UNIVERSITI SAINS MALAYSIA

Kursus Semasa Cuti Panjang
Academic Session 2007/2008

Jun 2008

BOI 109/4 – Biostatistics
[Biostatistik]

Duration: 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains NINE printed pages and ELEVEN Appendixs before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN muka surat dan SEBELAS Lampiran yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer **FIVE** (5) out of **SIX** (6) questions, in English or Bahasa Malaysia. Each question carries 20 marks.

*[**Arahan:** Jawab **LIMA** (5) daripada **ENAM** (6) soalan yang diberikan dalam Bahasa Inggeris atau Bahasa Malaysia. Tiap-tiap soalan bernilai 20 markah.]*

1. A biology student has conducted an experiment on growth of catfish fries in concrete ponds in USM. The body weights (g) of the catfish after 4 months are as follows. Present these data in the form of a histogram. List five (5) most important conclusions or characteristics that can be derived from your histogram in relation to the population of the catfish in the ponds after 4 months.

157	165	200	167	200	185	192	173	174	176	160
203	209	185	163	190	170	174	164	201	181	182
185	169	183	156	168	172	180	170	175	182	175
178	193	183	159	194	191	165	165	196	192	166
150	149	162	189	195	172	166	202	171	190	160
189	177	161	180	177						

(20 marks)

2. [a] Based on Question No. 1 above, conduct a suitable statistical analysis to show that the concrete ponds built by USM student are better than those built by officers in the Fisheries Department who managed to get an average of 169 g of catfish after the same period of time. $\alpha = 0.05$.

(11 marks)

[b] What is the probability in having the weight of a catfish between:

[i] 135 -150 g

(3 marks)

[ii] 190 - 200 g

(3 marks)

[iii] 140 - 190 g

(3 marks)

3. Write an essay on sampling techniques, sizes and errors.

(20 marks)

4. A researcher is trying to investigate whether different feeding methods can affect the life span of the rats. She randomly assigned newborn rats to the three methods understudy: (1) unlimited access of food, (2) 90% of the amount of food that a rat that size would normally eat, (3) 80% of the amount of food that a rat normally would eat. He maintained the rats on three modes of feeding throughout their lives and recorded their life spans (years). The data collected were tabulated below:

Unlimited	90% diet	80% diet
2.5	2.7	3.1
3.1	3.1	2.9
2.3	2.9	3.8
1.9	3.7	3.9
2.4	3.5	4.0

[a] Analyze the data and conclude whether the different mode of feeding has affected the lifespan of the rats.

(12 marks)

[b] Make a recommendation which feeding method would be suitable prolonging the life span of the rats.

(8 marks)

5. A biology student wishes to determine the relationship between temperature and heart rate in the common leopard frog, *Rana pipiens.* He regulates the temperature in 2° increments ranging from 2 to 18 °C and records the heart rate as each interval. His data are presented in the table below:

Temperature (°C)	Heart rate (beats/minute)
2	5
4	11
6	11
8	14
10	22
12	23
14	32
16	29
18	32

[a] Indicate which one is the independent variable and the dependent variable.

(4 marks)

[b] From the above data, construct a scatterplot. Is there a linear relationship between the temperature and the heart rate of the leopard frog?

(5 marks)

[c] Compute the linear equation from these data.

(8 marks)

[d] What is the suitable temperature so as to maintain the heart beat at 20 beats/minute?

(3 marks)

...5/-

6. [a] A new invented drug was suspected to have an effect on the systolic blood pressure especially the women. Table below are the systolic blood pressure of 10 women measured before and after having taken the new drug for a 6-month period. Assuming the systolic blood pressure to be not normally distributed. Using a suitable statistical test to determine whether the new drug did affect the systolic pressure of women.

Woman	Before	After
1	113	118
2	117	123
3	111	114
4	107	115
5	115	122
6	134	140
7	121	120
8	108	105
9	106	111
10	125	129

(10 marks)

[b] Suppose that the same data sets shown below were independent samples taken from two different women population: women not taking the new drug and women taking the new drug for 6-months period. Assuming that the systolic pressure to be not normally distributed. Which type of statistical test would now be appropriate? Analyze that data using the suggested test and determine whether the new drug has affected the systolic blood pressure of the women.

women not taking the new drug	women taking the new drug
113	118
117	123
111	114
107	115
115	122
134	140
121	120
108	105
106	111
125	129

(10 marks)

1. Seorang pelajar biologi telah melakukan satu eksperimen terhadap pertumbuhan anak ikan keli di dalam kolam simen di USM. Berat badan (g) ikan setelah 4 bulan adalah seperti di bawah. Persembahkan data ini dalam bentuk histogram. Senaraikan lima (5) kesimpulan atau ciri paling penting yang boleh diperolehi daripada histogram ini mengenai populasi ikan keli di dalam kolam tersebut setelah 4 bulan.

157	165	200	167	200	185	192	173	174	176	160
203	209	185	163	190	170	174	164	201	181	182
185	169	183	156	168	172	180	170	175	182	175
178	193	183	159	194	191	165	165	196	192	166
150	149	162	189	195	172	166	202	171	190	160
189	177	161	180	177						

(20 markah)

2. [a] Berdasarkan pada Soalan No. 1 di atas, lakukan satu analisis statistik yang sesuai untuk menunjukkan bahawa kolam simen yang dibangunkan oleh pelajar USM adalah lebih baik daripada kolam ikan yang dibangunkan oleh pegawai Jabatan Perikanan yang memperolehi purata 169 g ikan keli setelah jangka masa yang sama. $\alpha = 0.05$.

