UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang 1989/90

Oktober/November 1989
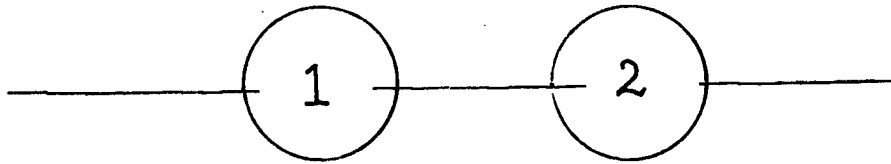
FMT 202   Statistik

Masa: (2 jam)

Kertas ini mengandungi ENAM soalan.

Jawab LIMA (5) soalan sahaja.

Semua soalan mesti dijawab di dalam Bahasa Malaysia.

1. (A) Sebuah mesin tablet mempunyai dua bahagian yang dalam siri seperti yang ditunjukkan

Mesin ini tidak dapat dipasang sekiranya salah satu atau kedua-dua bahagiannya rosak.
Katakan kebarangkalian bahawa '1' rosak ialah 0.08 dan kebarangkalian bahawa '2" rosak ialah 0.05 dan kejadian kerosakan itu adalah tak bersandar, berapakah kebarangkalian bahawa mesin tablet itu tidak dapat dipasang?

(10 markah)

(B)

Kelas	Frekuensi
25- 49	15
50- 74	25
75- 99	30
100-124	20
125-149	10
	$\Sigma f = 100$

Dengan kaedah pengkodan dapatkan kevarianan bagi taburan frekuensi di atas.

(10 markah)

2. (A) Jangkamasa penggunaan (service life) sejenis
         hasilan farmaseutik bertaburan normal. Katakan
         92.5% hasilan itu mempunyai jangkamasa penggunaan
         melebihi 2160 jam dan 3.92% hasilan itu mempunyai
         jangkamasa penggunaan melebihi 17,040 jam.
         Kirakan (i) min (mean)
                 (ii) sisihan piawai
         jangkamasa penggunaan itu.

                                            (10 markah)

    (B) Diberikan

Kelas	Frekuensi
1-11	15
12-22	16
23-33	5
34-44	5
45-55	4

         Tentukan

         (i) jarak interkuartil
         (ii) trimean

         untuk taburan frekuensi tersebut.

                                            (10 markah)

3. Satu eksperimen dijalankan untuk menentukan perhubungan antara umur dengan kadar nadi dan data berikut didapati

Subjek	Umur	Kadar Nadi
A	2	110
B	3	109
C	4	101
D	6	90
E	8	86
F	9	86
G	11	86
H	12	84
I	14	81
J	15	80

(A) Hitungkan pekali regresi.

(6 markah)

(B) Lukiskan garisan penyesuaian terbaik.

(3 markah)

(C) Ujikan pekali regresi bagi keertian berstatistik.

(4 markah)

(D) Apakah pekali penentuan bagi analisis regresi ini?

(3 markah)

(E) Berdasarkan keputusan bahagian (A), (B) dan (C), apakah pendapat anda tentang perhubungan umur dan kadar nadi?

(4 markah)

302

4. Satu eksperimen dijalankan untuk membanding tiga
    kaedah analisis parasetamol dalam plasma. Satu sampel
    darah diambil dari seorang pesakit yang mengalami
    ketoksikan parasetamol dan plasma dianalisiskan dengan
    ketiga-tiga kaedah analisis. Bagi setiap kaedah,
    penentuan kepekatan diulangi sepuluh kali. Berikut
    adalah keputusannya:

Kaedah	A	B	C
Kepekatan	73.5	56.1	60.7
(μg/ml)	71.1	54.0	52.0
	69.9	52.6	56.9
	67.2	49.9	54.3
	71.6	54.4	58.7
	68.4	51.3	55.5
	69.4	52.1	56.4
	72.5	55.2	59.5
	65.1	47.9	52.0
	66.4	49.2	54.0

(A) Adakah varians data ini homogen?

(4 markah)

(B) Jalankan ujian statistik yang sesuai untuk
     menentukan sama ada wujud sebarang perbezaan
     bererti di antara keputusan ketiga-tiga
     kaedah ini.

(10 markah)

(C) Berikan sebab-sebab mengapa anda memilih ujian
     statistik ini.

(3 markah)

(D) Bagaimanakah kuasa ujian statistik yang anda
     pilih boleh ditingkatkan?

(3 markah)

5. Di dalam makmal farmakologi, satu percubaan anestesia
    ke atas mencit oleh 4 kumpulan pelajar menghasilkan
    data berikut:

Kumpulan	A	B	C	D
Bilangan pelajar	10	3	7	7
Bilangan Mencit	30	10	6	7
Masa Anestesia (purata)	30 min	36 min	60 min	10 min
Agen Anestesia	Tiopenton	Ketamin	Tiopenton	Fenobarb
Suhu badan (purata)	$36^{O}C$	$30^{O}C$	$36^{O}C$	$31^{O}C$

(A) Tentukan kumpulan mencit manakah yang menunjukkan
     masa anestesia yang lama berbanding dengan populasi
     yang mempunyai masa anestesia purata 33 min serta
     kevarianan 13. Gunakan peringkat kesignifikanan
     99%.

(B) Jika nilai s untuk kumpulan A, B, C dan D bagi
     suhu badan mencit ialah 1, 7, 1, $7^{O}C$ masing-masing,
     tentukan julat untuk mencit kumpulan A dan D.
     Gunakan sempadan keyakinan 90%.

(C) Apakah nilai masa anestesia yang sepatutnya
     diperolehi oleh kumpulan B dan C pada peringkat
     kesignifikanan 95%?

                                        (20 markah)

PENAGIH

6.

		YA	TIDAK
AIDS	YA	53	40
	TIDAK	77	71

Daripada data di atas,

(A) Nyatakan jenis jadual kontingensi yang dipamerkan.

(B) Lukiskan suatu jadual kontingensi 3 x 2.

(C) Tentukan perhubungan di antara penyakit AIDS dan penyalahgunaan dadah. Gunakan peringkat kesignifikanan 99%. Apakah tafsiran anda tentang keputusan yang telah dihitungkan?

(D) Daripada 53 orang penagih yang menghidap penyakit AIDS, 33 adalah lelaki. Jika nisbah penagih di Malaysia ialah 3:1 (lelaki:perempuan), tentukan jika jantina mempengaruhi penyakit AIDS. Gunakan peringkat kesignifikanan 99%.

