UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2000/2001

September/Oktober 2000

BOI 109/4 - Biostatistik

Masa : [3 jam]

Jawab **LIMA** daripada **ENAM** soalan yang diberikan, dalam Bahasa Malaysia.

Tiap-tiap soalan bernilai 20 markah.

ARAHAN: Gunakan kaedah parametrik bagi semua analisis melainkan jika syarat tidak di penuhi.

1. Bagi kedua-dua kes di bawah, huraikan bagaimana anda akan menjalankan kajian berkenaan dan seterusnya huraikan juga kaedah statistik yang sesuai bagi menganalisis data yang akan dihasilkan. Bagi penghuraian statistik, sertakan hipotesis, ujian statistik, nilai genting (kawasan tolak) dan kesimpulan jika H_0 ditolak.

   (a) Anda telah ditugaskan mengkaji hasil 2 varieti kacang soya A dan B. Anda diberi 7 plot tanah, yang tiap satunya mempunyai luas melebihi 2 hektar. Setelah melihat plot-plot tersebut anda merasakan besar kemungkinan keadaan plot-plot ini agak berbeza dan dengan demikian mungkin mempengaruhi hasil kacang soya.

   (10 markah)

   (b) Anda diminta membandingkan kandungan protein di dalam tisu kerang yang dipelihara di Kuala Juru dan Pulau Aman.

   (10 markah)

2. Seorang penyelidik ingin menjalankan kajian mengenai kandungan oksigen terlarut di dalam air laut. Kaedah analisis yang paling sesuai digunakan ialah kaedah Winkler (kimia basah di dalam makmal). Bagi memudahkan kajiannya, penyelidik berhasrat untuk menentukan kandungan oksigen terlarut *in situ* (penentuan terus) dengan menggunakan alat meter DO. Dengan demikian dia perlu memastikan bahawa nilai kandungan oksigen terlarut yang dihasilkan dengan menggunakan alat meter DO menyamai nilai yang dihasilkan melalui kaedah Winkler. Untuk tujuan tersebut penyelidik telah mengenalpasti 12 stesen persampelan dan pada setiap stesen ini, ia mengambil sampel air untuk analisis kandungan oksigen terlarut (dengan kaedah Winkler) serta menentukan kandungan oksigen terlarut dengan menggunakan meter DOnya. Kandungan oksigen terlarut (mg/L) yang diperolehi adalah seperti berikut:

STESEN	Winkler	DO meter		STESEN	Winkler	DO meter
1	6.25	6.31		7	5.08	5.28
2	6.16	5.95		8	6.03	6.03
3	5.48	5.52		9	5.88	5.21
4	5.34	5.53		10	6.39	6.29
5	6.00	6.08		11	5.83	5.95
6	4.54	4.62		12	6.02	6.00

Berasaskan data ini dan dengan menjalankan ujian statistik yang sesuai, tunjukkan sama ada terdapat perbezaan antara nilai kandungan oksigen terlarut yang ditentukan dengan menggunakan kaedah Winkler dan dengan menggunakan alat meter DO. Seterusnya apakah nasihat anda kepada penyelidik mengenai hasratnya untuk menggunakan meter DO bagi penentuan kandungan oksigen terlarut.

(20 markah)

3. Sembilan ekor ikan tilapia jantan dan sembilan ekor tilapia betina telah diberi 3 jenis olahan hormon. Selepas itu kandungan kalsium darah ditentukan dalam unit mg Ca/100 ml darah. Nilai yang didapati adalah seperti berikut.

	Olahan 1	Olahan 2	Olahan 3
	16.87	19.07	32.45
Jantan	16.18	18.77	28.71
	17.12	17.63	34.65
	15.86	17.20	30.54
Betina	14.92	17.64	32.41
	15.63	17.89	29.97

(a) Uji hipotesis yang mengatakan tiada perbezaan kandungan kalsium darah antara 3 olahan hormon ini.

(b) Adakah terdapat perbezaan yang bererti antara kandungan kalsium darah tilapia jantan dan betina?

(20 markah)

4. (a) Semasa menjalankan analisis data kita menggunakan dua nilai iaitu α dan p untuk membuat kesimpulan. Tuliskan ringkasan mengenai dua nilai ini.