(11 markah)

[b] Apakah kemungkinan memperolehi berat seekor ikan keli terletak di antara:

[ii] 135 - 150 g

(3 markah)

[ii] 190 - 200 g

(3 markah)

[ii] 140 - 190 g

(3 markah)

3. Tulis satu esei mengenai teknik, saiz dan ralat pensampelan.

(20 markah)

4. Seorang penyelidik cuba menyiasat sama ada cara pemberian makanan yang berbeza boleh mempengaruhi hayat tikus. Beliau mengagih tikus yang baru lahir secara rawak kepada tiga cara memberi makanan: (1) makanan diberi tidak ada had (2) jumlah makanan yang diberi hanya 90% yang biasa dimakan (3) jumlah makanan yang diberi hanya 80% yang biasa dimakan. Beliau mengekalkan tiga cara pemberian makanan sepanjang hayat tikus dan merekodkan panjang hayat (tahun) bagi tikus yang dikaji. Data yang diperolehi adalah seperti berikut:

Tidak terhad	90% makanan	80% makanan
2.5	2.7	3.1
3.1	3.1	2.9
2.3	2.9	3.8
1.9	3.7	3.9
2.4	3.5	4.0

[a] Lakukan analisis data dan simpulkan sama ada cara pemberian makanan yang berbeza telah mempengaruhi panjang hayat tikus-tikus tersebut.

(12 markah)

[b] Cadangkan cara pemberian makanan yang sesuai untuk memanjangkan hayat tikus.

(8 markah)

5. Seorang pelajar Biologi ingin menentukan pertalian antara suhu dan kadar denyutan jantung bagi katak biasa "leopard", *Rana pipiens.* Beliau mengawalatur suhu dengan peningkatan 2°C berjarak daripada 2 hingga 18°C dan merekodkan denyutan jantung setiap jarak suhu. Data dipersembahkan seperti berikut:-

Suhu (°C)	Denyutan Jantung (bilangan dengutan/minit)
2	5
4	11
6	11
8	14
10	22
12	23
14	32
16	29
18	32

[a] Nyatakan yang mana satu pembolehubah tak bersandar dan pembolehubah bersandar.

(4 markah)

[b] Lakarkan satu plot serakan bagi data tersebut. Sebutkan sama ada terdapat pertalian linear antara suhu dan denyutan jantung bagi katak biasa "leopard".

(5 markah)

[c] Dapatkan persamaan regresi linear daripada data tersebut.

(8 markah)

[d] Apakah suhu yang sesuai untuk mengekalkan denyutan jantung pada 20 denyutan/minit?

(3 markah)

6. [a] Satu ubat baru yabg direka disyaki mempengaruhi tekanan darah sistolik terutaman kepada kaum wanita. Jadual berikut adalah tekanan darah sistolik wanita yang ditentukan sebelum dan selepas diberikan ubat baru selama 6 bulan. Andaikan tekanan darah sistolik tidak bertabur secara normal. Gunakan satu ujian statistik yang sesuai untuk menentukan sama ada ubat baru tersebut mempengaruhi tekanan darah sistolik wanita.

Wanita	Sebelum	Selepas
1	113	118
2	117	123
3	111	114
4	107	115
5	115	122
6	134	140
7	121	120
8	108	105
9	106	111
10	125	129

(10 markah)

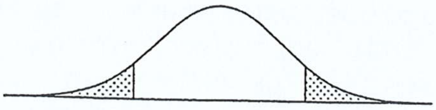
[a] Sekiranya data yang sama berikut adalah sampel-sampel yang diambil daripada dua populasi wanita yang berlainan: wanita yang tidak dirawat ubat dan wanita yang dirawat dengam ubat baru selama 6 bulan. Andaikan tekanan darah sistolik tidak bertabur secara normal. Kini jenis ujian statistik yang mana satu lebih sesuai? Lakukan analisis data dengan mengunakan ujian statistik yang dicadangkan dan menetukan sama ada ubat baru tersebut mempengaruhi tekanan darah sistolik wanita.

women not taking the new drug	women taking the new drug
113	118
117	123
111	114
107	115
115	122
134	140
121	120
108	105
106	111
125	129

(10 markah)

