UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT NAME	: MOBILE RADIO COMMUNICATION
SUBJECT CODE	: BEP 4273
COURSE	: 4 BEE
EXAMINATION DATE	: APRIL 2009
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER **ALL** QUESTIONS IN SECTION A AND **THREE (3)** QUESTIONS IN SECTION B

THIS QUESTION PAPER CONSISTS OF ELEVEN (11) PAGES

SECTION A

Q1 (a) There are three mobile standards adopted by the International Telecommunication Union (ITU) for the International Mobile Telecommunication – 2000 (IMT-2000). Choose any one of the standard in terms of its migration path, minimum data rate, adopted countries/ region and multiple access technique used.

(4 marks)

(b) General Packet Radio Service (GPRS) provides GSM network with packet data network capabilities. Discuss the advantages of GPRS compared to data service available in the original Global System for Mobile (GSM) service.

(2 marks)

(c) Draw the migration path from 2G GSM to 3G Universal Mobile Telecommunication System (UMTS).

(2 marks)

Q2 (a) Analyze the source and the effect of Co-channel Interference (CCI) and Adjacent Channel Interference (ACI) in cellular design.

(4 marks)

(b) Find the minimum cluster size, N_{min}, for a GSM system with minimum carrier to interference ratio (C/I) of 13 dB. Assume propagation loss constant, $n = 4$, and the mobile is located equidistance from every interfering base station.

(2 marks)

(c) Calculate the Co-channel Reuse Factor (Q) for system in Q2(b).

(2 marks)

Q3 (a) Define the meaning of Doppler Effect.

(2 marks)

(b) Determine the maximum and minimum spectral frequencies received from a stationary GSM transmitter that has a center frequency exactly 1950 MHz . Assuming that the receiver is travelling at speeds of 100 km/hr.

(6 marks)

Q4 (a) Frequency modulation (FM) is the most popular analog modulation technique used in mobile radio systems. Classify two advantages and disadvantages of FM over amplitude modulation (AM).

(4 marks)

(b) Find the first zero crossing RF bandwidth of a rectangular pulse which has $T_S = 41.06\mu s$. Compare this to the bandwidth of a raised cosine filter pulse with $T_s = 41.06\mu s$ and $\alpha = 0.35$.

(4 marks)

Q5 (a) Explain the terms of narrowband and wideband systems that been group in wireless communication system.

(2 marks)

(b) Illustrate the diagram that can show the comparison among frequency division multiple access (FDMA), time division multiple access TDMA and code division multiple access CDMA.

(6 marks)

SECTION B

Q6 (a) Handover or handoff is an important activity in cellular network. Describe THREE (3) common scenarios in GSM system where handoff is executed and list the components involved in each scenarios.

(6 marks)

(b) Mobile Assisted Handover (MAHO) is a technique employed by GSM system to monitor handover process. Discover how this technique works in GSM system.

(3 marks)

(c) Handover requires the cellular network to transfer the call from one radio channel to another radio channel. Point out the steps that should be taken by a mobile network to ensure that each handover is successfully executed and no call is lost during handover process.

(3 marks)

(d) A GSM system with cluster size of four (4) is allocated 8 MHz of frequency bandwidth for its forward channel. The system employs three (3) sectored cells with each sector having roughly the same number of channel. During peak hour, a client is expected to make two (2) calls that lasted for about 100 seconds each and the system is designed for blocking probability of 2% in a block call lost system. Determine,

(i) the number of available physical and logical channel in each sector in each cell ,
(ii) the amount of traffic generated by each client during peak hour , and
(iii) the maximum number of clients that can be serve in one (1) cluster.

(8 marks)

Q7 (a) Explain the following propagation mechanism related to mobile radio propagation.

(i) Reflection
(ii) Diffraction
(iii) Scattering

(6 marks)

(b) Consider the following scenario:

A 30 meter high base station transmits 5 W of signal power using omni-directional antenna with gain of 2.6 dB over a medium. A mobile station, located some distance away from the base station, is receiving signals from the base station with a 2 dB antenna at 1.5 meter height. Operating frequency is at 900 MHz and average noise floor is -110 dBm. Minimum received signal strength at the mobile station shall not fall below -90 dBm for the communication to be established.