(10 markah)

(b) Data berikut menunjukkan bilangan telur dalam satu sarang burung belibis yang dipelihara dan yang liar.

Dipelihara	Liar
10	9
11	8
12	11
11	12
10	10
11	13
11	11
	10
	12

Dengan andaian **data ini datangnya daripada populasi yang tidak bertaburan normal**, jalankan ujian statistik yang sesuai bagi menunjukkan bahawa keadaan kaptiviti (iaitu sama ada dipelihara atau liar) tidak mempengaruhi bilangan telur per sarang burung.

(10 markah)

5. Seorang penyelidik telah mengkaji kandungan fosforus (mg/100g) di dalam 4 jenis organ burung merpati, iaitu jantung, peparu, hati dan ginjal. Penyelidik telah menggunakan 4 ekor burung untuk mendapatkan 4 sampel bagi setiap organ tadi. Kandungan fosforus yang didapati adalah seperti berikut.

Organ	Jantung	Peparu	Hati	Ginjal
Min Kandungan Fosforus	88.8	106.2	199.7	185.6

Penyelidik seterusnya telah memulakan analisis varians, dan memperolehi hasil berikut:

Sumber	SS
Antara Populasi	41880
Dalam Populasi	8210

Teruskan analisis varians ini dan seterusnya jalankan ujian statistik yang sesuai bagi membandingkan kandungan fosforus di dalam 4 jenis organ ini.

(20 markah)

6. Enam belas ekor tikus yang telah diberi sejenis racun mati akibat keracunan ini. Di bawah disertakan berat tikus berserta jangka masa untuk ia mati selepas diberi racun tersebut.

Berat (kg)	Masa untuk mati (jam)
0.66	36
0.63	36
0.60	35
0.67	39
0.64	34
0.59	34
0.71	44
0.75	46
0.64	36
0.75	44
0.61	32
0.55	27
0.46	24
0.50	28
0.61	29
0.54	30

(a) Adakah terdapat pertalian antara berat badan tikus dan jangka masa ia mati setelah diracuni? Apakah jenis pertalian tersebut? Beri alasan anda.

(5 markah)

(b) Tunjukkan pertalian ini dalam bentuk satu persamaan matematik.

(12 markah)

(c) Jika anda mempunyai seekor tikus seberat 0.76 kg, apakah anggaran jangka masa ia akan mati selepas diberi racun tersebut? Adakah anggaran ini baik?

(3 markah)

- oooOooo -

FORMULA YANG MUNGKIN DIPERLUKAN

A. $z = \dfrac{\bar{y} - u_o}{\sigma_{\bar{y}}}$

B. $t = \dfrac{(\bar{y}_1 - \bar{y}_2)}{s\sqrt{(1/n_1) + (1/n_2)}}$

C. $t = \dfrac{(\bar{y}_1 - \bar{y}_2)}{\sqrt{(s_1^2/n_1) + (s_2^2/n_2)}}$

D. $z = \dfrac{y - 0.5n}{\sqrt{0.25n}}$

E. $t = \dfrac{\bar{d}}{s_d/\sqrt{n}}$

F. $s = \sqrt{\dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)\, s_2^2}{n_1 + n_2 - 2}}$

G. $|t'| = \dfrac{(t_1 s_1^2/n_1) + (t_2 s_2^2/n_2)}{(s_1^2/n_1) + (s_2^2/n_2)}$

H. $\chi^2 = \dfrac{\Sigma(n_{ij} - E_{ij})^2}{E_{ij}}$

J. $S_d^2 = \dfrac{1}{n-1}\left[\Sigma d_i^2 - \dfrac{(\Sigma d_i)^2}{n}\right]$

K. Ujian statistik Kruskal - Wallis

1. $H = \dfrac{12}{N(N+1)} \displaystyle\sum_{i=1}^{K} \dfrac{R_i^2}{n_i} - 3(N+1)$