Appendix 1

Student's *t* distribution



1-tail 2-tail	0.25 0.50	0.10 0.20	0.05 0.10	0.025 0.05	0.01 0.02	0.005 0.010	0.0025 0.005	0.001 0.002	0.0005 0.001	1-tail 2-tail
df: 1	1.000	3.078	6.314	12.71	31.82	63.66	127.3	636.6	1273	df: 1
2	0.816	1.886	2.920	4.303	6.965	9.925	14.09	31.60	44.70	2
3	0.765	1.638	2.353	3.182	4.541	5.841	7.453	12.92	16.33	3
4	0.741	1.533	2.132	2.776	3.747	4.604	5.598	8.610	10.31	4
5	0.727	1.476	2.015	2.571	3.365	4.032	4.773	6.869	7.976	5
6	0.718	1.440	1.943	2.447	3.143	3.707	4.317	5.959	6.788	6
7	0.711	1.415	1.895	2.365	2.998	3.499	4.029	5.408	6.082	7
8	0.706	1.397	1.860	2.306	2.896	3.355	3.833	5.041	5.617	8
9	0.703	1.383	1.833	2.262	2.821	3.250	3.690	4.781	5.291	9
10	0.700	1.372	1.812	2.228	2.764	3.169	3.581	4.587	5.049	10
11	0.697	1.363	1.796	2.201	2.718	3.106	3.497	4.437	4.863	11
12	0.695	1.356	1.782	2.179	2.681	3.055	3.428	4.318	4.717	12
13	0.694	1.350	1.771	2.160	2.650	3.012	3.372	4.221	4.597	13
14	0.692	1.345	1.761	2.145	2.624	2.977	3.326	4.140	4.499	14
15	0.691	1.341	1.753	2.131	2.602	2.947	3.286	4.073	4.417	15
16	0.690	1.337	1.746	2.120	2.583	2.921	3.252	4.015	4.346	16
17	0.689	1.333	1.740	2.110	2.567	2.898	3.222	3.965	4.286	17
18	0.688	1.330	1.734	2.101	2.552	2.878	3.197	3.922	4.233	18
19	0.688	1.328	1.729	2.093	2.539	2.861	3.174	3.883	4.187	19
20	0.687	1.325	1.725	2.086	2.528	2.845	3.153	3.850	4.146	20
21	0.686	1.323	1.721	2.080	2.518	2.831	3.135	3.819	4.109	21
22	0.686	1.321	1.717	2.074	2.508	2.819	3.119	3.792	4.077	22
23	0.685	1.319	1.714	2.069	2.500	2.807	3.104	3.768	4.047	23
24	0.685	1.318	1.711	2.064	2.492	2.797	3.091	3.745	4.021	24
25	0.684	1.316	1.708	2.060	2.485	2.787	3.078	3.725	3.997	25
26	0.684	1.315	1.706	2.056	2.479	2.779	3.067	3.707	3.974	26
27	0.684	1.314	1.703	2.052	2.473	2.771	3.057	3.689	3.954	27
28	0.683	1.313	1.701	2.048	2.467	2.763	3.047	3.674	3.935	28
29	0.683	1.311	1.699	2.045	2.462	2.756	3.038	3.660	3.918	29
30	0.683	1.310	1.697	2.042	2.457	2.750	3.030	3.646	3.902	30
31	0.682	1.309	1.696	2.040	2.453	2.744	3.022	3.633	3.887	31
32	0.682	1.309	1.694	2.037	2.449	2.738	3.015	3.622	3.873	32
33	0.682	1.308	1.692	2.035	2.445	2.733	3.008	3.611	3.860	33
34	0.682	1.307	1.691	2.032	2.441	2.728	3.002	3.601	3.848	34
35	0.682	1.306	1.690	2.030	2.438	2.724	2.996	3.591	3.836	35
36	0.681	1.306	1.688	2.028	2.434	2.719	2.990	3.582	3.825	36
37	0.681	1.305	1.687	2.026	2.431	2.715	2.985	3.574	3.816	37
38	0.681	1.304	1.686	2.024	2.429	2.712	2.980	3.566	3.806	38
39	0.681	1.304	1.685	2.023	2.426	2.708	2.976	3.558	3.797	39
40	0.681	1.303	1.684	2.021	2.423	2.704	2.971	3.551	3.788	40
41	0.681	1.303	1.683	2.020	2.421	2.701	2.967	3.544	3.780	41
42	0.680	1.302	1.682	2.018	2.418	2.698	2.963	3.538	3.773	42
43	0.680	1.302	1.681	2.017	2.416	2.695	2.959	3.532	3.765	43
44	0.680	1.301	1.680	2.015	2.414	2.692	2.956	3.526	3.758	44
45	0.680	1.301	1.679	2.014	2.412	2.690	2.952	3.520	3.752	45