(i) Find the maximum distance between the mobile station and the base station.
(ii) Find the signal to noise ratio if the mobile station is located at the distance found in Q(b)(i).
(iii) If the system is designed to provide coverage to an area approximately 1000 km^2, find the minimum number of cell and cluster to provide full coverage to the area. Assume cluster of size of 4 is chosen for the system.

Hata model is given as below:

$$L_{50} = 69.55 + 26.16\log f - 13.82\log h_T - a(h_R) + (44.9 - 6.55\log h_T)\log d$$

with $a(h_R) = (1.1\log f - 0.7)h_R - (1.56\log f - 0.8)$

(12 marks)

(c) Few models are developed to specifically target mobile indoor propagation. Explain why such models are necessary to estimate the propagation loss in the buildings.

(2 marks)

Q8 (a) State why impulse response is useful in channel characterization?

(2 marks)

(b) (i) Prove that a mobile radio channel can be modeled as a linear filter with time varying impulse response, consider the case where time variation is due strictly to receiver motion in space as shown in Figure Q8(b).

(9 marks)

(ii) What you can conclude from your proving in Q(b)(i)?

(3 marks)

(c) Construct a tree structure of FOUR (4) different types of small scale fading.

(6 marks)

Q9 (a) Modulation is the process of encoding information from a message source in a manner suitable for transmission.

(i) Identify modulation scheme used in GSM system.

(4 marks)

(ii) Using suitable figure, analyze technique that can be used to produce the modulation signal.

(4 marks)

(b) Apart from TDMA, GSM also employs slow frequency hopping. Explain why and how it is done.

(4 marks)

(c) TDMA/ Frequency division duplexing (FDD) and TDMA/ Time division duplexing (TDD) are two possible modes of TDMA system. Using suitable figure, compare both systems.

(8 marks)

Q10 (a) Figure Q10(a) shows a power delay profile for a certain outdoor channel. Determine :

(i) The RMS delay spread.
(ii) If BPSK modulation is used, what is the maximum bit rate that can be sent through the channel without needing an equalizer?
(iii) Estimate the 50% coherence bandwidth of the channel.
(iv) Recommend would this channel be suitable for GSM service without the use of equalizer?

Where the mean access delay, excess delay spread and rms delay spread is given as below:-

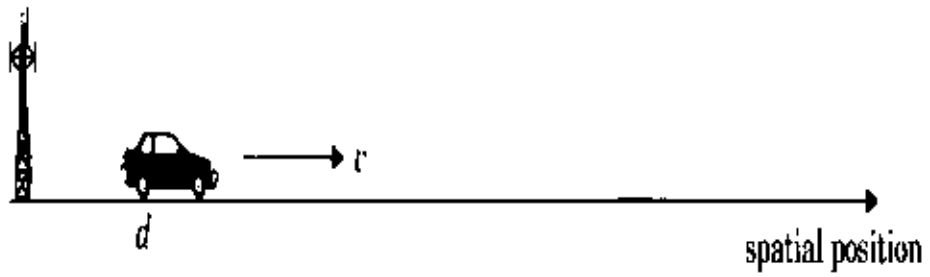
$$\bar{\tau} = \frac{\sum_k a_k^2 \tau_k}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k}{\sum_k P(\tau_k)} \qquad \overline{\tau^2} = \frac{\sum_k a_k^2 \tau_k^2}{\sum_k a_k^2} = \frac{\sum_k P(\tau_k)\tau_k^2}{\sum_k P(\tau_k)} \qquad \sigma_\tau = \sqrt{\overline{\tau^2} - (\bar{\tau})^2}$$

Correlation >0.9, $B_C \approx \frac{1}{50\sigma_\tau}$ and Correlation > 0.5, $B_C \approx \frac{1}{5\sigma_\tau}$

(16 marks)

(b) Find the theoretical maximum data rate that can be supported in a 200 kHz channel for signal-to-noise ratio (SNR) of 10 dB. Compare this value with the actual data rate for GSM system.