2. $C = 1 - \dfrac{\Sigma T}{N^3 - N}$

3. $\Sigma T = \Sigma(t_i^3 - t_i)$

L. Ujian statistik Friedman

1. $\chi_r^2 = \frac{12}{ba\ (a + 1)} \sum_{i=1}^{a} R_1^2 - 3b\ (a + 1)$

M. Ujian statistik Wilcoxon

1. $\mu_T = \frac{n(n + 1)}{4}$

2. $\sigma_T = \sqrt{\frac{n(n + 1)(2n + 1)}{24}}$

3. $Z = \frac{T - \mu_T}{\sigma_T}$

N. Ujian statistik Mann - Whitney

1. $U = n_1 n_2 + \frac{n_1\ (n_1 + 1)}{2} - R_1$

2. $U' = n_1 n_2 - U$

O. Ujian Blok Rawak:

1. $TSS = \Sigma\Sigma\ Y_{ij}^2 - \frac{G^2}{n}$

2. $SST = \Sigma \frac{Ti^2}{b} - \frac{G^2}{n}$

3. $SSB = \Sigma \frac{B_j^2}{t} - \frac{G^2}{n}$

P. Ujian Segiempat sama Latin

1. $SST = \sum \frac{Ti^2}{t} - \frac{G^2}{n}$

2. $SSR = \sum \frac{R_j^2}{t} - \frac{G^2}{n}$

3. $SSC = \sum \frac{C_k^2}{t} - \frac{G^2}{n}$

Q. Eksperimen Faktoran

1. $SSA = \sum \frac{Ai^2}{n_A} - \frac{G^2}{n}$

2. $SSB = \sum \frac{Bj^2}{n_B} - \frac{G^2}{n}$

3. $\sum\sum \frac{(AB)_{ij}^2}{n_{AB}} - SSA - SSB - \frac{G^2}{n} = SSAB$

R. Ujian Sepenuh rawak:

1. $SSB = \sum \frac{Ti^2}{n_i} - \frac{G^2}{n}$

S. Regresi

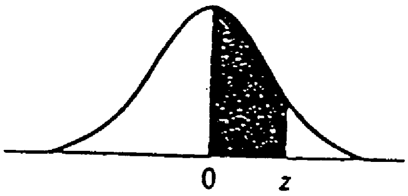
$SS_{xx} = \sum x^2 - \frac{(\sum x)^2}{n}$ $\qquad SS_{xy} = \sum xy - \frac{\sum x \sum y}{n}$

$r = \frac{SS_{xy}}{\sqrt{SS_{xx}\, SS_{yy}}}$ $\qquad \frac{SS_{xy}}{SS_{xx}}$

T. Perbandingan berganda:

$LSD = t_{\alpha/2} \sqrt{s_w^2 \left(\frac{1}{n_i} + \frac{1}{n_j}\right)}$ $\qquad Wr = q'_\alpha (r, v) \sqrt{\frac{sw^2}{n}}$

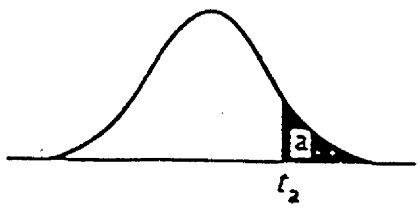
Jadual 1: Keluasan Lengkung Normal



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

This table is abridged from Table I of *Statistical Tables and Formulas*, by A. Hald (New York: John Wiley & Sons, 1952). Reproduced by permission of A. Hald and the publishers, John Wiley & Sons.

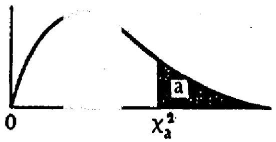
Jadual 2: Titik Peratusan Taburan t



df	a = .10	a = .05	a = .025	a = .010	a = .005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
inf.	1.282	1.645	1.960	2.326	2.576

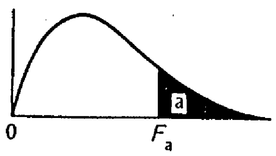
From "Table of Percentage Points of the *t*-distribution." Computed by Maxine Merrington, *Biometrika*, Vol. 32 (1941), p. 300. Reproduced by permission of the *Biometrika* Trustees.