Appendix 2

Tables of Distributions and Critical Values

1-tail 2-tail	0.25 0.50	0.10 0.20	0.05 0.10	0.025 0.05	0.01 0.02	0.005 0.010	0.0025 0.005	0.001 0.002	0.0005 0.001	1-tail 2-tail
df: 46	0.680	1.300	1.679	2.013	2.410	2.687	2.949	3.515	3.746	df: 46
47	0.680	1.300	1.678	2.012	2.408	2.685	2.946	3.510	3.740	47
48	0.680	1.299	1.677	2.011	2.407	2.682	2.943	3.505	3.734	48
49	0.680	1.299	1.677	2.010	2.405	2.680	2.940	3.500	3.728	49
50	0.679	1.299	1.676	2.009	2.403	2.678	2.937	3.496	3.723	50
51	0.679	1.298	1.675	2.008	2.402	2.676	2.934	3.492	3.718	51
52	0.679	1.298	1.675	2.007	2.400	2.674	2.932	3.488	3.713	52
53	0.679	1.298	1.674	2.006	2.399	2.672	2.929	3.484	3.709	53
54	0.679	1.297	1.674	2.005	2.397	2.670	2.927	3.480	3.704	54
55	0.679	1.297	1.673	2.004	2.396	2.668	2.925	3.476	3.700	55
56	0.679	1.297	1.673	2.003	2.395	2.667	2.923	3.473	3.696	56
57	0.679	1.297	1.672	2.002	2.394	2.665	2.920	3.469	3.692	57
58	0.679	1.296	1.672	2.002	2.392	2.663	2.918	3.466	3.688	58
59	0.679	1.296	1.671	2.001	2.391	2.662	2.916	3.463	3.684	59
60	0.679	1.296	1.671	2.000	2.390	2.660	2.915	3.460	3.681	60
61	0.679	1.296	1.670	2.000	2.389	2.659	2.913	3.457	3.677	61
62	0.678	1.295	1.670	1.999	2.388	2.657	2.911	3.454	3.674	62
63	0.678	1.295	1.669	1.998	2.387	2.656	2.909	3.452	3.671	63
64	0.678	1.295	1.669	1.998	2.386	2.655	2.908	3.449	3.668	64
65	0.678	1.295	1.669	1.997	2.385	2.654	2.906	3.447	3.665	65
66	0.678	1.295	1.668	1.997	2.384	2.652	2.904	3.444	3.662	66
67	0.678	1.294	1.668	1.996	2.383	2.651	2.903	3.442	3.659	67
68	0.678	1.294	1.668	1.995	2.382	2.650	2.902	3.439	3.656	68
69	0.678	1.294	1.667	1.995	2.382	2.649	2.900	3.437	3.653	69
70	0.678	1.294	1.667	1.994	2.381	2.648	2.899	3.435	3.651	70
71	0.678	1.294	1.667	1.994	2.380	2.647	2.897	3.433	3.648	71
72	0.678	1.293	1.666	1.993	2.379	2.646	2.896	3.431	3.646	72
73	0.678	1.293	1.666	1.993	2.379	2.645	2.895	3.429	3.644	73
74	0.678	1.293	1.666	1.993	2.378	2.644	2.894	3.427	3.641	74
75	0.678	1.293	1.665	1.992	2.377	2.643	2.892	3.425	3.639	75
76	0.678	1.293	1.665	1.992	2.376	2.642	2.891	3.423	3.637	76
77	0.678	1.293	1.665	1.991	2.376	2.641	2.890	3.421	3.635	77
78	0.678	1.292	1.665	1.991	2.375	2.640	2.889	3.420	3.633	78
79	0.678	1.292	1.664	1.990	2.374	2.639	2.888	3.418	3.631	79
80	0.678	1.292	1.664	1.990	2.374	2.639	2.887	3.416	3.629	80
81	0.678	1.292	1.664	1.990	2.373	2.638	2.886	3.415	3.627	81
82	0.677	1.292	1.664	1.989	2.373	2.637	2.885	3.413	3.625	82
83	0.677	1.292	1.663	1.989	2.372	2.636	2.884	3.412	3.623	83
84	0.677	1.292	1.663	1.989	2.372	2.636	2.883	3.410	3.622	84
85	0.677	1.292	1.663	1.988	2.371	2.635	2.882	3.409	3.620	85
86	0.677	1.291	1.663	1.988	2.370	2.634	2.881	3.407	3.618	86
90	0.677	1.291	1.662	1.987	2.368	2.632	2.878	3.402	3.612	90
95	0.677	1.291	1.661	1.985	2.366	2.629	2.874	3.396	3.605	95
100	0.677	1.290	1.660	1.984	2.364	2.626	2.871	3.390	3.598	100
∞	0.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.290	∞

Appendix 3

Tables of Distributions and Critical Values

$P(F_{\nu_1,\nu_2}) \leq 0.95$

ν_2 \ ν_1	1	2	3	4	5	6	7	8	9	10	12	15
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92
50	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.03	1.95	1.87
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84
70	3.98	3.13	2.74	2.50	2.35	2.23	2.14	2.07	2.02	1.97	1.89	1.81
80	3.96	3.11	2.72	2.49	2.33	2.21	2.13	2.06	2.00	1.95	1.88	1.79
90	3.95	3.10	2.71	2.47	2.32	2.20	2.11	2.04	1.99	1.94	1.86	1.78
100	3.94	3.09	2.70	2.46	2.31	2.19	2.10	2.03	1.97	1.93	1.85	1.77
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75
150	3.90	3.06	2.66	2.43	2.27	2.16	2.07	2.00	1.94	1.89	1.82	1.73
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67