(20 markah)

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FORMULA

1. Median $(m) = b + c \times \dfrac{d}{f}$

2. $u_i = Ax_i + B$

3. $\bar{x} = \dfrac{1}{A}(\bar{u} - B)$

4. $S_x^{\ 2} = \dfrac{1}{A^2} S_u^{\ 2}$

5. $S_u^{\ 2} = \dfrac{\Sigma ui^2 fi - n\bar{u}^2}{n - 1}$

6. Trimean $= \dfrac{\text{kuartil atas} + (2 \times \text{median}) + \text{kuartil bawah}}{4}$

7. <u>Ujian-t</u>

$$t = \dfrac{\bar{x} - \mu_o}{S/\sqrt{n}}$$

$$s = \sqrt{\dfrac{x^2 - \dfrac{(x)^2}{n}}{n - 1}}$$

$$t = \dfrac{\bar{x}_1 - \bar{x}_2}{S\sqrt{1/n_1 + 1/n_2}}$$

$$s = \sqrt{\dfrac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

$$t = \dfrac{\bar{D}}{S/\sqrt{n}}$$

$$s = \sqrt{\dfrac{\Sigma D^2 - \dfrac{(\Sigma D)^2}{n}}{n - 1}}$$

306

8. **Ujian Wilcoxon** (independent samples)

$$U = n_1\, n_2 + \frac{n_2(n_2 + 1)}{2} - \Sigma_R$$

$$U' = n_1\, n_2 - U$$

9. **Ujian Sign**

$$P\,(s \geq k) = 1 - P\,(s \geq k-1)$$

10. **ANOVA** (1-way)

$$SS_{Total} = \Sigma X^2 - \frac{(\Sigma X)^2}{n_T}$$

$$SS_{Treatments} = \frac{(\Sigma X_A)^2}{n_A} + \frac{(\Sigma X_B)^2}{n_B} \quad \ldots \ldots \quad - \frac{(\Sigma X)^2}{n_T}$$

$$SS_{Error} = SS_{Total} - SS_{Treatments}$$

$$d.f.\ (Total) = (n_T - 1)$$

$$d.f.\ (Treatment) = (k - 1)$$

$$d.f.\ (Error) = (n_1 + n_2 \ldots \ldots + n_k - k)$$

$$HSD = \frac{q\sqrt{MS_{error}}}{\sqrt{n}}$$

$$n_{nm} = \frac{2\, n_1 n_2}{n_1 + n_2}$$

11. **Ujian Kruskal-Wallis**

$$H = \frac{12}{N(N + 1)} \left(\frac{R_1^2}{n_1} + \frac{R_2^2}{n_2} + \ldots + \frac{R_k^2}{n_k} \right) - 3 (N + 1)$$

$$N = n_1 + n_2 + \ldots + n_k$$

$$d.f. = k - 1$$

Ujian perbandingan berganda:

$$\Delta \bar{R} = Z_{(\alpha/k (k-1))} \sqrt{\frac{N(N + 1)}{12} \left(\frac{1}{n_i} + \frac{1}{n_j} \right)}$$

12. **Ujian Friedman**

$$Q = \frac{12}{n_k(k + 1)} (R_1^2 + R_2^2 + \ldots + R_k^2) - 3 n (k + 1)$$

$$d.f. = k - 1$$

Ujian perbandingan berganda:

$$\Delta R = Z_{(\alpha/k (k-1))} \sqrt{\frac{b \ k \ (K + 1)}{6}}$$

13. **Formula Sturges**

$$k = 1 + 3.3 \log_{10} n$$

14. **Ujian Korelasi**

$$R = \frac{n \, \Sigma xy - \Sigma x \, \Sigma y}{\sqrt{n \, \Sigma x^2 - (\Sigma x)^2} \; \sqrt{n \, \Sigma y^2 - (\Sigma y)^2}}$$

15. **Analisis Regresi**

$$y = mx + c$$

$$m = \frac{\Sigma xy - \dfrac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \dfrac{(\Sigma x)^2}{n}}$$

$$c = \frac{\Sigma y - m(\Sigma x)}{n}$$

$$SS_E = \Sigma y^2 - m \, \Sigma xy - \frac{(\Sigma y)^2}{n} + \frac{m \, \Sigma x \Sigma y}{n}$$

$$S_{yx} = \sqrt{\frac{SS_E}{n-2}}$$

16. $\chi^2 = \dfrac{N(AD - BC)^2}{(A+B)(C+D)(A+C)(B+D)}$

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TABLE III   Critical values of t

For any given df, the table shows the values of t corresponding to various levels of probability. Obtained t is significant at a given level if it is equal to or greater than the value shown in the table.

	Level of significance for one-tailed test					
	.10	.05	.025	.01	.005	.0005
	Level of significance for two-tailed test					
df	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

From R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver and Boyd Ltd., Edinburgh) and by permission of the authors and publishers.

Wilcoxon table

This table gives the significance probabilities for the Wilcoxon signed-rank test for paired comparisons, for various selected values of the test statistic $W = $ sum of all signed ranks. The significance probabilities included in the table are the ones closest to the commonly used levels of significance $\alpha = .10$, $\alpha = .05$, and $\alpha = .01$. Thus the table may be used to obtain the appropriate critical value of W for a given value of α, the level of significance.

The critical values c in the table correspond to the critical value for a one-sided test which rejects for large values of W. If the test is one-sided, and rejects for small (negative) values of W, then the critical value is $-c$, where c is the value in the table for which $P(W \geq c)$ = desired level of significance. If the test is two-sided, then the critical value c is determined by finding the value in the table for which $P(W \geq c) = 1/2 \, \alpha$, where α is the desired level of significance. In this case the test is to reject H_0 if $W \leq -c$ or $W \geq c$.

Examples

(a) The test is one-sided and rejects for large values of W. Suppose $\alpha = .05$ and $n = 8$. Then the critical value is $c = 24$, since $P(W \geq c) = .055$, and $.055$ is closest to the desired level $\alpha = .05$. Thus, the test rejects H_0 if $W \geq 24$, and accepts otherwise.

(b) The test is one-sided and rejects for small (negative) values of W. Suppose $\alpha = .10$ and $n = 12$. The critical value is -34, since $P(W \geq 34) = .102$, and $.102$ is the value closest to $.10$. Thus the test rejects H_0 if $W \leq -34$.

(c) The test is two-sided. Suppose $\alpha = .05$ and $n = 20$. Then the critical values are 106 and -106, since $P(W \geq 106) = .024$, and $.024$ is the value closest to $.025 \; (= 1/2\alpha)$. Thus the test rejects H_0 if $W \leq -106$ or $W \geq 106$.

n	c	$P(W \geq c)$
1	1	.500
2	3	.250
3	6	.125
4	10	.062
	8	.125
5	15	.031
	13	.062
	11	.094
6	21	.016
	19	.031
	17	.047
	13	.109
7	28	.008
	24	.023
	20	.055
	16	.109

n	c	$P(W \geq c)$
8	32	.012
	28	.027
	24	.055
	20	.098
9	39	.010
	33	.027
	29	.049
	23	.102
10	45	.010
	39	.024
	33	.053
	27	.097
11	52	.009
	44	.027
	38	.051
	30	.013

n	c	$P(W \geq c)$
12	56	.010
	50	.026
	44	.046
	34	.102
13	65	.011
	57	.024
	49	.047
	39	.095
14	73	.010
	63	.025
	53	.052
	43	.097
15	80	.011
	70	.024
	60	.047
	46	.104

n	c	$P(W \geq c)$
16	88	.011
	76	.025
	64	.052
	52	.096
17	97	.010
	83	.025
	71	.049
	55	.103
18	105	.010
	91	.024
	77	.049
	61	.098
19	114	.010
	98	.025
	82	.052
	66	.098
20	124	.010
	106	.024
	90	.049
	70	.101