Jadual 3: Titik Peratusan Tab... ki-gandadua



df	a = .995	a = .9[illegible]	a = .975	a = .950	a = .900	a = .10	a = .05	a = .025	a = .010	a = .005	df
1	0.0000393	0.0001[illegible]	0.0009821	0.0039321	0.0157908	2.70554	3.84146	5.02389	6.63490	7.87944	1
2	0.0100251	0.0201[illegible]	0.0506356	0.102587	0.210720	4.60517	5.99147	7.37776	9.21034	10.5966	2
3	0.0717212	0.1148[illegible]	0.215795	0.351846	0.584375	6.25139	7.81473	9.34840	11.3449	12.8381	3
4	0.206990	0.2971[illegible]	0.484419	0.710721	1.063623	7.77944	9.48773	11.1433	13.2767	14.8602	4
5	0.411740	0.5543[illegible]	0.831211	1.145476	1.61031	9.23635	11.0705	12.8325	15.0863	16.7496	5
6	0.675727	0.8720[illegible]	1.237347	1.63539	2.20413	10.6446	12.5916	14.4494	16.8119	18.5476	6
7	0.989265	1.2390[illegible]	1.68987	2.16735	2.83311	12.0170	14.0671	16.0128	18.4753	20.2777	7
8	1.344419	1.6464[illegible]	2.17973	2.73264	3.48954	13.3616	15.5073	17.5346	20.0902	21.9550	8
9	1.734926	2.08791	2.70039	3.32511	4.16816	14.6837	16.9190	19.0228	21.6660	23.5893	9
10	2.15585	2.55821	3.24697	3.94030	4.86518	15.9871	18.3070	20.4831	23.2093	25.1882	10
11	2.60321	3.05347	3.81575	4.57481	5.57779	17.2750	19.6751	21.9200	24.7250	26.7569	11
12	3.07382	3.57056	4.40379	5.22603	6.30380	18.5494	21.0261	23.3367	26.2170	28.2995	12
13	3.56503	4.10691	5.00874	5.89186	7.04150	19.8119	22.3621	24.7356	27.6883	29.8194	13
14	4.07468	4.66043	5.62872	6.57063	7.78953	21.0642	23.6848	26.1190	29.1413	31.3193	14
15	4.60094	5.22935	6.26214	7.26094	8.54675	22.3072	24.9958	27.4884	30.5779	32.8013	15
16	5.14224	5.81221	6.90766	7.96164	9.31223	23.5418	26.2962	28.8454	31.9999	34.2672	16
17	5.69724	6.40776	7.56418	8.67176	10.0852	24.7690	27.5871	30.1910	33.4087	35.7185	17
18	6.26481	7.01491	8.23075	9.39046	10.8649	25.9894	28.8693	31.5264	34.8053	37.1564	18
19	6.84398	7.63273	8.90655	10.1170	11.6509	27.2036	30.1435	32.8523	36.1908	38.5822	19
20	7.43386	8.26040	9.59083	10.8508	12.4426	28.4120	31.4104	34.1696	37.5662	39.9968	20
21	8.03366	8.89720	10.28293	11.5913	13.2396	29.6151	32.6705	35.4789	38.9321	41.4010	21
22	8.64272	9.54249	10.9823	12.3380	14.0415	30.8133	33.9244	36.7807	40.2894	42.7956	22
23	9.26042	10.19567	1.6885	13.0905	14.8479	32.0069	35.1725	38.0757	41.6384	44.1813	23
24	9.88623	10.8564	2.4011	13.8484	15.6587	33.1963	36.4151	39.3641	42.9798	45.5585	24
25	10.5197	11.5240	3.1197	14.6114	16.4734	34.3816	37.6525	40.6465	44.3141	46.9278	25
26	11.1603	12.1981	3.8439	15.3791	17.2919	35.5631	38.8852	41.9232	45.6417	48.2899	26
27	11.8076	12.8786	4.5733	16.1513	18.1138	36.7412	40.1133	43.1944	46.9630	49.6449	27
28	12.4613	13.5648	5.3079	16.9279	18.9392	37.9159	41.3372	44.4607	48.2782	50.9933	28
29	13.1211	14.2565	6.0471	17.7083	19.7677	39.0875	42.5569	45.7222	49.5879	52.3356	29
30	13.7867	14.9535	6.7908	18.4926	20.5992	40.2560	43.7729	46.9792	50.8922	53.6720	30
40	20.7065	22.1643	4.4331	26.5093	29.0505	51.8050	55.7585	59.3417	63.6907	66.7659	40
50	27.9907	29.7067	2.3574	34.7642	37.6886	63.1671	67.5048	71.4202	76.1539	79.4900	50
60	35.5346	37.4848	0.4817	43.1879	46.4589	74.3970	79.0819	83.2976	88.3794	91.9517	60
70	43.2752	45.4418	8.7576	51.7393	55.3290	85.5271	90.5312	95.0231	100.425	104.215	70
80	51.1720	53.5400	7.1532	60.3915	64.2778	96.5782	101.879	106.629	112.329	116.321	80
90	59.1963	61.7541	5.6466	69.1260	73.2912	107.565	113.145	118.136	124.116	128.299	90
100	67.3276	70.0648	4.2219	77.9295	82.3581	118.498	124.342	129.561	135.807	140.169	100