Appendix 4

$P(F_{\nu_1,\nu_2}) \leq 0.95$

$\nu_2 \backslash \nu_1$	18	20	24	25	30	40	50	60	90	120	∞
1	247.3	248.0	249.1	249.3	250.1	251.1	251.8	252.2	252.9	253.3	254.3
2	19.44	19.45	19.45	19.46	19.46	19.47	19.48	19.48	19.48	19.49	19.50
3	8.67	8.66	8.64	8.63	8.62	8.59	8.58	8.57	8.56	8.55	8.53
4	5.82	5.80	5.77	5.77	5.75	5.72	5.70	5.69	5.67	5.66	5.63
5	4.58	4.56	4.53	4.52	4.50	4.46	4.44	4.43	4.41	4.40	4.37
6	3.90	3.87	3.84	3.83	3.81	3.77	3.75	3.74	3.72	3.70	3.67
7	3.47	3.44	3.41	3.40	3.38	3.34	3.32	3.30	3.28	3.27	3.23
8	3.17	3.15	3.12	3.11	3.08	3.04	3.02	3.01	2.98	2.97	2.93
9	2.96	2.94	2.90	2.89	2.86	2.83	2.80	2.79	2.76	2.75	2.71
10	2.80	2.77	2.74	2.73	2.70	2.66	2.64	2.62	2.59	2.58	2.54
11	2.67	2.65	2.61	2.60	2.57	2.53	2.51	2.49	2.46	2.45	2.40
12	2.57	2.54	2.51	2.50	2.47	2.43	2.40	2.38	2.36	2.34	2.30
13	2.48	2.46	2.42	2.41	2.38	2.34	2.31	2.30	2.27	2.25	2.21
14	2.41	2.39	2.35	2.34	2.31	2.27	2.24	2.22	2.19	2.18	2.13
15	2.35	2.33	2.29	2.28	2.25	2.20	2.18	2.16	2.13	2.11	2.07
16	2.30	2.28	2.24	2.23	2.19	2.15	2.12	2.11	2.07	2.06	2.01
17	2.26	2.23	2.19	2.18	2.15	2.10	2.08	2.06	2.03	2.01	1.96
18	2.22	2.19	2.15	2.14	2.11	2.06	2.04	2.02	1.98	1.97	1.92
19	2.18	2.16	2.11	2.11	2.07	2.03	2.00	1.98	1.95	1.93	1.88
20	2.15	2.12	2.08	2.07	2.04	1.99	1.97	1.95	1.91	1.90	1.84
21	2.12	2.10	2.05	2.05	2.01	1.96	1.94	1.92	1.88	1.87	1.81
22	2.10	2.07	2.03	2.02	1.98	1.94	1.91	1.89	1.86	1.84	1.78
23	2.08	2.05	2.01	2.00	1.96	1.91	1.88	1.86	1.83	1.81	1.76
24	2.05	2.03	1.98	1.97	1.94	1.89	1.86	1.84	1.81	1.79	1.73
25	2.04	2.01	1.96	1.96	1.92	1.87	1.84	1.82	1.79	1.77	1.71
26	2.02	1.99	1.95	1.94	1.90	1.85	1.82	1.80	1.77	1.75	1.69
27	2.00	1.97	1.93	1.92	1.88	1.84	1.81	1.79	1.75	1.73	1.67
28	1.99	1.96	1.91	1.91	1.87	1.82	1.79	1.77	1.73	1.71	1.65
29	1.97	1.94	1.90	1.89	1.85	1.81	1.77	1.75	1.72	1.70	1.64
30	1.96	1.93	1.89	1.88	1.84	1.79	1.76	1.74	1.70	1.68	1.62
40	1.87	1.84	1.79	1.78	1.74	1.69	1.66	1.64	1.60	1.58	1.51
50	1.81	1.78	1.74	1.73	1.69	1.63	1.60	1.58	1.53	1.51	1.44
60	1.78	1.75	1.70	1.69	1.65	1.59	1.56	1.53	1.49	1.47	1.39
70	1.75	1.72	1.67	1.66	1.62	1.57	1.53	1.50	1.46	1.44	1.35
80	1.73	1.70	1.65	1.64	1.60	1.54	1.51	1.48	1.44	1.41	1.32
90	1.72	1.69	1.64	1.63	1.59	1.53	1.49	1.46	1.42	1.39	1.30
100	1.71	1.68	1.63	1.62	1.57	1.52	1.48	1.45	1.40	1.38	1.28
120	1.69	1.66	1.61	1.60	1.55	1.50	1.46	1.43	1.38	1.35	1.25
150	1.67	1.64	1.59	1.58	1.54	1.48	1.44	1.41	1.36	1.33	1.22
∞	1.60	1.57	1.52	1.51	1.46	1.39	1.35	1.32	1.26	1.22	1.00

Appendix 5

: Tables of Distributions and Critical Values

$P(F_{\nu_1,\nu_2}) \leq 0.99$

ν_2 \ ν_1	1	2	3	4	5	6	7	8	9	10	12	15
1	4052	4999	5404	5624	5764	5859	5928	5981	6022	6056	6107	6157
2	98.50	99.00	99.16	99.25	99.30	99.33	99.36	99.38	99.39	99.40	99.42	99.43
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.34	27.23	27.05	26.87
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.37	14.20
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.89	9.72
6	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.80	3.66
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41
17	8.40	6.11	5.19	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.96	2.81
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.93	2.78
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.90	2.75
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.87	2.73
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52
50	7.17	5.06	4.20	3.72	3.41	3.19	3.02	2.89	2.78	2.70	2.56	2.42
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35
70	7.01	4.92	4.07	3.60	3.29	3.07	2.91	2.78	2.67	2.59	2.45	2.31
80	6.96	4.88	4.04	3.56	3.26	3.04	2.87	2.74	2.64	2.55	2.42	2.27
90	6.93	4.85	4.01	3.53	3.23	3.01	2.84	2.72	2.61	2.52	2.39	2.24
100	6.90	4.82	3.98	3.51	3.21	2.99	2.82	2.69	2.59	2.50	2.37	2.22
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19
150	6.81	4.75	3.91	3.45	3.14	2.92	2.76	2.63	2.53	2.44	2.31	2.16
∞	6.64	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04