TABLE IV Normal curve areas

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
3.1	.49903									
3.2	.49931									
3.3	.49952									
3.4	.49966									
3.5	.49977									
3.6	.49984									
3.7	.49989									
3.8	.49993									
3.9	.49995									
4.0	.50000									

TABLE VII   Critical Values of F

The obtained F is significant at a given level if it is equal to or greater than the value shown in the table.
0.05 (light row) and 0.01 (dark row) points for the distribution of F

Degrees of freedom for greater mean square

Values given as 0.05 (light) / 0.01 (dark). Rows = Degrees of freedom for lesser mean square.

df₂	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞
1	161 / 4052	200 / 4999	216 / 5403	225 / 5625	230 / 5764	234 / 5859	237 / 5928	239 / 5981	241 / 6022	242 / 6056	243 / 6082	244 / 6106	245 / 6142	246 / 6169	248 / 6208	249 / 6234	250 / 6258	251 / 6286	252 / 6302	253 / 6323	253 / 6334	254 / 6352	254 / 6361	254 / 6366
2	18.51 / 98.49	19.00 / 99.01	19.16 / 99.17	19.25 / 99.25	19.30 / 99.30	19.33 / 99.33	19.36 / 99.34	19.37 / 99.36	19.38 / 99.38	19.39 / 99.40	19.40 / 99.41	19.41 / 99.42	19.42 / 99.43	19.43 / 99.44	19.44 / 99.45	19.45 / 99.46	19.46 / 99.47	19.47 / 99.48	19.47 / 99.48	19.48 / 99.49	19.49 / 99.49	19.49 / 99.49	19.50 / 99.50	19.50 / 99.50
3	10.13 / 34.12	9.55 / 30.81	9.28 / 29.46	9.12 / 28.71	9.01 / 28.24	8.94 / 27.91	8.88 / 27.67	8.84 / 27.49	8.81 / 27.34	8.78 / 27.23	8.76 / 27.13	8.74 / 27.05	8.71 / 26.92	8.69 / 26.83	8.66 / 26.69	8.64 / 26.60	8.62 / 26.50	8.60 / 26.41	8.58 / 26.30	8.57 / 26.27	8.56 / 26.23	8.54 / 26.18	8.54 / 26.14	8.53 / 26.12
4	7.71 / 21.20	6.94 / 18.00	6.59 / 16.69	6.39 / 15.98	6.26 / 15.52	6.16 / 15.21	6.09 / 14.98	6.04 / 14.80	6.00 / 14.66	5.96 / 14.54	5.93 / 14.45	5.91 / 14.37	5.87 / 14.24	5.84 / 14.15	5.80 / 14.02	5.77 / 13.93	5.74 / 13.83	5.71 / 13.74	5.70 / 13.69	5.68 / 13.61	5.66 / 13.57	5.65 / 13.52	5.64 / 13.48	5.63 / 13.46
5	6.61 / 16.26	5.79 / 13.27	5.41 / 12.06	5.19 / 11.39	5.05 / 10.97	4.95 / 10.67	4.88 / 10.45	4.82 / 10.27	4.78 / 10.15	4.74 / 10.05	4.70 / 9.96	4.68 / 9.89	4.64 / 9.77	4.60 / 9.68	4.56 / 9.55	4.53 / 9.47	4.50 / 9.38	4.46 / 9.29	4.44 / 9.24	4.42 / 9.17	4.40 / 9.13	4.38 / 9.07	4.37 / 9.04	4.36 / 9.02
6	5.99 / 13.74	5.14 / 10.92	4.76 / 9.78	4.53 / 9.15	4.39 / 8.75	4.28 / 8.47	4.21 / 8.26	4.15 / 8.10	4.10 / 7.98	4.06 / 7.87	4.03 / 7.79	4.00 / 7.72	3.96 / 7.60	3.92 / 7.52	3.87 / 7.39	3.84 / 7.31	3.81 / 7.23	3.77 / 7.14	3.75 / 7.09	3.72 / 7.02	3.71 / 6.99	3.69 / 6.94	3.68 / 6.90	3.67 / 6.88
7	5.59 / 12.25	4.74 / 9.55	4.35 / 8.45	4.12 / 7.85	3.97 / 7.46	3.87 / 7.19	3.79 / 7.00	3.73 / 6.84	3.68 / 6.71	3.63 / 6.62	3.60 / 6.54	3.57 / 6.47	3.52 / 6.35	3.49 / 6.27	3.44 / 6.15	3.41 / 6.07	3.38 / 5.98	3.34 / 5.90	3.32 / 5.85	3.29 / 5.78	3.28 / 5.75	3.25 / 5.70	3.24 / 5.67	3.23 / 5.65
8	5.32 / 11.26	4.46 / 8.65	4.07 / 7.59	3.84 / 7.01	3.69 / 6.63	3.58 / 6.37	3.50 / 6.19	3.44 / 6.03	3.39 / 5.91	3.34 / 5.82	3.31 / 5.74	3.28 / 5.67	3.23 / 5.56	3.20 / 5.48	3.15 / 5.36	3.12 / 5.28	3.08 / 5.20	3.05 / 5.11	3.03 / 5.06	3.00 / 5.00	2.98 / 4.96	2.96 / 4.91	2.94 / 4.88	2.93 / 4.86
9	5.12 / 10.56	4.26 / 8.02	3.86 / 6.99	3.63 / 6.42	3.48 / 6.06	3.37 / 5.80	3.29 / 5.62	3.23 / 5.47	3.18 / 5.35	3.13 / 5.26	3.10 / 5.18	3.07 / 5.11	3.02 / 5.00	2.98 / 4.92	2.93 / 4.80	2.90 / 4.73	2.86 / 4.64	2.82 / 4.56	2.80 / 4.51	2.77 / 4.45	2.76 / 4.41	2.73 / 4.36	2.72 / 4.33	2.71 / 4.31
10	4.96 / 10.04	4.10 / 7.56	3.71 / 6.55	3.48 / 5.99	3.33 / 5.64	3.22 / 5.39	3.14 / 5.21	3.07 / 5.06	3.02 / 4.95	2.97 / 4.85	2.94 / 4.78	2.91 / 4.71	2.86 / 4.60	2.82 / 4.52	2.77 / 4.41	2.74 / 4.33	2.70 / 4.25	2.67 / 4.17	2.64 / 4.12	2.61 / 4.05	2.59 / 4.01	2.56 / 3.96	2.55 / 3.93	2.54 / 3.91
11	4.84 / 9.65	3.98 / 7.20	3.59 / 6.22	3.36 / 5.67	3.20 / 5.32	3.09 / 5.07	3.01 / 4.88	2.95 / 4.74	2.90 / 4.63	2.86 / 4.54	2.82 / 4.46	2.79 / 4.40	2.74 / 4.29	2.70 / 4.21	2.65 / 4.10	2.61 / 4.02	2.57 / 3.94	2.53 / 3.86	2.50 / 3.80	2.47 / 3.74	2.45 / 3.70	2.42 / 3.66	2.41 / 3.62	2.40 / 3.60
12	4.75 / 9.33	3.88 / 6.93	3.49 / 5.95	3.26 / 5.41	3.11 / 5.06	3.00 / 4.82	2.92 / 4.65	2.85 / 4.50	2.80 / 4.39	2.76 / 4.30	2.72 / 4.22	2.69 / 4.16	2.64 / 4.05	2.60 / 3.98	2.54 / 3.86	2.50 / 3.78	2.46 / 3.70	2.42 / 3.61	2.40 / 3.56	2.36 / 3.49	2.35 / 3.46	2.32 / 3.41	2.31 / 3.38	2.30 / 3.36
13	4.67 / 9.07	3.80 / 6.70	3.41 / 5.74	3.18 / 5.20	3.02 / 4.86	2.92 / 4.62	2.84 / 4.44	2.77 / 4.30	2.72 / 4.19	2.67 / 4.10	2.63 / 4.02	2.60 / 3.96	2.55 / 3.85	2.51 / 3.78	2.46 / 3.67	2.42 / 3.59	2.38 / 3.51	2.34 / 3.42	2.32 / 3.37	2.28 / 3.30	2.26 / 3.27	2.24 / 3.21	2.22 / 3.18	2.21 / 3.16
14	4.60 / 8.86	3.74 / 6.51	3.34 / 5.56	3.11 / 5.03	2.96 / 4.69	2.85 / 4.46	2.77 / 4.28	2.70 / 4.14	2.65 / 4.03	2.60 / 3.94	2.56 / 3.86	2.53 / 3.80	2.48 / 3.70	2.44 / 3.62	2.39 / 3.51	2.35 / 3.43	2.31 / 3.34	2.27 / 3.26	2.24 / 3.21	2.21 / 3.14	2.19 / 3.11	2.16 / 3.06	2.14 / 3.02	2.13 / 3.00
15	4.54 / 8.68	3.68 / 6.36	3.29 / 5.42	3.06 / 4.89	2.90 / 4.56	2.79 / 4.32	2.70 / 4.14	2.64 / 4.00	2.59 / 3.89	2.55 / 3.80	2.51 / 3.73	2.48 / 3.67	2.43 / 3.56	2.39 / 3.48	2.33 / 3.36	2.29 / 3.29	2.25 / 3.20	2.21 / 3.12	2.18 / 3.07	2.15 / 3.00	2.12 / 2.97	2.10 / 2.92	2.08 / 2.89	2.07 / 2.87