Jadual 4: Titik Peratusan Taburan F



Degrees of freedom (a = .05)

df_2 \ df_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞	df_1 / df_2
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	248.0	249.1	250.1	251.1	252.2	253.3	254.3	1
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	19.45	19.45	19.46	19.47	19.48	19.49	19.50	2
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	8.66	8.64	8.62	8.59	8.57	8.55	8.53	3
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	5.80	5.77	5.75	5.72	5.69	5.66	5.63	4
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	4.56	4.53	4.50	4.46	4.43	4.40	4.36	5
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	3.87	3.84	3.81	3.77	3.74	3.70	3.67	6
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	3.44	3.41	3.38	3.34	3.30	3.27	3.23	7
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	3.15	3.12	3.08	3.04	3.01	2.97	2.93	8
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.11	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71	9
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	2.77	2.74	2.70	2.66	2.62	2.58	2.54	10
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	2.65	2.61	2.57	2.53	2.49	2.45	2.40	11
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	2.54	2.51	2.47	2.43	2.38	2.34	2.30	12
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	2.46	2.42	2.38	2.34	2.30	2.25	2.21	13
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	2.39	2.35	2.31	2.27	2.22	2.18	2.13	14
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	2.33	2.29	2.25	2.20	2.16	2.11	2.07	15
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	2.28	2.24	2.19	2.15	2.11	2.06	2.01	16
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	2.23	2.19	2.15	2.10	2.06	2.01	1.96	17
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	2.19	2.15	2.11	2.06	2.02	1.97	1.92	18
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	2.16	2.11	2.07	2.03	1.98	1.93	1.88	19
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	2.12	2.08	2.04	1.99	1.95	1.90	1.84	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	2.10	2.05	2.01	1.96	1.92	1.87	1.81	21
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	2.07	2.03	1.98	1.94	1.89	1.84	1.78	22
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	2.05	2.01	1.96	1.91	1.86	1.81	1.76	23
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	2.03	1.98	1.94	1.89	1.84	1.79	1.73	24
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	2.01	1.96	1.92	1.87	1.82	1.77	1.71	25
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	1.99	1.95	1.90	1.85	1.80	1.75	1.69	26
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	1.97	1.93	1.88	1.84	1.79	1.73	1.67	27
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	1.96	1.91	1.87	1.82	1.77	1.71	1.65	28
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	1.94	1.90	1.85	1.81	1.75	1.70	1.64	29
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	1.93	1.89	1.84	1.79	1.74	1.68	1.62	30
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	1.84	1.79	1.74	1.69	1.64	1.58	1.51	40
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	1.75	1.70	1.65	1.59	1.53	1.47	1.39	60
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25	120
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00	∞

From "Tables of Percentage Points of the Inverted Beta (*F*)-Distribution," *Biometrika*, Vol. 33 (1943), pp. 73–88, by Maxine Merrington and Catherine M. Thompson. Reproduced by permission of the *Biometrika* Trustees.

