NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES
SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS, STATISTICS AND ACTUARIAL SCIENCES

QUALIFICATION: BACHELOR OF SCIENCES IN APPLIED MATHEMATICS AND STATISTICS	
QUALIFICATION CODE: 07BAMS	**LEVEL**: 7
COURSE CODE: SMS701S	**COURSE**: SURVEY METHODS AND SAMPLING TECHNIQUES
SESSION: JUNE 2023	**PAPER** : THEORY
DURATION: 3 Hours	**MARKS**: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER	Mr. J. J. SWARTZ
MODERATOR:	Dr. I. NEEMA

INSTRUCTIONS

1. Answer all the questions in the booklet provided
2. Show clearly all the steps used in the calculations.
3. Write clearly and neatly.
4. Number the answers clearly.

PERMISSIBLE MATERIALS

1. Calculator

ATTACHMENTS

1. Normal distribution table
2. T-table
3. Chi-square table

THIS QUESTION PAPER CONSISTS OF 4 PAGES (Including this front page)

Question 1 [25 marks]

1.1 Define the term survey methodology in your own words. [3]

1.2 The Namibia Statistics Agency (NSA) is mandated to conduct annual Labour Force Surveys (NLFS). Describe the basic characteristics of the NLFS in terms of the following:

1.2.1 one of the main objectives of the NLFS
1.2.2 the target population they try to describe
1.2.3 the sources from which they draw samples
1.2.4 the design of the way they sample people
1.2.5 the use of interviewers
1.2.6 the mode of data collection
1.2.7 the use of computers in the collection of responses [7]

1.3 Define the following terms:

1.3.1 A random variable [1]
1.3.2 Sampling unit [1]
1.3.3 Population parameter [1]
1.3.4 Random Sample [1]
1.3.5 Statistical modeling [1]

1.4 Provide a diagrammatically representation of a survey lifecycle from a quality perspective. [10]

Question 2 [25 marks]

2.1 Provide and explain four basic criteria for the acceptability of a sampling method? [8]

2.2 Write at least 4 properties of the normal probability distribution [4]

2.3 Write a short note on the importance of the normal distribution in sampling theory [3]

2.4 The Ministry of Health and Social Services wants to estimate the rate of incidence of respiratory disorders among the middle aged male and female smokers in Namibia. How large a sample should be taken to be 95% confident that the error of estimation of the proportion of the population with such disorders does not exceed 0.05? The true value of p is expected to be near 0.20. [4]

2.5 To estimate the percentage of rats that carries a viral infection which produces a certain sickness, 128 rats are examined and 72 of them are found to be infected. Calculate the standard error of the estimated proportion and compute a 95% confidence interval for the population proportion? [6]

Question 3 [25 marks]

3.1 Distinguish between probability and non-probability sampling in terms of approaches to sampling. [4]

3.2 Consider the population of 32 housing units organised into 8 clusters of 4 housing units in each cluster. A sample of 3 clusters 2, 4, 8 was selected (n = 3) and all housing units within these 3 clusters were interviewed. The sample data collected are as follows.

$y_{21} = 9$ $y_{41} = 6$ $y_{81} = 10$

$y_{22} = 7$ $y_{42} = 5$ $y_{82} = 11$

$y_{23} = 6$ $y_{43} = 8$ $y_{83} = 3$

$y_{24} = 4$ $y_{44} = 9$ $y_{84} = 8$

$y_2 = 26$ $y_4 = 28$ $y_8 = 32$

3.2.1 Estimate Y, population total [4]

3.2.2 Estimate $\bar{y}$, average cluster value of the characteristic [3]

3.2.3 Calculate $\mathrm{Var}(\hat{Y})$ [4]

3.3 Recent census data on the number of cattle per farm are given below: Farms have been stratified based on their total acreage (L=5). The present total number of farms in each stratum is also given in the table.