Degrees of freedom for lesser mean square

TABLE VII (continued)

0.05 (light row) and 0.01 (dark row) points for the distribution of F

Each cell shows the 0.05 point / 0.01 point. Column headings are the degrees of freedom for greater mean square; the first column is the degrees of freedom for lesser mean square.

df (lesser)	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞
16	4.49/8.53	3.63/6.23	3.24/5.29	3.01/4.77	2.85/4.44	2.74/4.20	2.66/4.03	2.59/3.89	2.54/3.78	2.49/3.69	2.45/3.61	2.42/3.55	2.37/3.45	2.33/3.37	2.28/3.25	2.24/3.18	2.20/3.10	2.16/3.01	2.13/2.96	2.09/2.89	2.07/2.86	2.04/2.80	2.02/2.77	2.01/2.75
17	4.45/8.40	3.59/6.11	3.20/5.18	2.96/4.67	2.81/4.34	2.70/4.10	2.62/3.93	2.55/3.79	2.50/3.68	2.45/3.59	2.41/3.52	2.38/3.45	2.33/3.35	2.29/3.27	2.23/3.16	2.19/3.08	2.15/3.00	2.11/2.92	2.08/2.86	2.04/2.79	2.02/2.76	1.99/2.70	1.97/2.67	1.96/2.65
18	4.41/8.28	3.55/6.01	3.16/5.09	2.93/4.58	2.77/4.25	2.66/4.01	2.58/3.85	2.51/3.71	2.46/3.60	2.41/3.51	2.37/3.44	2.34/3.37	2.29/3.27	2.25/3.19	2.19/3.07	2.15/3.00	2.11/2.91	2.07/2.83	2.04/2.78	2.00/2.71	1.98/2.68	1.95/2.62	1.93/2.59	1.92/2.57
19	4.38/8.18	3.52/5.93	3.13/5.01	2.90/4.50	2.74/4.17	2.63/3.94	2.55/3.77	2.48/3.63	2.43/3.52	2.38/3.43	2.34/3.36	2.31/3.30	2.26/3.19	2.21/3.12	2.15/3.00	2.11/2.92	2.07/2.84	2.02/2.76	2.00/2.70	1.96/2.63	1.94/2.60	1.91/2.54	1.90/2.51	1.88/2.49
20	4.35/8.10	3.49/5.85	3.10/4.94	2.87/4.43	2.71/4.10	2.60/3.87	2.52/3.71	2.45/3.56	2.40/3.45	2.35/3.37	2.31/3.30	2.28/3.23	2.23/3.13	2.18/3.05	2.12/2.94	2.08/2.86	2.04/2.77	1.99/2.69	1.96/2.63	1.92/2.56	1.90/2.53	1.87/2.47	1.85/2.44	1.84/2.42
21	4.32/8.02	3.47/5.78	3.07/4.87	2.84/4.37	2.68/4.04	2.57/3.81	2.49/3.65	2.42/3.51	2.37/3.40	2.32/3.31	2.28/3.24	2.25/3.17	2.20/3.07	2.15/2.99	2.09/2.88	2.05/2.80	2.00/2.72	1.96/2.63	1.93/2.58	1.89/2.51	1.87/2.47	1.84/2.42	1.82/2.38	1.81/2.36
22	4.30/7.94	3.44/5.72	3.05/4.82	2.82/4.31	2.66/3.99	2.55/3.76	2.47/3.59	2.40/3.45	2.35/3.35	2.30/3.26	2.26/3.18	2.23/3.12	2.18/3.02	2.13/2.94	2.07/2.83	2.03/2.75	1.98/2.67	1.93/2.58	1.91/2.53	1.87/2.46	1.84/2.42	1.81/2.37	1.80/2.33	1.78/2.31
23	4.28/7.88	3.42/5.66	3.03/4.76	2.80/4.26	2.64/3.94	2.53/3.71	2.45/3.54	2.38/3.41	2.32/3.30	2.28/3.21	2.24/3.14	2.20/3.07	2.14/2.97	2.10/2.89	2.04/2.78	2.00/2.70	1.96/2.62	1.91/2.53	1.88/2.48	1.84/2.41	1.82/2.37	1.79/2.32	1.77/2.28	1.76/2.26
24	4.26/7.82	3.40/5.61	3.01/4.72	2.78/4.22	2.62/3.90	2.51/3.67	2.43/3.50	2.36/3.36	2.30/3.25	2.26/3.17	2.22/3.09	2.18/3.03	2.13/2.93	2.09/2.85	2.02/2.74	1.98/2.66	1.94/2.58	1.89/2.49	1.86/2.44	1.82/2.36	1.80/2.33	1.76/2.27	1.74/2.23	1.73/2.21
25	4.24/7.77	3.38/5.57	2.99/4.68	2.76/4.18	2.60/3.86	2.49/3.63	2.41/3.46	2.34/3.32	2.28/3.21	2.24/3.13	2.20/3.05	2.16/2.99	2.11/2.89	2.06/2.81	2.00/2.70	1.96/2.62	1.92/2.54	1.87/2.45	1.84/2.40	1.80/2.32	1.77/2.29	1.74/2.23	1.72/2.19	1.71/2.17
26	4.22/7.72	3.37/5.53	2.98/4.64	2.74/4.14	2.59/3.82	2.47/3.59	2.39/3.42	2.32/3.29	2.27/3.17	2.22/3.09	2.18/3.02	2.15/2.96	2.10/2.86	2.05/2.77	1.99/2.66	1.95/2.58	1.90/2.50	1.85/2.41	1.82/2.36	1.78/2.28	1.76/2.25	1.72/2.19	1.70/2.15	1.69/2.13
27	4.21/7.68	3.35/5.49	2.96/4.60	2.73/4.11	2.57/3.79	2.46/3.56	2.37/3.39	2.30/3.26	2.25/3.14	2.20/3.06	2.16/2.98	2.13/2.93	2.08/2.83	2.03/2.74	1.97/2.63	1.93/2.55	1.88/2.47	1.84/2.38	1.80/2.33	1.76/2.25	1.74/2.21	1.71/2.16	1.68/2.12	1.67/2.10
28	4.20/7.64	3.34/5.45	2.95/4.57	2.71/4.07	2.56/3.76	2.44/3.53	2.36/3.36	2.29/3.23	2.24/3.11	2.19/3.03	2.15/2.95	2.12/2.90	2.06/2.80	2.02/2.71	1.96/2.60	1.91/2.52	1.87/2.44	1.81/2.35	1.78/2.30	1.75/2.22	1.72/2.18	1.69/2.13	1.67/2.09	1.65/2.06
29	4.18/7.60	3.33/5.42	2.93/4.54	2.70/4.04	2.54/3.73	2.43/3.50	2.35/3.33	2.28/3.20	2.22/3.08	2.18/3.00	2.14/2.92	2.10/2.87	2.05/2.77	2.00/2.68	1.94/2.57	1.90/2.49	1.85/2.41	1.80/2.32	1.77/2.27	1.73/2.19	1.71/2.15	1.68/2.10	1.65/2.06	1.64/2.03
30	4.17/7.56	3.32/5.39	2.92/4.51	2.69/4.02	2.53/3.70	2.42/3.47	2.34/3.30	2.27/3.17	2.21/3.06	2.16/2.98	2.12/2.90	2.09/2.84	2.04/2.74	1.99/2.66	1.93/2.55	1.89/2.47	1.84/2.38	1.79/2.29	1.76/2.24	1.72/2.16	1.69/2.13	1.66/2.07	1.64/2.03	1.62/2.01