Jadual 5 Titik Peratusan bagi Ujian Julat Berganda Baru Duncan

Error		r = number of ordered steps between means													
df	α	2	3	4	5	6	7	8	9	10	12	14	16	18	20
1	.05	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	.01	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
2	.05	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09	6.09
	.01	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
3	.05	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
	.01	8.26	8.5	8.6	8.7	8.8	8.9	8.9	9.0	9.0	9.0	9.1	9.2	9.3	9.3
4	.05	3.93	4.01	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02	4.02
	.01	6.51	6.8	6.9	7.0	7.1	7.1	7.2	7.2	7.3	7.3	7.4	7.4	7.5	7.5
5	.05	3.64	3.74	3.79	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
	.01	5.70	5.96	6.11	6.18	6.26	6.33	6.40	6.44	6.5	6.6	6.6	6.7	6.7	6.8
6	.05	3.46	3.58	3.64	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68	3.68
	.01	5.24	5.51	5.65	5.73	5.81	5.88	5.95	6.00	6.0	6.1	6.2	6.2	6.3	6.3
7	.05	3.35	3.47	3.54	3.58	3.60	3.61	3.61	3.61	3.61	3.61	3.61	3.61	3.61	3.61
	.01	4.95	5.22	5.37	5.45	5.53	5.61	5.69	5.73	5.8	5.8	5.9	5.9	6.0	6.0
8	.05	3.26	3.39	3.47	3.52	3.55	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
	.01	4.74	5.00	5.14	5.23	5.32	5.40	5.47	5.51	5.5	5.6	5.7	5.7	5.8	5.8
9	.05	3.20	3.34	3.41	3.47	3.50	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
	.01	4.60	4.86	4.99	5.08	5.17	5.25	5.32	5.36	5.4	5.5	5.5	5.6	5.7	5.7
10	.05	3.15	3.30	3.37	3.43	3.46	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.47	3.48
	.01	4.48	4.73	4.88	4.96	5.06	5.13	5.20	5.24	5.28	5.36	5.42	5.48	5.54	5.55
11	.05	3.11	3.27	3.35	3.39	3.43	3.44	3.45	3.46	3.46	3.46	3.46	3.46	3.47	3.48
	.01	4.39	4.63	4.77	4.86	4.94	5.01	5.06	5.12	5.15	5.24	5.28	5.34	5.38	5.39
12	.05	3.08	3.23	3.33	3.36	3.40	3.42	3.44	3.44	3.46	3.46	3.46	3.46	3.47	3.48
	.01	4.32	4.55	4.68	4.76	4.84	4.92	4.96	5.02	5.07	5.13	5.17	5.22	5.23	5.26
13	.05	3.06	3.21	3.30	3.35	3.38	3.41	3.42	3.44	3.45	3.45	3.46	3.46	3.47	3.47
	.01	4.26	4.48	4.62	4.69	4.74	4.84	4.88	4.94	4.98	5.04	5.08	5.13	5.14	5.15
14	.05	3.03	3.18	3.27	3.33	3.37	3.39	3.41	3.42	3.44	3.45	3.46	3.46	3.47	3.47
	.01	4.21	4.42	4.55	4.63	4.70	4.78	4.83	4.87	4.91	4.96	5.00	5.04	5.06	5.07
15	.05	3.01	3.16	3.25	3.31	3.36	3.38	3.40	3.42	3.43	3.44	3.45	3.46	3.47	3.47
