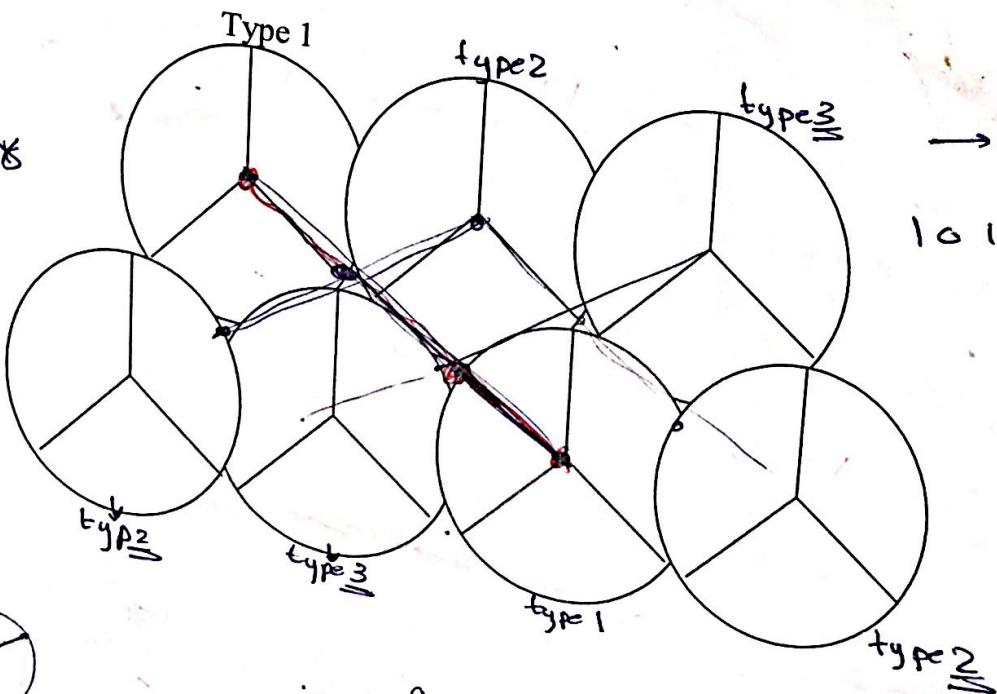
$$10 \log \left(\frac{d_1}{d_2} \right)^{-\gamma}$$

$$10 \log \frac{800^{-3}}{(5200)^{-3}}$$

3- Find the best C/I for a user at 800m from his Base Station and 5700m from the co-channel base station.

$$C/I = \frac{27.294}{24} \text{ dB.}$$

$$10 \log \frac{800^{-3}}{(5700 + 800)}$$



\rightarrow type 2

$10 \log R$

$$10 \log \left(\frac{D_p}{6} \right)^{\gamma} \rightarrow \left(\frac{2R}{R} \right)^2$$

$\rightarrow \gamma = 2$

Q.3 (10 Points 1 each)

1.	Frequency plan reduces the effect of adjacent-channel interference	<input checked="" type="radio"/> T	F
2.	Frequency reuse is implemented by creating full spatial orthogonality.	<input checked="" type="radio"/> T	F
3.	Sectorization increases the Number of Cells for the same C/I.	<input checked="" type="radio"/> T	F
4.	The propagation constant γ depends on the multi-paths in the channel.	<input checked="" type="radio"/> T	F
5.	Increasing the required Channel BW increases the total no of cells.	<input checked="" type="radio"/> T	F
6.	Imperfect frequency Orthogonality causes adjacent channel interference problem.	<input checked="" type="radio"/> T	F
7.	Control Channels are used to update only active users data.	<input checked="" type="radio"/> T	F
8.	Down Telting reduce the co-channel interference and the signal strength from Home Base Station. ↘ ↗	<input checked="" type="radio"/> T	F
9.	Near End Far End problem happens at the cell center.	<input checked="" type="radio"/> T	F
10.	Users near cell center has better C/I.	<input checked="" type="radio"/> T	F