(continued)

TABLE VII (continued)

0.05 (light row) and 0.01 (dark row) points for the distribution of F

Each cell shows the 0.05 value (upper) / 0.01 value (lower). Top column headings are "Degrees of freedom for greater mean square"; the left column is "Degrees of freedom for lesser mean square".

df	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞
32	4.15/7.50	3.30/5.34	2.90/4.46	2.67/3.97	2.51/3.66	2.40/3.42	2.32/3.25	2.25/3.12	2.19/3.01	2.14/2.94	2.10/2.86	2.07/2.80	2.02/2.70	1.97/2.62	1.91/2.51	1.86/2.42	1.82/2.34	1.76/2.25	1.74/2.20	1.69/2.12	1.67/2.08	1.64/2.02	1.61/1.98	1.59/1.96
34	4.13/7.44	3.28/5.29	2.88/4.42	2.65/3.93	2.49/3.61	2.38/3.38	2.30/3.21	2.23/3.08	2.17/2.97	2.12/2.89	2.08/2.82	2.05/2.76	2.00/2.66	1.95/2.58	1.89/2.47	1.84/2.38	1.80/2.30	1.74/2.21	1.71/2.15	1.67/2.08	1.64/2.04	1.61/1.98	1.59/1.94	1.57/1.91
35	4.11/7.39	3.26/5.25	2.87/4.38	2.63/3.89	2.48/3.58	2.36/3.35	2.28/3.18	2.21/3.04	2.15/2.94	2.10/2.86	2.06/2.78	2.03/2.72	1.96/2.62	1.93/2.54	1.87/2.43	1.82/2.35	1.78/2.26	1.72/2.17	1.69/2.12	1.65/2.04	1.62/2.00	1.59/1.94	1.56/1.90	1.55/1.87
38	4.10/7.35	3.25/5.21	2.85/4.34	2.62/3.86	2.46/3.54	2.35/3.32	2.26/3.15	2.19/3.02	2.14/2.91	2.09/2.82	2.05/2.75	2.02/2.69	1.96/2.59	1.92/2.51	1.85/2.40	1.80/2.32	1.76/2.22	1.71/2.14	1.67/2.08	1.63/2.00	1.60/1.97	1.57/1.90	1.54/1.86	1.53/1.84
40	4.08/7.31	3.23/5.18	2.84/4.31	2.61/3.83	2.45/3.51	2.34/3.29	2.25/3.12	2.18/2.99	2.12/2.88	2.07/2.80	2.04/2.73	2.00/2.66	1.95/2.56	1.90/2.49	1.84/2.37	1.79/2.29	1.74/2.20	1.69/2.11	1.66/2.05	1.61/1.97	1.59/1.94	1.55/1.88	1.53/1.84	1.51/1.81
42	4.07/7.27	3.22/5.15	2.83/4.29	2.59/3.80	2.44/3.49	2.32/3.26	2.24/3.10	2.17/2.96	2.11/2.86	2.06/2.77	2.02/2.70	1.99/2.64	1.94/2.54	1.89/2.46	1.82/2.35	1.78/2.26	1.73/2.17	1.68/2.08	1.64/2.02	1.60/1.94	1.57/1.91	1.54/1.85	1.51/1.80	1.49/1.78
44	4.06/7.24	3.21/5.12	2.82/4.26	2.58/3.78	2.43/3.46	2.31/3.24	2.23/3.07	2.16/2.94	2.10/2.84	2.05/2.75	2.01/2.68	1.98/2.62	1.92/2.52	1.88/2.44	1.81/2.32	1.76/2.24	1.72/2.15	1.66/2.06	1.63/2.00	1.58/1.92	1.56/1.88	1.52/1.82	1.50/1.78	1.48/1.75
46	4.05/7.21	3.20/5.10	2.81/4.24	2.57/3.76	2.42/3.44	2.30/3.22	2.22/3.05	2.14/2.92	2.09/2.82	2.04/2.73	2.00/2.66	1.97/2.60	1.91/2.50	1.87/2.42	1.80/2.30	1.75/2.22	1.71/2.13	1.65/2.04	1.62/1.98	1.57/1.90	1.54/1.86	1.51/1.80	1.48/1.76	1.46/1.72
48	4.04/7.19	3.19/5.08	2.80/4.22	2.56/3.74	2.41/3.42	2.30/3.20	2.21/3.04	2.14/2.90	2.08/2.80	2.03/2.71	1.99/2.64	1.96/2.58	1.90/2.48	1.86/2.40	1.79/2.28	1.74/2.20	1.70/2.11	1.64/2.02	1.61/1.96	1.56/1.88	1.53/1.84	1.50/1.78	1.47/1.73	1.45/1.70
50	4.03/7.17	3.18/5.06	2.79/4.20	2.56/3.72	2.40/3.41	2.29/3.18	2.20/3.02	2.13/2.88	2.07/2.78	2.02/2.70	1.98/2.62	1.95/2.56	1.90/2.46	1.85/2.39	1.78/2.26	1.74/2.18	1.69/2.10	1.63/2.00	1.60/1.94	1.55/1.86	1.52/1.82	1.48/1.76	1.46/1.71	1.44/1.68
55	4.02/7.12	3.17/5.01	2.78/4.16	2.54/3.68	2.38/3.37	2.27/3.15	2.18/2.98	2.11/2.85	2.05/2.75	2.00/2.66	1.97/2.59	1.93/2.53	1.88/2.43	1.83/2.35	1.76/2.23	1.72/2.15	1.67/2.06	1.61/1.96	1.58/1.90	1.52/1.82	1.50/1.78	1.46/1.71	1.43/1.66	1.41/1.64