For a sample of n = 500 farms, compute the sample sizes in each stratum under;

3.3.1 Proportional allocation [5]

3.3.2 Optimal allocation [5]

Stratum	**Previous census**				**Present total number of farms**	**Estimated cost per unit**
		Total number of farms	**Average number of cattle**	**Estimated SD per unit**		
h	**size**	N_h'	$\bar{y}_h'$	s_h'	N_h	c_h
I	0 – 15	625	3.91	4.5	635	3.50
II	16 – 30	564	10.38	7.3	570	2.75
III	31 – 50	476	14.72	9.6	475	2.25
IV	51 – 75	304	21.99	12.2	303	3.00
V	76 - 100	86	27.38	15.8	89	2.50
All strata		2055			2072	

Question 4 [25 marks]

4.1 Coding is a process in which questionnaire entries are assigned numeric values. The objective is to prepare the data in a form suitable for entry into a computer. Provide three alternatives that the coding operation may involve. [6]

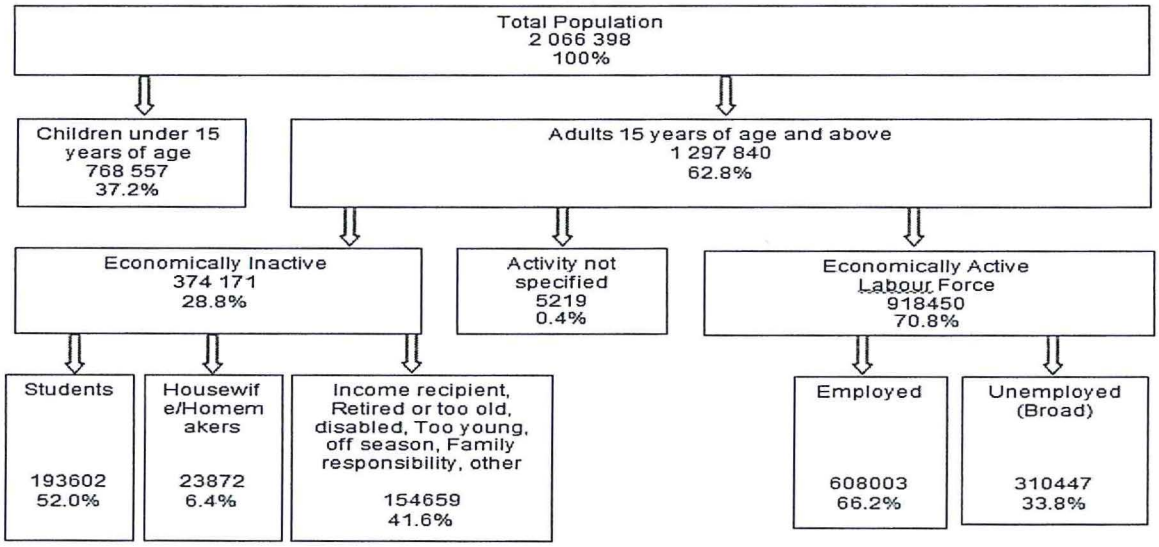
4.2 You have been approached by a client, Namibia Statistics Agency (NSA) to process the LFS 2012 data and are required to estimate the number of working days you will take to enter 10, 000 questionnaires. The following information is provided:

a. 12 x data entry stations
b. 2 x shifts of data entry operators

c. 7 x productive hours per work
d. 12 x operators
e. Average of 8,000 strokes per hour
f. 10,000 questionnaires
g. 2,500 strokes per questionnaires
h. 100 percent verification [9]