(4 marks)



x(t)	*transmitted signal*
y(d,t)	*received signal at position d*
h(d,t)	*channel impulse response*
v	*velocity (assume constant)*
d	*distance (fixed position)*

FIGURE Q8 (b) : Mobile radio channel as a function of time and space

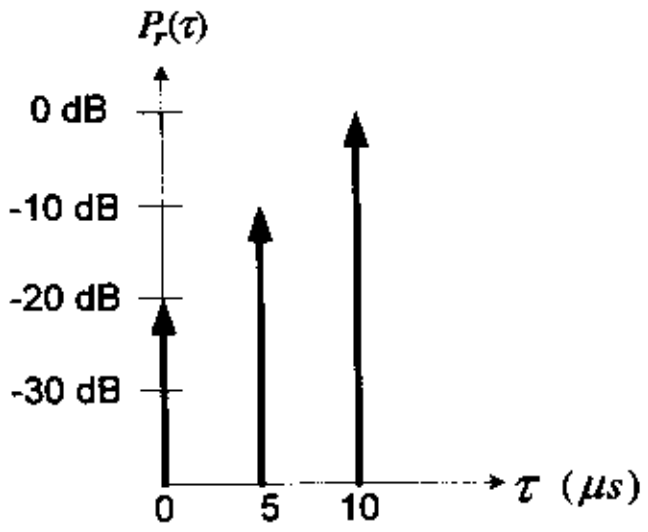


FIGURE Q10(a) : Power Delay Profile

Table I : Erlang B

Erlang B (Blocked Calls Cleared)