1	0.0	0.00	36	23.35	24.53	71	52.55	54.37
2	0.15	0.21	37	24.15	25.35	72	53.41	55.25
3	0.45	0.59	38	24.95	26.15	73	54.27	56.12
4	0.81	0.99	39	25.75	27.01	74	55.14	57.00
5	1.25	1.50	40	26.55	27.84	75	56.00	57.87
6	1.76	2.05	41	27.35	28.68	76	56.87	58.76
7	2.3	2.63	42	28.22	29.51	77	57.73	59.63
8	2.87	3.25	43	29.02	30.35	78	58.60	60.52
9	3.45	3.88	44	29.84	31.18	79	59.47	61.39
10	4.03	4.52	45	30.67	32.03	80	60.33	62.28
11	4.71	5.21	46	31.48	32.87	81	61.18	63.16
12	5.36	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	7.35	8.02	50	34.81	36.22	85	64.68	66.70
16	8.06	8.77	51	35.58	37.08	86	65.55	67.58
17	8.80	9.51	52	36.42	37.93	87	66.42	68.47
18	9.53	10.25	53	37.26	38.75	88	67.28	69.36
19	10.24	11.01	54	38.10	39.64	89	68.17	70.25
20	10.97	11.77	55	38.94	40.50	90	69.05	71.13
21	11.71	12.53	56	39.78	41.36	91	69.92	72.02
22	12.45	13.30	57	40.63	42.22	92	70.78	72.91
23	13.21	14.08	58	41.47	43.08	93	71.67	73.80
24	13.95	14.85	59	42.32	43.85	94	72.55	74.68
25	14.72	15.65	60	43.16	44.86	95	73.42	75.58
26	15.46	16.44	61	44.01	45.67	96	74.31	76.47
27	16.23	17.23	62	44.86	46.54	97	75.18	77.36
28	17.03	18.03	63	45.71	47.40	98	76.06	78.26
29	17.81	18.83	64	46.56	48.27	99	76.95	78.16
30	18.57	19.62	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	20.93	22.07	68	49.98	51.75	103	80.48	82.73
34	21.75	22.88	69	50.84	52.63	104	81.35	83.62
35	22.55	23.71	70	51.65	53.50	105	82.25	84.52

$$A_{sec} = 19.64 \rightarrow A_{cell} = 5 \times 19.64 = 98.92$$

$$\frac{40000}{58.92} = 679 \text{ cells}$$

$$BP/cell \rightarrow A_{area/cell} = \frac{200000 \times 10^3}{718} \rightarrow \sqrt{\frac{1}{2.6}} = 10.35$$

BP/cell

$$= \frac{200000}{679}$$

micro
18 channels from 273

$$A_{sec} = 9.25$$

$$A_{cell} = 3 \times 9.25$$

~~$$18 \times a = 162 \text{ ch/sec} \quad A_{cell} = 3$$~~

~~$$A_{cell} = 27.75$$~~

~~$$A_{sec} = 9.25 \times 718 = 6641.5$$~~

$$\begin{array}{r} 1000 \\ 480 \\ \hline 1440 \end{array}$$

~~$$\# \text{ of cells} = \frac{40000}{27.75} = 1441.4 = 1442$$~~

$$BP = 2\%$$

$$A_{sec} = 10.25 \rightarrow A_{cell} = 3 \times 10.25$$

$$Q_{\mu} = 1442 \times 9.25$$

18 ① Loss without knife edge $L = 40 + 34 \log(r)$

$$P_t = P_r + G_d - L$$

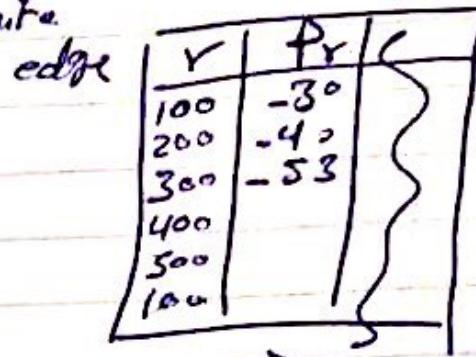
② @ what point you have knife edge

③ calculate L_k

④ $\gamma = ?$

⑤ $G = ?$

⑥ is it realistic? why?



② You have 5 cells, 3x2

(2) voice channel 1 control (Knife edge) تقطيع بسيط

Per Sector

-3°
-53
-4°
-5°

① # of control channel

②

③ $\frac{C}{I}$ min

④ $\frac{C}{I}$ max

density

③ You have 3x3, 66 channel, 1000 user/km², 1500 km²
with 1 control channel per sector

Find γ

18% \rightarrow $\gamma = 10 \log(18)$

① Diversity Solution for fading

② Mobility causes fading

③ γ لـ σ^2

Q.2 (8 Points)

1. For a 3×3 configuration system. Down tilting increases the home signal by 1.5dB and reduces the interference by 1dB each. Find the new C/I.

