UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2003/2004

September/Oktober 2003

BOI 109/4 - Biostatistik

Masa : [3 jam]

Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA BELAS muka surat yang bercetak (termasuk SEPULUH muka surat formula dan jadual) sebelum anda memulakan peperiksaan ini.

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

Tiap-tiap soalan bernilai 20 markah.

Guna kaedah nonparametrik **hanya** jika kaedah parametrik tidak boleh digunakan

...2/-

1. Untuk mengkaji tahap pencemaran udara di sesuatu kawasan perindustrian bahan pencemar yang sering dimantau ialah nitrogen oksida dan hidrokarbon. Kandungan bahan pencemar ini telah ditentukan di 12 lokasi di kawasan perindustrian Prai. Nilai-nilainya (dalam unit g/m^3) adalah seperti berikut:

Lokasi	Nitrogen oksida	Hidrokarbon
1	91	95
2	116	118
3	104	108
4	84	89
5	77	71
6	61	66
7	84	83
8	81	88
9	72	76
10	61	68
11	97	96
12	84	81

(a) Berasaskan data ini bolehkah kita mengatakan bahawa kandungan nitrogen oksida dan hidrokarbon di kawasan berkenaan sama?

(10 markah)

(b) Anda telah diberitahu bahawa min kandungan hidrokarbon di kawasan berkenaan bagi 15 tahun terdahulu ialah 75 g/m^3. Berasaskan maklumat-maklumat ini, apa yang dapat anda simpulkan mengenai keadaan udara di kawasan perindustrian Prai ketika ini.

(10 markah)

2. 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 diberi anak ikan siakap dan diminta mengkaji kesan saliniti air laut terhadap pembesaran anak ikan ini. Saliniti yang perlu dikaji ialah 10 dan 30 ‰.

(10 markah)

(b) Anda diberi rambutan yang telah diperolehi daripada 2 pembekal. Anda diminta menentukan rambutan yang mana yang lebih sedap.

(10 markah)

3. (a) Apakah yang dimaksudkan dengan kuasa bagi sesuatu ujian statistik itu?

(5 markah)

(b) Karbon dioksida (CO_2) diketahui mempengaruhi kadar pembesaran mikrob. Di dalam suatu eksperimen kadar pembesaran sejenis mikrob *Pseudomonas fragi* telah ditentukan pada 2 aras kandungan CO_2. Hasil yang dicerap ialah peratus perubahan jisim sel selepas tempoh 1 jam. Data yang diperolehi adalah seperti berikut:

Aras CO_2	**Peratus perubahan jisim sel**									
Rendah	62.6	59.6	64.5	59.3	58.6	64.6	50.9	56.2	52.3	62.8
Tinggi	50.9	44.3	47.5	49.5	48.5	50.4	35.2	49.9	42.6	41.6

Adakah terdapat bukti yang cukup daripada data ini untuk kita mengatakan bahawa kandungan CO_2 yang tinggi merencat (mengurangkan) kadar pembesaran organisma tersebut?

(15 markah)

4. Satu kajian tentang kandungan protein di dalam hati ikan kelisa telah dijalankan di mana hati ikan tersebut telah diolah dengan 3 jenis sebatian aromatik untuk mengetahui sama ada kandungan protein berbeza antara olahan. Lima ekor ikan kelisa jantan yang sebaya (sama umur) dipilih secara rawak untuk dijadikan sebagai faktor blok bagi struktur eksperimen ini. Tiga spesimen tisu hati (bersaiz sama) telah diambil daripada setiap ekor ikan tadi. Kandungan protein (dalam unit mg/g) bagi setiap spesimen ditentukan dan hasilnya adalah seperti berikut:

Ikan	**Sebatian Aromatik**		
	phenanthrene	**fluoranthene**	**naphthalene**
1	9.1	14.4	12.7
2	13.0	12.8	20.5
3	15.7	13.4	11.3
4	10.4	4.1	9.1
5	9.5	20.3	18.5

Uji hipotesis yang mengatakan tiada perbezaan kandungan protein dalam tisu hati ikan yang diolah dengan 3 jenis sebatian aromatik ini.