No. of Trunks (N)	Traffic (A) in erlangs for P =											
	0.1%	0.2%	0.5%	1%	1.2%	1.5%	1.8%	2%	3%	5%	7%	10%
1	0.001	0.002	0.005	0.010	0.012	0.013	0.02	0.020	0.031	0.053	0.075	0.111
2	0.046	0.065	0.105	0.153	0.168	0.176	0.19	0.223	0.282	0.381	0.470	0.595
3	0.194	0.249	0.349	0.455	0.489	0.505	0.53	0.602	0.715	0.899	1.06	1.27
4	0.439	0.535	0.701	0.869	0.922	0.946	0.99	1.09	1.26	1.52	1.75	2.05
5	0.762	0.900	1.13	1.36	1.43	1.46	1.52	1.66	1.88	2.22	2.50	2.88
6	1.15	1.33	1.62	1.91	2.00	2.04	2.11	2.28	2.54	2.96	3.30	3.76
7	1.58	1.80	2.16	2.50	2.60	2.65	2.73	2.94	3.25	3.74	4.14	4.67
8	2.05	2.31	2.73	3.13	3.25	3.30	3.40	3.63	3.99	4.54	5.00	5.60
9	2.56	2.85	3.33	3.78	3.92	3.98	4.08	4.34	4.75	5.37	5.88	6.55
10	3.09	3.43	3.96	4.46	4.61	4.68	4.80	5.08	5.53	6.22	6.78	7.51
11	3.65	4.02	4.61	5.16	5.32	5.40	5.53	5.84	6.33	7.08	7.69	8.49
12	4.23	4.64	5.28	5.88	6.05	6.14	6.27	6.61	7.14	7.95	8.61	9.47
13	4.83	5.27	5.96	6.61	6.80	6.89	7.03	7.40	7.97	8.83	9.54	10.5
14	5.45	5.92	6.66	7.35	7.56	7.65	7.81	8.20	8.80	9.73	10.5	11.5
15	6.08	6.58	7.38	8.11	8.33	8.43	8.59	9.01	9.65	10.6	11.4	12.5
16	6.72	7.26	8.10	8.88	9.11	9.21	9.39	9.83	10.5	11.5	12.4	13.5
17	7.38	7.95	8.83	9.65	9.89	10.0	10.19	10.7	11.4	12.5	13.4	14.5
18	8.05	8.64	9.58	10.4	10.7	10.8	11.00	11.5	12.2	13.4	14.3	15.5
19	8.72	9.35	10.3	11.2	11.5	11.6	11.82	12.3	13.1	14.3	15.3	16.6
20	9.41	10.1	11.1	12.0	12.3	12.4	12.65	13.2	14.0	15.2	16.3	17.6
21	10.1	10.8	11.9	12.8	13.1	13.3	13.48	14.0	14.9	16.2	17.3	18.7
22	10.8	11.5	12.6	13.7	14.0	14.1	14.32	14.9	15.8	17.1	18.2	19.7
23	11.5	12.3	13.4	14.5	14.8	14.9	15.16	15.8	16.7	18.1	19.2	20.7
24	12.2	13.0	14.2	15.3	15.6	15.8	16.01	16.6	17.6	19.0	20.2	21.8
25	13.0	13.8	15.0	16.1	16.5	16.6	16.87	17.5	18.5	20.0	21.2	22.8