$$C/I = 3 + 1.5 - 2 \times 1 \text{ dB}$$

$$\frac{C}{I} = \frac{10}{10 - 2} = 1.77 = 2 \text{ dB}$$

2. If a user at 500m from base station has C/I=11dB. What is the C/I for a user at 1000m in the same cell.

$$C/I = 5.5 \text{ dB}$$

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

(1) search network

(2) Authentication

(3) call research

(4) call setup (ring)

(5) call hold (hold)

(6) call drop

(1) search network ✓

(2) authentication ✓

(3) call research

(4) ring ✓

(5) call (hold) ✓

(6) call drop

(1) network search

(2) no work login (authentication)

(3) call request

(4) channel search

(5) call establish

(6) call drop - not always be because

END

2-

$$\frac{C}{I} = \frac{C}{I_{BS}} \text{ OR } \frac{C}{I_{BS}}$$

$$8.4 \text{ dBm } 6.5 \text{ dBm}$$

$$\frac{C}{I} = ?$$

$$\left(\frac{C}{I} = \frac{C}{I_{BS}} + 10 \log \left(\frac{R_1}{R_2} \right) \right)$$

$$= 2 \text{ dB } \angle \text{ m.m}$$

Design a Digital Cellular system for an area of 40000 Km^2 , if the total number of available channels is 287 and 800K subscribers are active at busy hour. If the average call duration is 3 min one control channel per cell, $\gamma=3$ and $\text{BP}=1\%$. Then Find.

Configuration	3x3	7x1
Total No of Cells	6.62 ✓	150.5 ✓
C/I	11.3 ✓	12.05 ✓
Cell radius	4.82 ✓	3.19 ✓

$$A_{cell} = 40 \text{ Kc}$$

$$\text{No. of chan.} = 287$$

$$G_{av} = 800 \text{ Kc}$$

$$J = 5$$

Repeat for $\text{BP}=2\%$.

Configuration	3x3	7x1
Total No of Cells	62.8 ✓	143 ✓
C/I	11.3 ✓	12.05 ✓

$$\# \text{ of cells} = \frac{A_{tot}}{A_{cell}} \rightarrow \frac{40 \text{ Kc}}{6.62} \quad (1) \\ \text{AC/CH} = 21.26 \times 3 = 63.78$$

$$(n \times \text{chan})$$

$$\# \text{ of cell} = \frac{A_{tot}}{A_{cell}} \rightarrow (n \times \text{chan})$$

$$A_{tot} = 40 \text{ Kc}$$

$$N_{sec} = \frac{287 - 3}{9} = 32$$

$$A_{cell} = 20.16 \times 3$$

$$\# \text{ of cell} = 66.2$$

$$I^2 = \frac{(6.62)^2}{6} = \frac{(3 \times 3)^2}{6/1}$$

$$= 10 \log \left(\frac{6.62}{3} \right)$$

$$\rightarrow 11.3$$

$$A_{cell}^{sec} = 2.6 \text{ r}^2 \left(\frac{40000}{66.2} \right)$$

$$= 4.82 \left(\frac{6000}{66.2} \right)$$

$$\# \text{ of cell} = \frac{A_{tot}}{A_{cell}} \quad (7 \times 1)$$

$$A_{tot} = 40 \text{ Kc}$$

$$A_{sec} = \frac{287 - 2}{7} = 40$$

$$\# \text{ of cell} = \frac{40000}{28.58 \times 1}$$

$$= 150.5$$

$$C/I = \frac{(150.5)^2}{6/1} = 12.05$$

$$\# \text{ of cell} = \frac{40000}{27.84 \times 1} = 143$$

$$A_{cell}^{sec} = \frac{26.58}{2.6} = 3.19$$

Q.3 (10 Points 1 each)

1.	Frequency plan reduces the effect of both co-channel and adjacent-channel interference	T	F
2.	Frequency reuse is implemented by creating partial 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.	T	F
6.	You get the message "The phone is unreachable" if it is turned off.	T	F
7.	Control Channels are used to update only active users data.	T	F
8.	Down Telting reduce the co-channel interference and the signal strength from Home Base Station.	T	F
9.	Near End Far End problem happens at the cell center.	T	F
10.	Hand over failure is only due to no available channel in the interred cell.	T	F