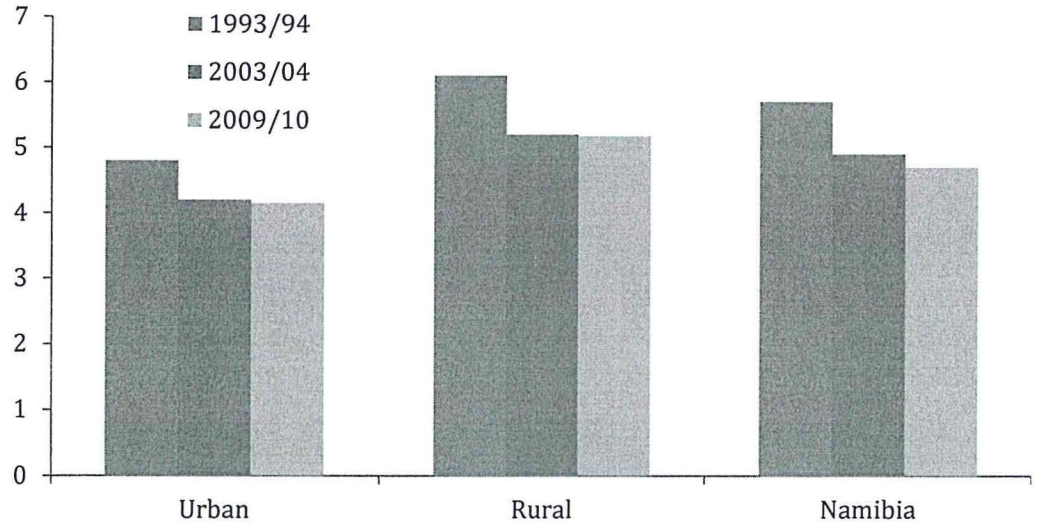
4.3 You were asked by a client to analyze the 2012 Namibia Labour Force Survey data. The following figure and table were produced from the data. Please write a short narrative or interpretation for the figures below on what they are representing.

4.3.1 **Figure 1: Population by activity status**



[5]

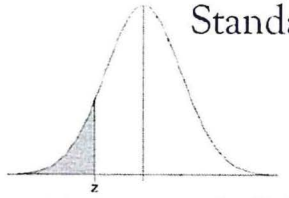
4.3.2 **Figure 1: Average household size by urban/rural areas**



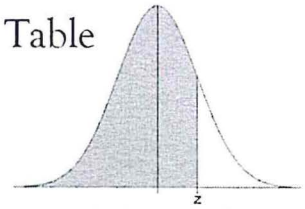
[5]

**********END OF EXAMINATION! **********

Standard Normal Distribution Probabilities Table



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Confidence Interval Critical Values, $z_{\alpha/2}$

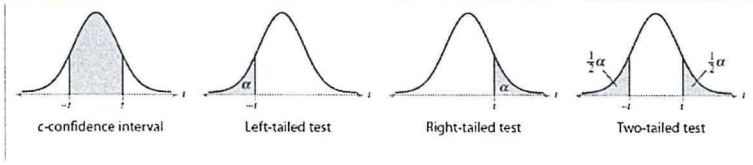
Level of Confidence	Critical Value, $z_{\alpha/2}$
0.90 or 90%	1.645
0.95 or 95%	1.96
0.98 or 98%	2.33
0.99 or 99%	2.575

Hypothesis Testing Critical Values

Level of Significance, α	Left-Tailed	Right-Tailed	Two-Tailed
0.10	− 1.28	1.28	±1.645
0.05	− 1.645	1.645	±1.96
0.01	− 2.33	2.33	±2.575