26	13.7	14.5	15.8	17.0	17.3	17.5	17.72	18.4	19.4	20.9	22.2	23.9
27	14.4	15.3	16.6	17.8	18.2	18.3	18.59	19.3	20.3	21.9	23.2	24.9
28	15.2	16.1	17.4	18.6	19.0	19.2	19.45	20.2	21.2	22.9	24.2	26.0
29	15.9	16.8	18.2	19.5	19.9	20.0	20.32	21.0	22.1	23.8	25.2	27.1
30	16.7	17.6	19.0	20.3	20.7	20.9	21.19	21.9	23.1	24.8	26.2	28.1
31	17.4	18.4	19.9	21.2	21.6	21.8	22.07	22.8	24.0	25.8	27.2	29.2
32	18.2	19.2	20.7	22.0	22.5	22.5	22.95	23.7	24.9	26.7	28.2	30.2
33	19.0	20.0	21.5	22.9	23.3	23.5	23.83	24.6	25.8	27.7	29.3	31.3
34	19.7	20.8	22.3	23.8	24.2	24.4	24.72	25.5	26.8	28.7	30.3	32.4
35	20.5	21.6	23.2	24.6	25.1	25.3	25.60	26.4	27.7	29.7	31.3	33.4
36	21.3	22.4	24.0	25.5	26.0	26.2	26.49	27.3	28.6	30.7	32.3	34.5
37	22.1	23.2	24.8	26.4	26.8	27.0	27.39	28.3	29.6	31.6	33.3	35.6
38	22.9	24.0	25.7	27.3	27.7	27.9	28.28	29.2	30.5	32.6	34.4	36.6
39	23.7	24.8	26.5	28.1	28.6	28.8	29.18	30.1	31.5	33.6	35.4	37.7
40	24.4	25.6	27.4	29.0	29.5	29.7	30.08	31.0	32.4	34.6	36.4	38.8
41	25.2	26.4	28.2	29.9	30.4	30.5	30.98	31.9	33.4	35.5	37.4	39.9
42	26.0	27.2	29.1	30.8	31.3	31.5	31.88	32.8	34.3	36.5	38.4	40.9
43	26.8	28.1	29.9	31.7	32.2	32.4	32.79	33.8	35.3	37.6	39.5	42.0
44	27.6	28.9	30.8	32.5	33.1	33.3	33.69	34.7	36.2	38.6	40.5	43.1
45	28.4	29.7	31.7	33.4	34.0	34.2	34.60	35.6	37.2	39.6	41.5	44.2
46	29.3	30.5	32.5	34.3	34.9	35.1	35.51	36.5	38.1	40.5	42.6	45.2
47	30.1	31.4	33.4	35.2	35.8	36.0	36.42	37.5	39.1	41.5	43.6	46.3
48	30.9	32.2	34.2	36.1	36.7	36.9	37.34	38.4	40.0	42.5	44.6	47.4
49	31.7	33.0	35.1	37.0	37.6	37.8	38.25	39.3	41.0	43.5	45.7	48.5
50	32.5	33.9	36.0	37.9	38.5	38.7	39.17	40.3	41.9	44.5	46.7	49.6

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER II/2008/09 COURSE : 4 BEE
SUBJECT NAME : MOBILE RADIO COMMUNICATION SUBJECT CODE : BEP 4273