1	54.37	55.22	56.12	57.00	57.87	58.76	59.63	60.50	61.38	62.26	63.14	64.02	64.89	65.76	66.64	67.52	68.40	69.28	70.16	71.04	71.92	72.80	73.68	74.56	75.44	76.32	77.20	78.08	78.96	79.84	80.72	81.60	82.48	83.36	84.24	85.12	86.00	86.88	87.76	88.64	89.52	90.40	91.28	92.16	93.04	93.92	94.80	95.68	96.56	97.44	98.32	99.20	100.08	100.96	101.84	102.72	103.60	104.48	105.36	106.24	107.12	108.00	108.88	109.76	110.64	111.52	112.40	113.28	114.16	115.04	115.92	116.80	117.68	118.56	119.44	120.32	121.20	122.08	122.96	123.84	124.72	125.60	126.48	127.36	128.24	129.12	130.00	130.88	131.76	132.64	133.52	134.40	135.28	136.16	137.04	137.92	138.80	139.68	140.56	141.44	142.32	143.20	144.08	144.96	145.84	146.72	147.60	148.48	149.36	150.24	151.12	152.00	152.88	153.76	154.64	155.52	156.40	157.28	158.16	159.04	160.92	161.80	162.68	163.56	164.44	165.32	166.20	167.08	167.96	168.84	169.72	170.60	171.48	172.36	173.24	174.12	175.00	175.88	176.76	177.64	178.52	179.40	180.28	181.16	182.04	182.92	183.80	184.68	185.56	186.44	187.32	188.20	189.08	190.96	191.84	192.72	193.60	194.48	195.36	196.24	197.12	198.00	198.88	199.76	200.64	201.52	202.40	203.28	204.16	205.04	205.92	206.80	207.68	208.56	209.44	210.32	211.20	212.08	212.96	213.84	214.72	215.60	216.48	217.36	218.24	219.12	220.00	220.88	221.76	222.64	223.52	224.40	225.28	226.16	227.04	227.92	228.80	229.68	230.56	231.44	232.32	233.20	234.08	234.96	235.84	236.72	237.60	238.48	239.36	240.24	241.12	242.00	242.88	243.76	244.64	245.52	246.40	247.28	248.16	249.04	250.92	251.80	252.68	253.56	254.44	255.32	256.20	257.08	257.96	258.84	259.72	260.60	261.48	262.36	263.24	264.12	265.00	265.88	266.76	267.64	268.52	269.40	270.28	271.16	272.04	272.92	273.80	274.68	275.56	276.44	277.32	278.20	279.08	280.96	281.84	282.72	283.60	284.48	285.36	286.24	287.12	288.00	288.88	289.76	290.64	291.52	292.40	293.28	294.16	295.04	295.92	296.80	297.68	298.56	299.44	299.92	300.80	301.68	302.56	303.44	304.32	305.20	306.08	306.96	307.84	308.72	309.60	310.48	311.36	312.24	313.12	314.00	314.88	315.76	316.64	317.52	318.40	319.28	320.16	321.04	321.92	322.80	323.68	324.56	325.44	326.32	327.20	328.08	328.96	329.84	330.72	331.60	332.48	333.36	334.24	335.12	336.00	336.88	337.76	338.64	339.52	340.40	341.28	342.16	343.04	343.92	344.80	345.68	346.56	347.44	348.32	349.20	350.08	350.96	351.84	352.72	353.60	354.48	355.36	356.24	357.12	358.00	358.88	359.76	360.64	361.52	362.40	363.28	364.16	365.04	365.92	366.80	367.68	368.56	369.44	370.32	371.20	372.08	372.96	373.84	374.72	375.60	376.48	377.36	378.24	379.12	380.00	380.88	381.76	382.64	383.52	384.40	385.28	386.16	387.04	387.92	388.80	389.68	390.56	391.44	392.32	393.20	394.08	394.96	395.84	396.72	397.60	398.48	399.36	399.92	400.80	401.68	402.56	403.44	404.32	405.20	406.08	406.96	407.84	408.72	409.60	410.48	411.36	412.24	413.12	414.00	414.88	415.76	416.64	417.52	418.40	419.28	420.16	421.04	421.92	422.80	423.68	424.56	425.44	426.32	427.20	428.08	428.96	429.84	430.72	431.60	432.48	433.36	434.24	435.12	436.00	436.88	437.76	438.64	439.52	440.40	441.28	442.16	443.04	443.92	444.80	445.68	446.56	447.44	448.32	449.20	450.08	450.96	451.84	452.72	453.60	454.48	455.36	456.24	457.12	458.00	458.88	459.76	460.64	461.52	462.40	463.28	464.16	465.04	465.92	466.80	467.68	468.56	469.44	470.32	471.20	472.08	472.96	473.84	474.72	475.60	476.48	477.36	478.24	479.12	480.00	