Student t Distribution Probabilities Table

	one-tail area	0.25	0.125	0.1	0.075	0.05	0.025	0.01	0.005	0.0005
	two-tail area	0.5	0.25	0.2	0.15	0.1	0.05	0.02	0.01	0.001
	confidence level	0.5	0.75	0.8	0.85	0.9	0.95	0.98	0.99	0.999
d.f.	1	1.000	2.414	3.078	4.165	6.314	12.706	31.821	63.657	636.619
	2	0.816	1.604	1.886	2.282	2.920	4.303	6.965	9.925	31.599
	3	0.765	1.423	1.638	1.924	2.353	3.182	4.541	5.841	12.924
	4	0.741	1.344	1.533	1.778	2.132	2.776	3.747	4.604	8.610
	5	0.727	1.301	1.476	1.699	2.015	2.571	3.365	4.032	6.869
	6	0.718	1.273	1.440	1.650	1.943	2.447	3.143	3.707	5.959
	7	0.711	1.254	1.415	1.617	1.895	2.365	2.998	3.499	5.408
	8	0.706	1.240	1.397	1.592	1.860	2.306	2.896	3.355	5.041
	9	0.703	1.230	1.383	1.574	1.833	2.262	2.821	3.250	4.781
	10	0.700	1.221	1.372	1.559	1.812	2.228	2.764	3.169	4.587
	11	0.697	1.214	1.363	1.548	1.796	2.201	2.718	3.106	4.437
	12	0.695	1.209	1.356	1.538	1.782	2.179	2.681	3.055	4.318
	13	0.694	1.204	1.350	1.530	1.771	2.160	2.650	3.012	4.221
	14	0.692	1.200	1.345	1.523	1.761	2.145	2.624	2.977	4.140
	15	0.691	1.197	1.341	1.517	1.753	2.131	2.602	2.947	4.073
	16	0.690	1.194	1.337	1.512	1.746	2.120	2.583	2.921	4.015
	17	0.689	1.191	1.333	1.508	1.740	2.110	2.567	2.898	3.965
	18	0.688	1.189	1.330	1.504	1.734	2.101	2.552	2.878	3.922
	19	0.688	1.187	1.328	1.500	1.729	2.093	2.539	2.861	3.883
	20	0.687	1.185	1.325	1.497	1.725	2.086	2.528	2.845	3.850
	21	0.686	1.183	1.323	1.494	1.721	2.080	2.518	2.831	3.819
	22	0.686	1.182	1.321	1.492	1.717	2.074	2.508	2.819	3.792
	23	0.685	1.180	1.319	1.489	1.714	2.069	2.500	2.807	3.768
	24	0.685	1.179	1.318	1.487	1.711	2.064	2.492	2.797	3.745
	25	0.684	1.198	1.316	1.485	1.708	2.060	2.485	2.787	3.725
	26	0.684	1.177	1.315	1.483	1.706	2.056	2.479	2.779	3.707
	27	0.684	1.176	1.314	1.482	1.703	2.052	2.473	2.771	3.690
	28	0.683	1.175	1.313	1.480	1.701	2.048	2.467	2.763	3.674
	29	0.683	1.174	1.311	1.479	1.699	2.045	2.462	2.756	3.659
	30	0.683	1.173	1.310	1.477	1.697	2.042	2.457	2.750	3.646
	35	0.682	1.170	1.306	1.472	1.690	2.030	2.438	2.724	3.591
	40	0.681	1.167	1.303	1.468	1.684	2.021	2.423	2.704	3.551
	45	0.680	1.165	1.301	1.465	1.679	2.014	2.412	2.690	3.520
	50	0.679	1.164	1.299	1.462	1.676	2.009	2.403	2.678	3.496
	60	0.679	1.162	1.296	1.458	1.671	2.000	2.390	2.660	3.460
	70	0.678	1.160	1.294	1.456	1.667	1.994	2.381	2.648	3.435
	80	0.678	1.159	1.292	1.453	1.664	1.990	2.374	2.639	3.416
	100	0.677	1.157	1.290	1.451	1.660	1.984	2.364	2.626	3.390
	500	0.675	1.152	1.283	1.442	1.648	1.965	2.334	2.586	3.310
	1000	0.675	1.151	1.282	1.441	1.646	1.962	2.330	2.581	3.300
	infinity	0.674	1.150	1.282	1.440	1.645	1.960	2.326	2.576	3.291



Chi Squared (χ^2) Distribution Probabilities

	Area to the Right of Critical Value									
d.f.	0.995	0.99	0.975	0.95	0.9	0.1	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169