60	4.00/7.08	3.15/4.98	2.76/4.13	2.52/3.65	2.37/3.34	2.25/3.12	2.17/2.95	2.10/2.82	2.04/2.72	1.99/2.63	1.95/2.56	1.92/2.50	1.86/2.40	1.81/2.32	1.75/2.20	1.70/2.12	1.65/2.03	1.59/1.93	1.56/1.87	1.50/1.79	1.48/1.74	1.44/1.68	1.41/1.63	1.39/1.60
65	3.99/7.04	3.14/4.95	2.75/4.10	2.51/3.62	2.36/3.31	2.24/3.09	2.15/2.93	2.08/2.79	2.02/2.70	1.98/2.61	1.94/2.54	1.90/2.47	1.85/2.37	1.80/2.30	1.73/2.18	1.68/2.09	1.63/2.00	1.57/1.90	1.54/1.84	1.49/1.76	1.46/1.71	1.42/1.64	1.39/1.60	1.37/1.56
70	3.98/7.01	3.13/4.92	2.74/4.08	2.50/3.60	2.35/3.29	2.23/3.07	2.14/2.91	2.07/2.77	2.01/2.67	1.97/2.59	1.93/2.51	1.89/2.45	1.84/2.35	1.79/2.28	1.72/2.15	1.67/2.07	1.62/1.98	1.56/1.88	1.53/1.82	1.47/1.74	1.45/1.69	1.40/1.62	1.37/1.56	1.35/1.53
80	3.96/6.96	3.11/4.88	2.72/4.04	2.48/3.56	2.33/3.25	2.21/3.04	2.12/2.87	2.05/2.74	1.99/2.64	1.95/2.55	1.91/2.48	1.88/2.41	1.82/2.32	1.77/2.24	1.70/2.11	1.65/2.03	1.60/1.94	1.54/1.84	1.51/1.78	1.45/1.70	1.42/1.65	1.38/1.57	1.35/1.52	1.32/1.49

TABLE VII (continued)

0.05 (light row) and 0.01 (dark row) points for the distribution of F

Degrees of freedom for greater mean square

lesser		1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞
100	.05	3.94	3.09	2.70	2.46	2.30	2.19	2.10	2.03	1.97	1.92	1.88	1.85	1.79	1.75	1.68	1.63	1.57	1.51	1.48	1.42	1.39	1.34	1.30	1.28
	.01	6.90	4.82	3.98	3.51	3.20	2.99	2.82	2.69	2.59	2.51	2.43	2.36	2.26	2.19	2.06	1.98	1.89	1.79	1.73	1.64	1.59	1.51	1.46	1.43
125	.05	3.92	3.07	2.68	2.44	2.29	2.17	2.08	2.01	1.95	1.90	1.86	1.83	1.77	1.72	1.65	1.60	1.55	1.49	1.45	1.39	1.36	1.31	1.27	1.25
	.01	6.84	4.78	3.94	3.47	3.17	2.95	2.79	2.65	2.56	2.47	2.40	2.33	2.23	2.15	2.03	1.94	1.85	1.75	1.68	1.59	1.54	1.46	1.40	1.37
150	.05	3.91	3.06	2.67	2.43	2.27	2.16	2.07	2.00	1.94	1.89	1.85	1.82	1.76	1.71	1.64	1.59	1.54	1.47	1.44	1.37	1.34	1.29	1.25	1.22
	.01	6.81	4.75	3.91	3.44	3.13	2.92	2.76	2.62	2.53	2.44	2.37	2.30	2.20	2.12	2.00	1.91	1.83	1.72	1.66	1.56	1.51	1.43	1.37	1.33
200	.05	3.89	3.04	2.65	2.41	2.26	2.14	2.05	1.98	1.92	1.87	1.83	1.80	1.74	1.69	1.62	1.57	1.52	1.45	1.42	1.35	1.32	1.26	1.22	1.19
	.01	6.76	4.71	3.88	3.41	3.11	2.90	2.73	2.60	2.50	2.41	2.34	2.28	2.17	2.09	1.97	1.88	1.79	1.69	1.62	1.53	1.48	1.39	1.33	1.28
400	.05	3.86	3.02	2.62	2.39	2.23	2.12	2.03	1.96	1.90	1.85	1.81	1.78	1.72	1.67	1.60	1.54	1.49	1.42	1.38	1.32	1.28	1.22	1.16	1.13
	.01	6.70	4.66	3.83	3.36	3.06	2.85	2.69	2.55	2.46	2.37	2.29	2.23	2.12	2.04	1.92	1.84	1.74	1.64	1.57	1.47	1.42	1.32	1.24	1.19
1000	.05	3.85	3.00	2.61	2.38	2.22	2.10	2.02	1.95	1.89	1.84	1.80	1.76	1.70	1.65	1.58	1.53	1.47	1.41	1.36	1.30	1.26	1.19	1.13	1.08
	.01	6.66	4.62	3.80	3.34	3.04	2.82	2.66	2.53	2.43	2.34	2.26	2.20	2.09	2.01	1.89	1.81	1.71	1.61	1.54	1.44	1.38	1.28	1.19	1.11
∞	.05	3.84	2.99	2.60	2.37	2.21	2.09	2.01	1.94	1.88	1.83	1.79	1.75	1.69	1.64	1.57	1.52	1.46	1.40	1.35	1.28	1.24	1.17	1.11	1.00
	.01	6.64	4.60	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.24	2.18	2.07	1.99	1.87	1.79	1.69	1.59	1.52	1.41	1.36	1.25	1.15	1.00