$P(F_{\nu_1,\nu_2}) \le 0.99$

$\nu_2 \backslash \nu_1$	18	20	24	25	30	40	50	60	90	120	∞
1	6191	6209	6234	6240	6260	6286	6302	6313	6331	6340	6366
2	99.44	99.45	99.46	99.46	99.47	99.48	99.48	99.48	99.49	99.49	99.50
3	26.75	26.69	26.60	26.58	26.50	26.41	26.35	26.32	26.25	26.22	26.13
4	14.08	14.02	13.93	13.91	13.84	13.75	13.69	13.65	13.59	13.56	13.46
5	9.61	9.55	9.47	9.45	9.38	9.29	9.24	9.20	9.14	9.11	9.02
6	7.45	7.40	7.31	7.30	7.23	7.14	7.09	7.06	7.00	6.97	6.88
7	6.21	6.16	6.07	6.06	5.99	5.91	5.86	5.82	5.77	5.74	5.65
8	5.41	5.36	5.28	5.26	5.20	5.12	5.07	5.03	4.97	4.95	4.86
9	4.86	4.81	4.73	4.71	4.65	4.57	4.52	4.48	4.43	4.40	4.31
10	4.46	4.41	4.33	4.31	4.25	4.17	4.12	4.08	4.03	4.00	3.91
11	4.15	4.10	4.02	4.01	3.94	3.86	3.81	3.78	3.72	3.69	3.60
12	3.91	3.86	3.78	3.76	3.70	3.62	3.57	3.54	3.48	3.45	3.36
13	3.72	3.66	3.59	3.57	3.51	3.43	3.38	3.34	3.28	3.25	3.17
14	3.56	3.51	3.43	3.41	3.35	3.27	3.22	3.18	3.12	3.09	3.00
15	3.42	3.37	3.29	3.28	3.21	3.13	3.08	3.05	2.99	2.96	2.87
16	3.31	3.26	3.18	3.16	3.10	3.02	2.97	2.93	2.87	2.84	2.75
17	3.21	3.16	3.08	3.07	3.00	2.92	2.87	2.83	2.78	2.75	2.65
18	3.13	3.08	3.00	2.98	2.92	2.84	2.78	2.75	2.69	2.66	2.57
19	3.05	3.00	2.92	2.91	2.84	2.76	2.71	2.67	2.61	2.58	2.49
20	2.99	2.94	2.86	2.84	2.78	2.69	2.64	2.61	2.55	2.52	2.42
21	2.93	2.88	2.80	2.79	2.72	2.64	2.58	2.55	2.49	2.46	2.36
22	2.88	2.83	2.75	2.73	2.67	2.58	2.53	2.50	2.43	2.40	2.31
23	2.83	2.78	2.70	2.69	2.62	2.54	2.48	2.45	2.39	2.35	2.26
24	2.79	2.74	2.66	2.64	2.58	2.49	2.44	2.40	2.34	2.31	2.21
25	2.75	2.70	2.62	2.60	2.54	2.45	2.40	2.36	2.30	2.27	2.17
26	2.72	2.66	2.58	2.57	2.50	2.42	2.36	2.33	2.26	2.23	2.13
27	2.68	2.63	2.55	2.54	2.47	2.38	2.33	2.29	2.23	2.20	2.10
28	2.65	2.60	2.52	2.51	2.44	2.35	2.30	2.26	2.20	2.17	2.06
29	2.63	2.57	2.49	2.48	2.41	2.33	2.27	2.23	2.17	2.14	2.03
30	2.60	2.55	2.47	2.45	2.39	2.30	2.25	2.21	2.14	2.11	2.01
40	2.42	2.37	2.29	2.27	2.20	2.11	2.06	2.02	1.95	1.92	1.80
50	2.32	2.27	2.18	2.17	2.10	2.01	1.95	1.91	1.84	1.80	1.68
60	2.25	2.20	2.12	2.10	2.03	1.94	1.88	1.84	1.76	1.73	1.60
70	2.20	2.15	2.07	2.05	1.98	1.89	1.83	1.78	1.71	1.67	1.54
80	2.17	2.12	2.03	2.01	1.94	1.85	1.79	1.75	1.67	1.63	1.49
90	2.14	2.09	2.00	1.99	1.92	1.82	1.76	1.72	1.64	1.60	1.46
100	2.12	2.07	1.98	1.97	1.89	1.80	1.74	1.69	1.61	1.57	1.43
120	2.09	2.03	1.95	1.93	1.86	1.76	1.70	1.66	1.58	1.53	1.38
150	2.06	2.00	1.92	1.90	1.83	1.73	1.66	1.62	1.54	1.49	1.33
∞	1.93	1.88	1.79	1.77	1.70	1.59	1.52	1.47	1.38	1.32	1.00

Critical values for Duncan's multiple range test*

Least significant studentized ranges for testing p successive values out of a linearly ordered arrangement of k sample means from a normal population with ν degrees of freedom.

	$\alpha = 0.05$						$\alpha = 0.01$				
$\nu \backslash p$	2	3	4	5	6	$\nu \backslash p$	2	3	4	5	6
1	17.97	17.97	17.97	17.97	17.97	1	90.03	90.03	90.03	90.03	90.03
2	6.085	6.085	6.085	6.085	6.085	2	14.04	14.04	14.04	14.04	14.04
3	4.501	4.516	4.516	4.516	4.516	3	8.261	8.321	8.321	8.321	8.321
4	3.927	4.013	4.033	4.033	4.033	4	6.512	6.677	6.740	6.756	6.756
5	3.635	3.749	3.797	3.814	3.814	5	5.702	5.893	5.989	6.040	6.065
6	3.461	3.587	3.649	3.680	3.694	6	5.243	5.439	5.549	5.614	5.655
7	3.344	3.477	3.548	3.588	3.611	7	4.949	5.145	5.260	5.334	5.383
8	3.261	3.399	3.475	3.521	3.549	8	4.746	4.939	5.057	5.135	5.189
9	3.199	3.339	3.420	3.470	3.502	9	4.596	4.787	4.906	4.986	5.043
10	3.151	3.293	3.376	3.430	3.465	10	4.482	4.671	4.790	4.871	4.931
11	3.113	3.256	3.342	3.397	3.435	11	4.392	4.579	4.697	4.780	4.841
12	3.082	3.225	3.313	3.370	3.410	12	4.320	4.504	4.622	4.706	4.767
13	3.055	3.200	3.289	3.348	3.389	13	4.260	4.442	4.560	4.644	4.706
14	3.033	3.178	3.268	3.329	3.372	14	4.210	4.391	4.508	4.591	4.654
15	3.014	3.160	3.250	3.312	3.356	15	4.168	4.347	4.463	4.547	4.610
16	2.998	3.144	3.235	3.298	3.343	16	4.131	4.309	4.425	4.509	4.572
17	2.984	3.130	3.222	3.285	3.331	17	4.099	4.275	4.391	4.475	4.539
18	2.971	3.118	3.210	3.274	3.321	18	4.071	4.246	4.362	4.445	4.509
19	2.960	3.107	3.199	3.264	3.311	19	4.046	4.220	4.335	4.419	4.483
20	2.950	3.097	3.190	3.255	3.303	20	4.024	4.197	4.312	4.395	4.459
24	2.919	3.066	3.160	3.226	3.276	24	3.956	4.126	4.239	4.322	4.386
30	2.888	3.035	3.131	3.199	3.250	30	3.889	4.056	4.168	4.250	4.314
40	2.858	3.006	3.102	3.171	3.224	40	3.825	3.988	4.098	4.180	4.244
60	2.829	2.976	3.073	3.143	3.198	60	3.762	3.922	4.031	4.111	4.174
120	2.800	2.947	3.045	3.116	3.172	120	3.702	3.858	3.965	4.044	4.107
∞	2.772	2.918	3.017	3.089	3.146	∞	3.643	3.796	3.900	3.978	4.040