(20 markah)

5. Suatu eksperimen telah direkabentuk untuk mengkaji tempoh membeku bagi plasma darah daripada peserta yang menghidap penyakit darah beku. Lima kepekatan sampel plasma yang diperolehi secara rawak daripada pesakit telah disediakan. Tempoh membeku setiap sampel adalah seperti berikut:

Kepekatan (%)	0.01	0.1	1.0	10.0	100
Tempoh membeku (saat)	95	82	71	58	52

(a) Adakah terdapat pertalian linear antara dua parameter ini? Jika ada, tunjukkan pertalian tersebut dalam suatu persamaan dan nyatakan berapa kuatkah pertalian tersebut.

(15 markah)

(b) Jika anda menyediakan plasma dengan kepekatan 0.001%, apakah anggaran tempoh bekunya? Bolehkah anggaran ini dianggap baik?

(5 markah)

6. Kandungan kadmium (Cd) bagi 4 spesies rumpai laut telah ditentukan dengan menggunakan 5 sampel bagi setiap spesies. Spesies-spesies tersebut ialah *Pelvetia* sp., *Fucus vasiculosus*, *Ascophyllum* sp., dan *Laminaria* sp. Berasaskan maklumat-maklumat berikut, beri kesimpulan mengenai aras pencemaran Cd bagi 4 spesies rumpai laut ini.

Spesies	*Pelvetia* sp.	*F. vasiculosus*	*Ascophyllum* sp.	*Laminaria* sp.
Min kandungan Cd (mg/g)	2.01	2.15	2.05	1.94

<u>Nilai-nilai ANOVA:</u>

TSS = 0.1806

SSB = 0.1162

(20 markah)

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

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

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

L. Ujian statistik Friedman

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

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

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

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

Q. Eksperimen Faktoran

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

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

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

R. Ujian Sepenuh rawak:

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

S. Regresi

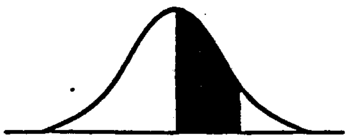
$SS_{xx} = \Sigma x^2 - \frac{(\Sigma x)^2}{n}$ $\quad$ $SS_{xy} = \Sigma xy - \frac{\Sigma x \, \Sigma y}{n}$

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

T. Perbandingan berganda:

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

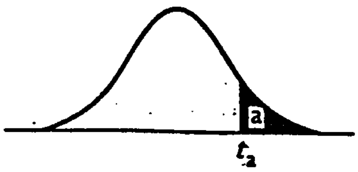
Jadual 1: Keluasan Lengkung Normal



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.

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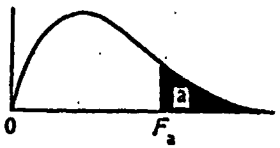
Jadual 3: Titik Peratusan Taburan F

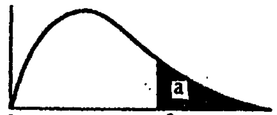


Degrees of freedom (a = .05)

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	3.14	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 4: Titik Peratusan χ^2