No. of Trunks (N)	Traffic (A) in erlangs for P =											
	0.1%	0.2%	0.5%	1%	1.2%	1.3%	1.5%	2%	3%	5%	7%	10%
51	33.3	34.7	36.9	38.8	39.4	39.6	40.08	41.2	42.9	45.5	47.7	50.6
52	34.2	35.6	37.7	39.7	40.3	40.6	41.30	42.1	43.9	46.5	48.8	51.7
53	35.0	36.4	38.6	40.6	41.2	41.5	41.92	43.1	44.8	47.5	49.8	52.8
54	35.8	37.2	39.5	41.5	42.1	42.4	42.84	44.0	45.8	48.5	50.8	53.9
55	36.6	38.1	40.4	42.4	43.0	43.3	43.77	44.9	46.7	49.5	51.9	55.0
56	37.5	38.9	41.2	43.3	43.9	44.2	44.69	45.9	47.7	50.5	52.9	56.1
57	38.3	39.8	42.1	44.2	44.8	45.1	45.62	46.8	48.7	51.5	53.9	57.1
58	39.1	40.6	43.0	45.1	45.8	46.1	46.54	47.8	49.8	52.6	55.0	58.2
59	40.0	41.5	43.9	46.0	46.7	47.0	47.47	48.7	50.6	53.6	56.0	59.3
60	40.8	42.4	44.8	46.9	47.6	47.9	48.40	49.6	51.6	54.6	57.1	60.4
61	41.6	43.2	45.6	47.9	48.5	48.8	49.33	50.6	52.5	55.6	58.1	61.5
62	42.5	44.1	46.5	48.8	49.4	49.7	50.26	51.5	53.5	56.6	59.1	62.6
63	43.3	44.9	47.4	48.7	50.4	50.7	51.19	52.5	54.5	57.6	60.2	63.7
64	44.2	45.8	48.3	50.6	51.3	51.6	52.12	53.4	55.4	58.6	61.2	64.8
65	45.0	46.6	49.2	51.5	52.2	52.5	53.05	54.4	56.4	59.6	62.3	65.8
66	45.8	47.5	50.1	52.4	53.1	53.5	53.99	55.3	57.4	60.6	63.3	66.9
67	46.7	48.4	51.0	53.4	54.1	54.4	54.92	56.3	58.4	61.6	64.4	68.0
68	47.5	49.2	51.9	54.3	55.0	55.3	55.86	57.2	59.3	62.6	65.4	69.1
69	48.4	50.1	52.8	55.2	55.9	56.2	56.79	58.2	60.3	63.7	66.4	70.2
70	49.2	51.0	53.7	56.1	56.8	57.2	57.73	59.1	61.3	64.7	67.5	71.3
71	50.1	51.8	54.6	57.0	57.8	58.1	58.67	60.1	62.3	65.7	68.5	72.4
72	50.9	52.7	55.5	58.0	58.7	59.0	59.61	61.0	63.2	66.7	69.6	73.5
73	51.8	53.6	56.4	58.9	59.6	60.0	60.55	62.0	64.2	67.7	70.6	74.6
74	52.7	54.5	57.3	59.8	60.6	60.9	61.49	62.9	65.2	68.7	71.7	75.6
75	53.5	55.3	58.2	60.7	61.5	61.8	62.43	63.9	66.2	69.7	72.7	76.7
76	54.4	56.2	59.1	61.7	62.4	62.8	63.37	64.9	67.2	70.8	73.8	77.8
77	55.2	57.1	60.0	62.6	63.4	63.7	64.32	65.8	68.1	71.8	74.8	78.9
78	56.1	58.0	60.9	63.5	64.3	64.7	65.26	66.8	69.1	72.8	75.9	80.0
79	56.9	58.8	61.8	64.4	65.2	65.6	66.20	67.7	70.1	73.8	76.9	81.1
80	57.8	59.7	62.7	65.4	66.2	66.5	67.15	68.7	71.1	74.8	78.0	82.2
81	58.7	60.6	63.6	66.3	67.1	67.5	68.09	69.6	72.1	75.8	79.0	83.3
82	59.5	61.5	64.5	67.2	68.0	68.4	69.04	70.6	73.0	76.9	80.1	84.4
83	60.4	62.4	65.4	68.2	69.0	69.4	69.99	71.6	74.0	77.9	81.1	85.5
84	61.3	63.2	66.3	69.1	69.9	70.3	70.93	72.5	75.0	78.9	82.2	86.6
85	62.1	64.1	67.2	70.0	70.9	71.2	71.88	73.5	76.0	79.9	83.2	87.7
86	63.0	65.0	68.1	70.9	71.8	72.2	72.83	74.5	77.0	80.9	84.3	88.8
87	63.9	65.9	69.0	71.9	72.7	73.1	73.78	75.4	78.0	82.0	85.3	89.9
88	64.7	66.8	69.9	72.8	73.7	74.1	74.73	76.4	78.9	83.0	86.4	91.0
89	65.6	67.7	70.8	73.7	74.6	75.0	75.68	77.3	79.9	84.0	87.4	92.1
90	66.5	68.6	71.8	74.7	75.6	76.0	76.63	78.3	80.9	85.0	88.5	93.1
91	67.4	69.4	72.7	75.6	76.5	76.9	77.58	79.3	81.9	86.0	89.5	94.2
92	68.2	70.3	73.6	76.6	77.4	77.8	78.53	80.2	82.9	87.1	90.6	95.3
93	69.1	71.2	74.5	77.5	78.4	78.8	79.48	81.2	83.9	88.1	91.6	96.4
94	70.0	72.1	75.4	78.4	79.3	79.7	80.43	82.2	84.9	89.1	92.7	97.5
95	70.9	73.0	76.3	79.4	80.3	80.7	81.39	83.1	85.8	90.1	93.7	98.6
96	71.7	73.9	77.2	80.3	81.2	81.6	82.34	84.1	86.8	91.1	94.8	99.7
97	72.6	74.8	78.2	81.2	82.2	82.6	83.29	85.1	87.8	92.2	95.8	100.8
98	73.5	75.7	79.1	82.2	83.1	83.5	84.25	86.0	88.8	93.2	96.9	101.9
99	74.4	76.6	80.0	83.1	84.1	84.5	85.20	87.0	89.8	94.2	97.9	103.0
100	75.2	77.5	80.9	84.1	85.0	85.4	86.16	88.0	90.8	95.2	99.0	104.1