480.88	481.76	482.64	483.52	484.40	485.28	486.16	487.04	487.92	488.80	489.68	490.56	491.44	492.32	493.20	494.08	494.96	495.84	496.72	497.60	498.48	499.36	499.92	500.80	501.68	502.56	503.44	504.32	505.20	506.08	506.96	507.84	508.72	509.60	510.48	511.36	512.24	513.12	514.00	514.88	515.76	516.64	517.52	518.40	519.28	520.16	521.04	521.92	522.80	523.68	524.56	525.44	526.32	527.20	528.08	528.96	529.84	530.72	531.60	532.48	533.36	534.24	535.12	536.00	536.88	537.76	538.64	539.52	540.40	541.28	542.16	543.04	543.92	544.80	545.68	546.56	547.44	548.32	549.20	550.08	550.96	551.84	552.72	553.60	554.48	555.36	556.24	557.12	558.00	558.88	559.76	560.64	561.52	562.40	563.28	564.16	565.04	565.92	566.80	567.68	568.56	569.44	570.32	571.20	572.08	572.96	573.84	574.72	575.60	576.48	577.36	578.24	579.12	580.00	580.88	581.76	582.64	583.52	584.40	585.28	586.16	587.04	587.92	588.80	589.68	590.56	591.44	592.32	593.20	594.08	594.96	595.84	596.72	597.60	598.48	599.36	599.92	600.80	601.68	602.56	603.44	604.32	605.20	606.08	606.96	607.84	608.72	609.60	610.48	611.36	612.24	613.12	614.00	614.88	615.76	616.64	617.52	618.40	619.28	620.16	621.04	621.92	622.80	623.68	624.56	625.44	626.32	627.20	628.08	628.96	629.84	630.72	631.60	632.48	633.36	634.24	635.12	636.00	636.88	637.76	638.64	639.52	640.40	641.28	642.16	643.04	643.92	644.80	645.68	646.56	647.44	648.32	649.20	650.08	650.96	651.84	652.72	653.60	654.48	655.36	656.24	657.12	658.00	658.88	659.76	660.64	661.52	662.40	663.28	664.16	665.04	665.92	666.80	667.68	668.56	669.44	670.32	671.20	672.08	672.96	673.84	674.72	675.60	676.48	677.36	678.24	679.12	680.00	680.88	681.76	682.64	683.52	684.40	685.28	686.16	687.04	687.92	688.80	689.68	690.56	691.44	692.32	693.20	694.08	694.96	695.84	696.72	697.60	698.48	699.36	699.92	700.80	701.68	702.56	703.44	704.32	705.20	706.08	706.96	707.84	708.72	709.60	710.48	711.36	712.24	713.12	714.00	714.88	715.76	716.64	717.52	718.40	719.28	720.16	721.04	721.92	722.80	723.68	724.56	725.44	726.32	727.20	728.08	728.96	729.84	730.72	731.60	732.48	733.36	734.24	735.12	736.00	736.88	737.76	738.64	739.52	740.40	741.28	742.16	743.04	743.92	744.80	745.68	746.56	747.44	748.32	749.20	750.08	750.96	751.84	752.72	753.60	754.48	755.36	756.24	757.12	758.00	758.88	759.76	760.64	761.52	762.40	763.28	764.16	765.04	765.92	766.80	767.68	768.56	769.44	770.32	771.20	772.08	772.96	773.84	774.72	775.60	776.48	777.36	778.24	779.12	780.00	780.88	781.76	782.64	783.52	784.40	785.28	786.16	787.04	787.92	788.80	789.68	790.56	791.44	792.32	793.20	794.08	794.96	795.84	796.72	797.60	798.48	799.36	799.92	800.80	801.68	802.56	803.44	804.32	805.20	806.08	806.96	807.84	808.72	809.60	810.48	811.36	812.24	813.12	814.00	814.88	815.76	816.64	817.52	818.40	819.28	820.16	821.04	821.92	822.80	823.68	824.56	825.44	826.32	827.20	828.08	828.96	829.84	830.72	831.60	832.48	833.36	834.24	835.12	836.00	836.88	837.76	838.64	839.52	840.40	841.28	842.16	843.04	843.92	844.80	845.68	846.56	847.44	848.32	849.20	850.08	850.96	851.84	852.72	853.60	854.48	855.36	856.24	857.12	858.00	858.88	859.76	860.64	861.52	862.40	863.28	864.16	865.04	865.92	866.80	867.68	868.56	869.44	870.32	871.20	872.08	872.96	873.84	874.72	875.60	876.48	877.36	878.24	879.12	880.00	880.88	881.76	882.64	883.52	884.40	885.28	886.16	887.04	887.92	888.80	889.68	890.56	891.44	892.32	893.20	894.08	894.96	895.8