	.01	4.17	4.37	4.50	4.58	4.64	4.72	4.77	4.81	4.84	4.90	4.94	4.97	4.99	5.00
16	.05	3.00	3.15	3.23	3.30	3.34	3.37	3.39	3.41	3.43	3.44	3.45	3.46	3.47	3.47
	.01	4.13	4.34	4.45	4.54	4.60	4.67	4.72	4.76	4.79	4.84	4.88	4.91	4.93	4.94
17	.05	2.98	3.13	3.22	3.28	3.33	3.36	3.38	3.40	3.42	3.44	3.45	3.46	3.47	3.47
	.01	4.10	4.30	4.41	4.50	4.56	4.63	4.68	4.72	4.75	4.80	4.83	4.86	4.88	4.89
18	.05	2.97	3.12	3.21	3.27	3.32	3.35	3.37	3.39	3.41	3.43	3.45	3.46	3.47	3.47
	.01	4.07	4.27	4.38	4.46	4.53	4.59	4.64	4.68	4.71	4.76	4.79	4.82	4.84	4.85
19	.05	2.96	3.11	3.19	3.26	3.31	3.35	3.37	3.39	3.41	3.43	3.44	3.46	3.47	3.47
	.01	4.05	4.24	4.35	4.43	4.50	4.56	4.61	4.64	4.67	4.72	4.76	4.79	4.81	4.82
20	.05	2.95	3.10	3.18	3.25	3.30	3.34	3.36	3.38	3.40	3.43	3.44	3.46	3.46	3.47
	.01	4.02	4.22	4.33	4.40	4.47	4.53	4.58	4.61	4.65	4.69	4.73	4.76	4.78	4.79
22	.05	2.93	3.08	3.17	3.24	3.29	3.32	3.35	3.37	3.39	3.42	3.44	3.45	3.46	3.47
	.01	3.99	4.17	4.28	4.36	4.42	4.48	4.53	4.57	4.60	4.65	4.68	4.71	4.74	4.75
24	.05	2.92	3.07	3.15	3.22	3.28	3.31	3.34	3.37	3.38	3.41	3.44	3.45	3.46	3.47
	.01	3.96	4.14	4.24	4.33	4.39	4.44	4.49	4.53	4.57	4.62	4.64	4.67	4.70	4.72
26	.05	2.91	3.06	3.14	3.21	3.27	3.30	3.34	3.36	3.38	3.41	3.43	3.45	3.46	3.47
	.01	3.93	4.11	4.21	4.30	4.36	4.41	4.46	4.50	4.53	4.58	4.62	4.65	4.67	4.69
28	.05	2.90	3.04	3.13	3.20	3.26	3.30	3.33	3.35	3.37	3.40	3.43	3.45	3.46	3.47
	.01	3.91	3.08	4.18	4.28	4.34	4.39	4.43	4.47	4.51	4.56	4.60	4.62	4.65	4.67
30	.05	2.89	3.04	3.12	3.20	3.25	3.29	3.32	3.35	3.37	3.40	3.43	3.44	3.46	3.47
	.01	3.89	4.06	4.16	4.22	4.32	4.36	4.41	4.45	4.48	4.54	4.58	4.61	4.63	4.65
40	.05	2.86	3.01	3.10	3.17	3.22	3.27	3.30	3.33	3.35	3.39	3.42	3.44	3.46	3.47
	.01	3.82	3.99	4.10	4.17	4.24	4.30	4.34	4.37	4.41	4.46	4.51	4.54	4.57	4.59
60	.05	2.83	2.98	3.08	3.14	3.20	3.24	3.28	3.31	3.33	3.37	3.40	3.43	3.45	3.47
	.01	3.76	3.92	4.03	4.12	4.17	4.23	4.27	4.31	4.34	4.39	4.44	4.47	4.50	4.53
100	.05	2.80	2.95	3.05	3.12	3.18	3.22	3.26	3.29	3.32	3.36	3.40	3.42	3.45	3.47
	.01	3.71	3.86	3.93	4.06	4.11	4.17	4.21	4.25	4.29	4.35	4.38	4.42	4.45	4.48
∞	.05	2.77	2.92	3.02	3.09	3.15	3.19	3.23	3.26	3.29	3.34	3.38	3.41	3.44	3.47
	.01	3.64	3.80	3.90	3.98	4.04	4.09	4.14	4.17	4.20	4.26	4.31	4.34	4.38	4.41