df	a = .995	a = .990	a = .975	a = .950	a = .900	a = .10	a = .05	a = .025	a = .010	a = .005	df
1	0.0000393	0.0001571	0.0009821	0.0039321	0.0157908	2.70554	3.84146	5.02389	6.63490	7.87944	1
2	0.0100251	0.0201007	0.0506356	0.102587	0.210720	4.60517	5.99147	7.37776	9.21034	10.5966	2
3	0.0717212	0.114832	0.215795	0.351846	0.584375	6.25139	7.81473	9.34840	11.3449	12.8381	3
4	0.206990	0.297110	0.484419	0.710721	1.063623	7.77944	9.48773	11.1433	13.2767	14.8602	4
5	0.411740	0.554300	0.831211	1.145476	1.61031	9.23635	11.0705	12.8325	15.0863	16.7496	5
6	0.675727	0.872085	1.237347	1.63539	2.20413	10.6446	12.5916	14.4494	16.8119	18.5476	6
7	0.989265	1.239043	1.68987	2.16735	2.83311	12.0170	14.0671	16.0128	18.4753	20.2777	7
8	1.344419	1.646482	2.17973	2.73264	3.48954	13.3616	15.5073	17.5346	20.0902	21.9550	8
9	1.734926	2.087912	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	11.6885	13.0905	14.8479	32.0069	35.1725	38.0757	41.6384	44.1813	23
24	9.88623	10.8564	12.4011	13.8484	15.6587	33.1963	36.4151	39.3641	42.9798	45.5585	24
25	10.5197	11.5240	13.1197	14.6114	16.4734	34.3816	37.6525	40.6465	44.3141	46.9278	25
26	11.1603	12.1981	13.8439	15.3791	17.2919	35.5631	38.8852	41.9232	45.6417	48.2899	26
27	11.8076	12.8786	14.5733	16.1513	18.1138	36.7412	40.1133	43.1944	46.9630	49.6449	27
28	12.4613	13.5648	15.3079	16.9279	18.9392	37.9159	41.3372	44.4607	48.2782	50.9933	28
29	13.1211	14.2565	16.0471	17.7083	19.7677	39.0875	42.5569	45.7222	49.5879	52.3356	29
30	13.7867	14.9535	16.7908	18.4926	20.5992	40.2560	43.7729	46.9792	50.8922	53.6720	30
40	20.7065	22.1643	24.4331	26.5093	29.0505	51.8050	55.7585	59.3417	63.6907	66.7659	40
50	27.9907	29.7067	32.3574	34.7642	37.6886	63.1671	67.5048	71.4202	76.1539	79.4900	50
60	35.5346	37.4848	40.4817	43.1879	46.4589	74.3970	79.0819	83.2976	88.3794	91.9517	60
70	43.2752	45.4418	48.7576	51.7393	55.3290	85.5271	90.5312	95.0231	100.425	104.215	70
80	51.1720	53.5400	57.1532	60.3915	64.2778	96.5782	101.879	106.629	112.329	116.321	80
90	59.1963	61.7541	65.6466	69.1260	73.2912	107.565	113.145	118.136	124.116	128.299	90
100	67.3276	70.0648	74.2219	77.9295	82.3581	118.498	124.342	129.561	135.807	140.169	100

From "Tables of the Percentage Points of the χ^2-Distribution." *Biometrika*, Vol. : (1941), pp. 188–189, by Catherine M. Thompson. Reproduced by permission of the *Biometrika* Trustees.

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Jadual 5: Titik Peratusan bagi Ujian Julat Berganda Baru Duncan

Error df	α	r = number of ordered steps between means													
		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

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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
		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
		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	
		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 Taburan U 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
8	38	198	210	220	232	240	247	255	260
	39	203	215	226	238	246	253	261	267
8	40	208	221	231	244	252	259	268	273
9	9	56	60	64	67	70	72	74	76
	10	62	66	70	74	77	79	82	83
	11	68	72	76	81	83	86	89	91
	12	73	78	82	87	90	93	96	98
	13	79	84	89	94	97	100	103	106
	14	85	90	95	100	104	167	111	113
	15	90	96	101	107	111	114	118	120
	16	96	102	107	113	117	121	125	128
	17	101	108	114	120	124	128	132	135
	18	107	114	120	126	131	135	139	142
	19	113	120	126	133	138	142	146	150
	20	118	126	132	140	144	149	154	157
	21	124	132	139	146	151	155	161	164
	22	130	138	145	153	158	162	168	172
	23	135	144	151	159	164	169	175	179
	24	141	150	157	166	171	176	182	186
	25	147	156	163	172	178	183	189	193
	26	152	162	170	179	185	190	196	201
	27	158	168	176	185	191	197	203	208
	28	164	174	182	192	198	204	211	215
	29	169	179	188	198	205	211	218	222
	30	175	185	194	205	212	218	225	230
	31	180	191	201	211	218	224	232	237
	32	186	197	207	218	225	231	239	244
	33	192	203	213	224	232	238	246	251
	34	197	209	219	231	238	245	253	259
	35	203	215	226	237	245	252	260	266
	36	209	221	232	244	252	259	267	273
	37	214	227	238	250	258	266	275	280
	38	220	233	244	257	265	273	282	288
	39	225	239	250	263	272	280	289	295
9	40	231	245	257	270	279	286	296	302
10	10	68	73	77	81	84	87	90	92
	11	74	79	84	88	92	94	98	100
	12	81	86	91	96	99	102	106	108
	13	87	93	97	103	106	110	113	116
	14	93	99	104	110	114	117	121	124
	15	99	106	111	117	121	125	129	132
	16	106	112	118	124	129	133	137	140
	17	112	119	125	132	136	140	145	148
	18	118	125	132	139	143	148	153	156
	19	124	132	138	146	151	155	161	164
	20	130	138	145	153	158	163	168	172
10	21	137	145	152	160	166	170	176	180