Degrees of freedom for lesser mean square

317

TABLE IX Critical values of U

n_1	n_2	0.10	0.05	0.025	0.01	0.005	0.001
3	2	6	-	-	-	-	-
	3	8	9	-	-	-	-
4	2	8	-	-	-	-	-
	3	11	12	-	-	-	-
	4	13	15	16	-	-	-
5	2	9	10	-	-	-	-
	3	13	14	15	-	-	-
	4	16	18	19	20	-	-
	5	20	21	23	24	25	-
6	2	11	12	-	-	-	-
6	3	15	16	17	-	-	-
	4	19	21	22	23	24	-
	5	23	25	27	28	29	-
	6	27	29	31	33	34	-
7	2	13	14	-	-	-	-
7	3	17	19	20	21	-	-
	4	22	24	25	27	28	-
	5	27	29	30	32	34	-
	6	31	34	36	38	39	42
	7	36	38	41	43	45	48
8	2	14	15	16	-	-	-
	3	19	21	22	24	-	-
	4	25	27	28	30	31	-
	5	30	32	34	36	38	40
	6	35	38	40	42	44	47
8	7	40	43	46	49	50	54
	8	45	49	51	55	57	60
9	1	9	-	-	-	-	-
	2	16	17	18	-	-	-
	3	22	23	25	26	27	-
9	4	27	30	32	33	35	-
	5	33	36	38	40	42	44
	6	39	42	44	47	49	52
	7	45	48	51	54	56	60
	8	50	54	57	61	63	67
9	9	56	60	64	67	70	74
10	1	10	-	-	-	-	-
	2	17	19	20	-	-	-
	3	24	26	27	29	30	-
	4	30	33	35	37	38	40

n_1	n_2	0.10	0.05	0.025	0.01	0.005	0.001
10	5	37	39	42	44	46	49
	6	43	46	49	52	54	57
	7	49	53	56	59	61	65
	8	56	60	63	67	69	74
	9	62	66	70	74	77	82
10	10	68	73	77	81	84	90
11	1	11	-	-	-	-	-
	2	19	21	22	-	-	-
	3	26	28	30	32	33	-
	4	33	36	38	40	42	44
11	5	40	43	46	48	50	53
	6	47	50	53	57	59	62
	7	54	58	61	65	67	71
	8	61	65	69	73	75	80
	9	68	72	76	81	83	89
11	10	74	79	84	88	92	98
	11	81	87	91	96	100	106
12	1	12	-	-	-	-	-
	2	20	22	23	-	-	-
	3	28	31	32	34	35	-
12	4	36	39	41	43	45	48
	5	43	47	49	52	54	58
	6	51	55	58	61	63	68
	7	58	63	66	70	72	77
	8	66	70	74	79	81	87
12	9	73	78	82	87	90	96
	10	81	86	91	96	99	106
	11	88	94	99	104	108	115
	12	95	102	107	113	117	124
13	1	13	-	-	-	-	-
13	2	22	24	25	26	-	-
	3	30	33	35	37	38	-
	4	39	42	44	47	49	51
	5	47	50	53	56	58	62
	6	55	59	62	66	68	73
13	7	63	67	71	75	78	83
	8	71	76	80	84	87	93
	9	79	84	89	94	97	103
	10	87	93	97	103	106	113
	11	95	101	106	112	116	123

TABLE IX (*continued*)

n_1	n_2	0.10	0.05	0.025	0.01	0.005	0.001	n_1	n_2	0.10	0.05	0.025	0.01	0.005	0.001
13	12	103	109	115	121	125	133	16	10	106	112	118	124	129	137
	13	111	118	124	130	135	143		11	115	122	129	135	140	149
14	1	14	-	-	-	-	-		12	125	132	139	146	151	161
	2	24	25	27	28	-	-		13	134	143	149	157	163	173
	3	32	35	37	40	41	-		14	144	153	160	168	174	185
14	4	41	45	47	50	52	55	16	15	154	163	170	179	185	197
	5	50	54	57	60	63	67		16	163	173	181	190	196	208
	6	59	63	67	71	73	78	17	1	17	-	-	-	-	-
	7	67	72	76	81	83	89		2	28	31	32	34	-	-
	8	76	81	86	90	94	100		3	39	42	45	47	49	51
14	9	85	90	95	100	104	111	17	4	50	53	57	60	62	66
	10	93	99	104	110	114	121		5	60	65	68	72	75	80
	11	102	108	114	120	124	132		6	71	76	80	84	87	93
	12	110	117	123	130	134	143		7	81	86	91	96	100	106
	13	119	126	132	139	144	153		8	91	97	102	108	112	119
14	14	127	135	141	149	154	164	17	9	101	108	114	120	124	132
15	1	15	-	-	-	-	-		10	112	119	125	132	136	145
	2	25	27	29	30	-	-		11	122	130	136	143	148	158
	3	35	38	40	42	43	-		12	132	140	147	155	160	170
	4	44	48	50	53	55	59		13	142	151	158	166	172	183
15	5	53	57	61	64	67	71	17	14	153	161	169	178	184	195
	6	63	67	71	75	78	83		15	163	172	180	189	195	208
	7	72	77	81	86	89	95		16	173	183	191	201	207	220
	8	81	87	91	96	100	106		17	183	193	202	212	219	232
	9	90	96	101	107	111	118	18	1	18	-	-	-	-	-
15	10	99	106	111	117	121	129		2	30	32	34	36	-	-
	11	108	115	121	128	132	141		3	41	45	47	50	52	54
	12	117	125	131	138	143	152		4	52	56	60	63	66	69
	13	127	134	141	148	153	163		5	63	68	72	76	79	84
	14	136	144	151	159	164	174		6	74	80	84	89	92	98
15	15	145	153	161	169	174	185	18	7	85	91	96	102	105	112
16	1	16	-	-	-	-	-		8	96	103	108	114	118	126
	2	27	29	31	32	-	-		9	107	114	120	126	131	139
	3	37	40	42	45	46	-		10	118	125	132	139	143	153
	4	47	50	53	57	59	62		11	129	137	143	151	156	166
16	5	57	61	65	68	71	75	18	12	139	148	155	163	169	179
	6	67	71	75	80	83	88		13	150	159	167	175	181	192
	7	76	82	86	91	94	101		14	161	170	178	187	194	206
	8	86	92	97	102	106	113		15	172	182	190	200	206	219
	9	96	102	107	113	117	125		16	182	193	202	212	218	232