Jadual 6 : Nilai Genting bagi Ujian Pangkat Bertanda Wilcoxon

n = 5(1)50

One-sided	*Two-sided*	*n* = 5	*n* = 6	*n* = 7	*n* = 8	*n* = 9	*n* = 10	*n* = 11	*n* = 12	*n* = 13	*n* = 14	*n* = 15	*n* = 16
.05	.10	1	2	4	6	8	11	14	17	21	26	30	36
.025	.05		1	2	4	6	8	11	14	17	21	25	30
.01	.02			0	2	3	5	7	10	13	16	20	24
.005	.01				0	2	3	5	7	10	13	16	19

One-sided	*Two-sided*	*n* = 17	*n* = 18	*n* = 19	*n* = 20	*n* = 21	*n* = 22	*n* = 23	*n* = 24	*n* = 25	*n* = 26	*n* = 27	*n* = 28
.05	.10	41	47	54	60	68	75	83	92	101	110	120	130
.025	.05	35	40	46	52	59	66	73	81	90	98	107	117
.01	.02	28	33	38	43	49	56	62	69	77	85	93	102
.005	.01	23	28	32	37	43	49	55	61	68	76	84	92

One-sided	*Two-sided*	*n* = 29	*n* = 30	*n* = 31	*n* = 32	*n* = 33	*n* = 34	*n* = 35	*n* = 36	*n* = 37	*n* = 38	*n* = 39
.05	.10	141	152	163	175	188	201	214	228	242	256	271
.025	.05	127	137	148	159	171	183	195	208	222	235	250
.01	.02	111	120	130	141	151	162	174	186	198	211	224
.005	.01	100	109	118	128	138	149	160	171	183	195	208

One-sided	*Two-sided*	*n* = 40	*n* = 41	*n* = 42	*n* = 43	*n* = 44	*n* = 45	*n* = 46	*n* = 47	*n* = 48	*n* = 49	*n* = 50
.05	.10	287	303	319	336	353	371	389	408	427	446	466
.025	.05	264	279	295	311	327	344	361	379	397	415	434
.01	.02	238	252	267	281	297	313	329	345	362	380	398
.005	.01	221	234	248	262	277	292	307	323	339	356	373

From *Some Rapid Approximate Statistical Procedures* (Revised) by Frank Wilcoxon and Roberta A. Wilcox (Pearl River, N.Y.: Lederle Laboratories, 1964), Table 2. Reproduced by permission of Lederle Laboratories, a division of American Cyanamid Company.

Jadual 7: Nilai Genting Mann-Whitney

n_1	n_2	α(2): 0.20 α(1): 0.10	0.10 0.05	0.05 0.025	0.02 0.01	0.01 0.005	0.005 0.0025	0.002 0.001	0.001 0.0005
6	9	39	42	44	47	49	50	52	53
	10	43	46	49	52	54	55	57	58
	11	47	50	53	57	59	60	62	64
	12	51	55	58	61	63	65	68	69
	13	55	59	62	66	68	70	73	74
	14	59	63	67	71	73	75	78	79
	15	65	67	71	75	78	80	83	85
	16	67	71	75	80	83	85	88	90
	17	71	76	80	84	87	90	93	95
	18	74	80	84	89	92	95	98	100
	19	78	84	89	94	97	100	103	106
	20	82	88	93	98	102	105	108	111
	21	86	92	97	103	107	110	114	116
	22	90	96	102	108	111	115	119	121
	23	94	101	106	112	116	120	124	126
	24	98	105	111	117	121	125	129	132
	25	102	109	115	121	126	130	134	137
	26	106	113	119	126	131	134	139	142
	27	110	117	124	131	135	139	144	147
	28	114	122	128	135	140	144	149	152
	29	118	126	132	140	145	149	154	157
	30	122	130	137	145	150	154	159	163
	31	125	134	141	149	154	159	164	168
	32	129	138	146	154	159	164	169	173
	33	133	142	150	158	164	169	174	178
	34	137	147	154	163	169	174	179	183
	35	141	151	159	168	173	179	185	188
	36	145	155	163	172	178	184	190	194
	37	149	159	167	177	183	188	195	199
	38	153	163	172	182	188	193	200	204
	39	157	167	176	186	193	198	205	209
6	40	161	172	181	191	197	203	210	214
7	7	49	38	41	43	45	46	48	49
	8	40	43	46	49	50	52	54	55
	9	45	48	51	54	56	58	60	61
	10	49	53	56	59	61	63	65	67
	11	54	58	61	65	67	69	71	73
	12	58	63	66	70	72	75	77	79
	13	63	67	71	75	78	80	83	85
	14	67	72	76	81	83	86	89	91
	15	72	77	81	86	89	92	95	97
	16	76	82	86	91	94	97	101	103
	17	81	86	91	96	100	103	106	109
	18	85	91	96	102	105	108	112	115
	19	90	96	101	107	111	114	118	120
	20	94	101	106	112	116	120	124	126
	21	99	106	111	117	122	125	129	132
7	22	103	110	116	123	127	131	135	138