*Reproduced with kind permission from H. Leon Harter and N. Balakrishnan, 1998. *Tables for the Use of Range and Studentized Range in Tests of Hypotheses,* CRC Press, New York, 558–561.

.. Tables of Distributions and Critical Values

Critical values for the Spearman rank correlation coefficient r_s*

2-tail	0.10	0.05	0.02	0.01
1-tail	0.05	0.025	0.01	0.005
n: 4	1.000			
5	0.900	1.000	1.000	
6	0.829	0.886	0.943	1.000
7	0.714	0.786	0.893	0.929
8	0.643	0.738	0.833	0.881
9	0.600	0.700	0.783	0.833
10	0.564	0.648	0.745	0.794
11	0.536	0.618	0.709	0.755
12	0.503	0.587	0.678	0.727
13	0.484	0.560	0.648	0.703
14	0.464	0.538	0.626	0.679
15	0.446	0.521	0.604	0.654
16	0.429	0.503	0.582	0.635
17	0.414	0.485	0.566	0.615
18	0.401	0.472	0.550	0.600
19	0.391	0.460	0.535	0.584
20	0.380	0.447	0.520	0.570
21	0.370	0.435	0.508	0.556
22	0.361	0.425	0.496	0.544
23	0.353	0.415	0.486	0.532
24	0.344	0.406	0.476	0.521
25	0.337	0.398	0.466	0.511
26	0.331	0.390	0.457	0.501
27	0.324	0.382	0.448	0.491
28	0.317	0.375	0.440	0.483
29	0.312	0.368	0.433	0.475
30	0.306	0.362	0.425	0.467

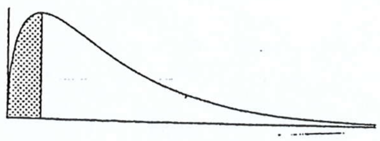
*Reproduced with kind permission from S. Kokoska and D. Zwillinger, 1999. *Probability and Statistics Tables and Formulae,* Chapman & Hall/CRC, Boca Raton, Florida, 188.

Appendix 9

Tables of Distributions and Critical Values

Cumulative chi-square distribution

$$F(\chi^2) = P(\chi^2 \leq X^2)$$



df	0.005	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99	0.995
1	0.0000393	0.000157	0.000982	0.00393	0.0158	2.71	3.84	5.02	6.63	7.88
2	0.0100	0.0201	0.0506	0.103	0.211	4.61	5.99	7.38	9.21	10.6
3	0.0717	0.115	0.216	0.352	0.584	6.25	7.81	9.35	11.3	12.8
4	0.207	0.297	0.484	0.711	1.06	7.78	9.49	11.1	13.3	14.9
5	0.412	0.554	0.831	1.15	1.61	9.24	11.1	12.8	15.1	16.7
6	0.676	0.872	1.24	1.64	2.20	10.6	12.6	14.4	16.8	18.5
7	0.989	1.24	1.69	2.17	2.83	12.0	14.1	16.0	18.5	20.3
8	1.34	1.65	2.18	2.73	3.49	13.4	15.5	17.5	20.1	22.0
9	1.73	2.09	2.70	3.33	4.17	14.7	16.9	19.0	21.7	23.6
10	2.16	2.56	3.25	3.94	4.87	16.0	18.3	20.5	23.2	25.2
11	2.60	3.05	3.82	4.57	5.58	17.3	19.7	21.9	24.7	26.8
12	3.07	3.57	4.40	5.23	6.30	18.5	21.0	23.3	26.2	28.3
13	3.57	4.11	5.01	5.89	7.04	19.8	22.4	24.7	27.7	29.8
14	4.07	4.66	5.63	6.57	7.79	21.1	23.7	26.1	29.1	31.3
15	4.60	5.23	6.26	7.26	8.55	22.3	25.0	27.5	30.6	32.8
16	5.14	5.81	6.91	7.96	9.31	23.5	26.3	28.8	32.0	34.3
17	5.70	6.41	7.56	8.67	10.1	24.8	27.6	30.2	33.4	35.7
18	6.26	7.01	8.23	9.39	10.9	26.0	28.9	31.5	34.8	37.2
19	6.84	7.63	8.91	10.1	11.7	27.2	30.1	32.9	36.2	38.6
20	7.43	8.26	9.59	10.9	12.4	28.4	31.4	34.2	37.6	40.0
21	8.03	8.90	10.3	11.6	13.2	29.6	32.7	35.5	38.9	41.4
22	8.64	9.54	11.0	12.3	14.0	30.8	33.9	36.8	40.3	42.8
23	9.26	10.2	11.7	13.1	14.8	32.0	35.2	38.1	41.6	44.2
24	9.89	10.9	12.4	13.8	15.7	33.2	36.4	39.4	43.0	45.6
25	10.5	11.5	13.1	14.6	16.5	34.4	37.7	40.6	44.3	46.9
26	11.2	12.2	13.8	15.4	17.3	35.6	38.9	41.9	45.6	48.3
27	11.8	12.9	14.6	16.2	18.1	36.7	40.1	43.2	47.0	49.6
28	12.5	13.6	15.3	16.9	18.9	37.9	41.3	44.5	48.3	51.0
29	13.1	14.3	16.0	17.7	19.8	39.1	42.6	45.7	49.6	52.3
30	13.8	15.0	16.8	18.5	20.6	40.3	43.8	47.0	50.9	53.7
31	14.5	15.7	17.5	19.3	21.4	41.4	45.0	48.2	52.2	55.0
32	15.1	16.4	18.3	20.1	22.3	42.6	46.2	49.5	53.5	56.3
33	15.8	17.1	19.0	20.9	23.1	43.7	47.4	50.7	54.8	57.6
34	16.5	17.8	19.8	21.7	24.0	44.9	48.6	52.0	56.1	59.0
35	17.2	18.5	20.6	22.5	24.8	46.1	49.8	53.2	57.3	60.3
36	17.9	19.2	21.3	23.3	25.6	47.2	51.0	54.4	58.6	61.6
37	18.6	20.0	22.1	24.1	26.5	48.4	52.2	55.7	59.9	62.9
38	19.3	20.7	22.9	24.9	27.3	49.5	53.4	56.9	61.2	64.2
39	20.0	21.4	23.7	25.7	28.2	50.7	54.6	58.1	62.4	65.5
40	20.7	22.2	24.4	26.5	29.1	51.8	55.8	59.3	63.7	66.8