No. of Trunks (N)	Traffic (A) in erlangs for P =										
	0.1%	0.2%	0.5%	1%	1.2%	1.3%	1.5%	2%	3%	5%	7%	10%
101	78.1	78.4	81.8	85.0	86.0	86.4	87.12	88.9	91.8	96.3	100.0	105.2
102	77.0	79.3	82.7	85.9	86.9	87.3	88.07	89.9	92.8	97.3	101.1	106.3
103	77.9	80.2	83.7	86.9	87.8	88.3	89.03	90.9	93.8	98.3	102.2	107.4
104	78.8	81.1	84.6	87.8	88.8	89.2	89.99	91.9	94.8	99.3	103.2	108.5
105	79.6	82.0	85.5	88.8	89.7	90.2	90.94	92.8	95.7	100.4	104.3	109.6
106	80.5	82.8	86.4	89.7	90.7	91.1	91.90	93.8	96.7	101.4	105.3	110.7
107	81.4	83.7	87.4	90.7	91.6	92.1	92.86	94.8	97.7	102.4	106.4	111.8
108	82.3	84.6	88.3	91.6	92.6	93.1	93.82	95.7	98.7	103.4	107.4	112.9
109	83.2	85.5	89.2	92.5	93.5	94.0	94.78	96.7	99.7	104.5	108.5	114.0
110	84.1	86.4	90.1	93.5	94.5	95.0	95.74	97.7	100.7	105.5	109.5	115.1
111	85.0	87.3	91.0	94.4	95.5	95.9	96.70	98.7	101.7	106.5	110.6	116.2
112	85.8	88.3	92.0	95.4	96.4	96.9	97.66	99.6	102.7	107.5	111.7	117.3
113	86.7	89.2	92.9	96.3	97.4	97.8	98.62	100.6	103.7	108.6	112.7	118.4
114	87.6	90.1	93.8	97.3	98.3	98.8	99.58	101.6	104.7	109.6	113.8	119.5
115	88.5	91.0	94.7	98.2	99.3	99.7	100.54	102.5	105.7	110.6	114.8	120.6
116	89.4	91.9	95.7	99.2	100.2	100.7	101.50	103.5	106.7	111.7	115.9	121.7
117	90.3	92.8	96.6	100.1	101.2	101.7	102.46	104.5	107.7	112.7	116.9	122.8
118	91.2	93.7	97.5	101.1	102.1	102.6	103.43	105.5	108.7	113.7	118.0	123.9
119	92.1	94.6	98.5	102.0	103.1	103.6	104.39	106.4	109.7	114.7	119.1	125.0
120	93.0	95.5	99.4	103.0	104.0	104.5	105.35	107.4	110.7	115.8	120.1	126.1
121	93.9	96.4	100.3	103.9	105.0	105.5	106.31	108.4	111.6	116.8	121.2	127.2
122	94.7	97.3	101.2	104.9	105.9	106.4	107.28	109.4	112.6	117.8	122.2	128.3
123	95.6	98.2	102.2	105.8	106.9	107.4	108.24	110.3	113.6	118.9	123.3	129.4
124	96.5	99.1	103.1	106.8	107.9	108.4	109.21	111.3	114.6	119.9	124.4	130.5
125	97.4	100.0	104.0	107.7	108.8	109.3	110.17	112.3	115.6	120.9	125.4	131.6
126	98.3	100.9	105.0	108.7	109.8	110.3	111.14	113.3	116.6	121.9	126.5	132.7
127	99.2	101.8	105.9	109.6	110.7	111.2	112.10	114.3	117.6	123.0	127.5	133.8
128	100.1	102.8	106.9	110.6	111.7	112.2	113.07	115.2	118.6	124.0	128.6	134.9
129	101.0	103.7	107.8	111.5	112.6	113.2	114.03	116.2	119.6	125.0	129.6	136.0
130	101.9	104.6	108.7	112.5	113.6	114.1	115.00	117.2	120.6	126.1	130.7	137.1
131	102.8	105.5	109.6	113.4	114.6	115.1	115.96	118.2	121.6	127.1	131.8	138.2
132	103.7	106.4	110.6	114.4	115.5	116.0	116.93	119.1	122.6	128.1	132.8	139.3
133	104.6	107.3	111.5	115.3	116.5	117.0	117.90	120.1	123.6	129.2	133.9	140.4
134	105.5	108.2	112.4	116.3	117.4	118.0	118.87	121.1	124.6	130.2	134.9	141.5
135	106.4	109.1	113.3	117.2	118.4	118.9	119.83	122.1	125.6	131.2	136.0	142.6
136	107.3	110.0	114.3	118.2	119.4	119.9	120.80	123.1	126.5	132.2	137.1	143.7
137	108.2	111.0	115.2	119.1	120.3	120.9	121.77	124.0	127.6	133.3	138.1	144.8
138	109.1	111.9	116.2	120.1	121.3	121.8	122.74	125.0	128.6	134.3	139.2	145.9
139	110.0	112.8	117.1	121.0	122.2	122.8	123.71	126.0	129.6	135.3	140.2	147.0
140	110.9	113.7	118.0	122.0	123.2	123.7	124.67	127.0	130.6	136.4	141.3	148.1
141	111.8	114.6	118.9	123.0	124.2	124.7	125.64	128.0	131.6	137.4	142.4	149.2
142	112.7	115.5	120.0	123.9	125.1	125.7	126.66	129.0	132.6	138.5	143.5	150.3
143	113.5	116.3	120.8	124.9	126.1	126.7	127.59	129.9	133.6	139.5	144.5	151.4
144	114.4	117.2	121.8	125.9	127.1	127.6	128.52	130.9	134.6	140.5	145.5	152.5
145	115.3	118.2	122.7	126.8	128.0	128.6	129.54	132.0	135.7	141.6	146.6	153.6
146	116.3	119.2	123.7	127.8	129.0	129.5	130.46	132.9	136.6	142.6	147.6	154.7
147	117.2	120.1	124.6	128.7	129.9	130.5	131.44	133.9	137.6	143.6	148.6	155.8
148	118.1	121.0	125.5	129.6	130.9	131.4	132.38	134.8	138.6	144.7	149.6	156.9
149	119.0	121.9	126.4	130.6	131.8	132.5	133.40	135.8	139.6	145.7	150.8	158.0
150	119.9	122.9	127.4	131.6	132.8	133.4	134.39	136.8	140.7	146.7	151.9	159.1