TABLE OF CRITICAL VALUES OF T IN THE WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST*

N	Level of significance for one-tailed test		
	.025	.01	.005
	Level of significance for two-tailed test		
	.05	.02	.01
6	0	—	—
7	2	0	—
8	4	2	0
9	6	3	2
10	8	5	3
11	11	7	5
12	14	10	7
13	17	13	10
14	21	16	13
15	25	20	16
16	30	24	20
17	35	28	23
18	40	33	28
19	46	38	32
20	52	43	38
21	59	49	43
22	66	56	49
23	73	62	55
24	81	69	61
25	89	77	68

* Adapted from Table I of Wilcoxon, F. 1949. *Some rapid approximate statistical procedures.* New York: American Cyanamid Company, p. 13, with the kind permission of the author and publisher.

Appendix 11

Critical Value T Table for Wilcoxon Mann-Whitney for two-tail test

n_2=larger sample size	p	n_1=smaller sample size													
		2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	.05			10											
	.01			-											
5	.05		6	11	17										
	.01		-	-	15										
6	.05		7	12	18	26									
	.01		-	10	16	23									
7	.05		7	13	20	27	36								
	.01		-	10	17	24	32								
8	.05	3	8	14	21	29	38	49							
	.01	-	-	11	17	25	34	43							
9	.05	3	8	15	22	31	40	51	63						
	.01	-	6	11	18	26	35	45	56						
10	.05	4	9	15	23	32	42	53	65	78					
	.01	-	6	12	19	27	37	47	58	71					
11	.05	4	9	16	24	34	44	55	68	81	96				
	.01	-	6	12	20	28	38	49	61	74	87				
12	.05	4	10	17	26	35	46	58	71	85	99	115			
	.01	-	7	13	21	30	40	51	63	76	90	106			
13	.05	4	10	18	27	37	48	60	73	88	103	119	137		
	.01	-	7	14	22	31	41	53	65	79	93	109	125		
14	.05	4	11	19	28	38	50	63	76	91	106	123	141	160	
	.01	-	7	14	22	32	43	54	67	81	96	112	129	147	
15	.05	4	11	20	29	40	52	65	79	94	110	127	145	164	185
	.01	-	8	15	23	33	44	56	70	84	99	115	133	151	171
16	.05	4	12	21	31	42	54	67	82	97	114	131	150	169	
	.01	-	8	15	24	34	46	58	72	86	102	119	137	155	
17	.05	5	12	21	32	43	56	70	84	100	117	135	154		
	.01	-	8	16	25	36	47	60	74	89	105	122	140		
18	.05	5	13	22	33	45	58	72	87	103	121	139			
	.01	-	8	16	26	37	49	62	76	92	108	125			
19	.05	5	13	23	34	46	60	74	90	107	124				
	.01	3	9	17	27	38	50	64	78	94	111				
20	.05	5	14	24	35	48	62	77	93	110					
	.01	3	9	18	28	39	52	66	81	97					
21	.05	6	14	25	37	50	64	79	95						
	.01	3	9	18	29	40	53	68	83						
22	.05	6	15	26	38	51	66	82							
	.01	3	10	19	29	42	55	70							
23	.05	6	15	27	39	53	60								
	.01	3	10	19	30	43	57								
24	.05	6	16	28	40	55									
	.01	3	10	20	31	44									
25	.05	6	16	28	42										
	.01	3	11	20	32										
26	.05	7	17	29											
	.01	3	11	21											
27	.05	7	17												
	.01	4	11												
28	.05	7													
	.01	4													

Sumber: Colin White. The use of ranks in a test of significance for comparing two treatments. 1950. Biometrics.

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