TABLE IX   (continued)

n_1	n_2	0.10	0.05	0.025	0.01	0.005	0.001
18	17	193	204	213	224	231	245
	18	204	215	225	236	243	258
19	1	18	19	-	-	-	-
	2	31	34	36	37	38	-
	3	43	47	50	53	54	57
19	4	55	59	63	67	69	73
	5	67	72	76	80	83	88
	6	78	84	89	94	97	103
	7	90	96	101	107	111	118
	8	101	108	114	120	124	132
19	9	113	120	126	133	138	146
	10	124	132	138	146	151	161
	11	136	144	151	159	164	175
	12	147	156	163	172	177	188
	13	158	167	175	184	190	202
19	14	169	179	188	197	203	216
	15	181	191	200	210	216	230
	16	192	203	212	222	230	244
	17	203	214	224	235	242	257
	18	214	226	236	248	255	271
19	19	226	238	248	260	268	284
20	1	19	20	-	-	-	-
	2	33	36	38	39	40	-
	3	45	49	52	55	57	60
	4	58	62	66	70	72	77
20	5	70	75	80	84	87	93
	6	82	88	93	98	102	108
	7	94	101	106	112	116	124
	8	106	113	119	126	130	139
	9	118	126	132	140	144	154
20	10	130	138	145	153	158	168
	11	142	151	158	167	172	183
	12	154	163	171	180	186	198
	13	166	176	184	193	200	212
	14	178	188	197	207	213	226
20	15	190	200	210	220	227	241
	16	201	213	222	233	241	255
	17	213	225	235	247	254	270
	18	225	237	248	260	268	284
	19	237	250	261	273	281	298
	20	249	262	273	286	295	312

Binomial distribution

The table gives cumulative binomial probabilities $P(S \leq k)$ for a variable S having a binomial distribution with parameters n and p. For example, if $n = 10$ and $p = .40$ then $P(S \leq 3) = .3823$, or if $n = 13$ and $p = .85$ then $P(S \leq 10) = .2704$. Other probabilities of interest may be obtained according to the formulas

$$P(S > k) = 1 - P(S \leq k)$$

$$P(S = k) = P(S \leq k) - P(S \leq k - 1)$$

$$\therefore \ P(S \geq k) = 1 - P(S \leq k - 1)$$

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
1	0	.5000	.4500	.4000	.3500	.3000	.2500	.2000	.1500	.1000	.0500
	1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0	.2500	.2025	.1600	.1225	.0900	.0625	.0400	.0225	.0100	.0025
	1	.7500	.6975	.6400	.5775	.5100	.4373	.3600	.2775	.1900	.0975
	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0	.1250	.0911	.0640	.0429	.0270	.0156	.0080	.0034	.0010	.0001
	1	.5000	.4252	.3520	.2818	.2160	.1562	.1040	.0608	.0280	.0072
	2	.8750	.8336	.7840	.7254	.6570	.5781	.4880	.3959	.2710	.1426
	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0	.0625	.0410	.0256	.0150	.0081	.0039	.0016	.0005	.0001	.0000
	1	.3125	.2415	.1792	.1265	.0837	.0508	.0272	.0120	.0037	.0005
	2	.6875	.6090	.5248	.4370	.3483	.2617	.1808	.1095	.0523	.0140
	3	.9375	.9085	.8705	.8215	.7599	.6836	.5904	.4780	.3439	.1855
	4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0	.0312	.0185	.0102	.0053	.0024	.0010	.0003	.0001	.0000	.0000
	1	.1875	.1312	.0870	.0540	.0308	.0156	.0067	.0022	.0005	.0000
	2	.5000	.4069	.3174	.2352	.1631	.1035	.0579	.0266	.0086	.0012
	3	.8125	.7438	.6630	.5716	.4718	.3672	.2627	.1648	.0815	.0226
	4	.9688	.9497	.9222	.8840	.8319	.7627	.6723	.5563	.4095	.2262
	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0	.0156	.0083	.0041	.0018	.0007	.0002	.0001	.0000	.0000	.0000
	1	.1094	.0692	.0410	.0223	.0109	.0046	.0016	.0004	.0001	.0000
	2	.3438	.2553	.1792	.1174	.0705	.0376	.0170	.0059	.0013	.0001
	3	.6562	.5585	.4557	.3529	.2557	.1694	.0989	.0473	.0158	.0022
	4	.8906	.8364	.7667	.6809	.5798	.4661	.3446	.2235	.1143	.0328
	5	.9844	.9723	.9533	.9246	.8824	.8220	.7379	.6229	.4686	.2649
	6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	0	.0078	.0037	.0016	.0006	.0002	.0001	.0000	.0000	.0000	.0000
	1	.0625	.0357	.0188	.0090	.0038	.0013	.0004	.0001	.0000	.0000
	2	.2266	.1529	.0963	.0556	.0288	.0129	.0047	.0012	.0002	.0000
	3	.5000	.3917	.2898	.1998	.1260	.0706	.0333	.0121	.0027	.0002
	4	.7734	.6836	.5801	.4677	.3529	.2436	.1480	.0738	.0257	.0038
	5	.9375	.8976	.8414	.7662	.6706	.5551	.4233	.2834	.1497	.0444
	6	.9922	.9848	.9720	.9510	.9176	.8665	.7903	.6794	.5217	.3917
	7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
8	0	.0030	.0017	.0007	.9992	.0001	.0000	.0000	.0000	.0000	.0000
	1	.0352	.0181	.0085	.0086	.0013	.0004	.0001	.0000	.0000	.0000
	2	.1445	.0885	.0498	.0253	.0113	.0042	.0012	.0002	.0004	.0000
	3	.3633	.2604	.1737	.1061	.0580	.0273	.0104	.0029	.0050	.0004
	4	.6367	.5230	.4059	.2936	.1941	.1138	.0563	.0214	.0381	.0058
	5	.8555	.7799	.6846	.5722	.4482	.3215	.2031	.1052	.1869	.0572
	6	.9648	.9368	.8936	.8309	.7447	.6329	.4967	.3428	.5695	.3366
	7	.9961	.9916	.9832	.9681	.9424	.8999	.8322	.7275	1.0000	1.0000
	8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.0000	.0000
9	0	.0020	.0008	.0003	.0001	.0000	.0001	.0000	.0000	.0000	.0000
	1	.0195	.0091	.0038	.0014	.0043	.0013	.0003	.0000	.0000	.0000
	2	.0898	.0498	.0250	.0112	.0253	.0100	.0031	.0006	.0001	.0000
	3	.2539	.1658	.0994.	.1717	.0988	.0489	.0196	.0056	.0009	.0006
	4	.5000	.3786	.2666	.3911	.2703	.1657	.0856	.0339	.0530	.0084
	5	.7461	.6386	.5174	.6627	.5372	.3993	.2618	.1409	.2252	.0712
	6	.9102	.8505	.7682	.8789	.8040	.6997	.5638	.4005	.6126	.3698
	7	.9805	.9615	.9295	.9793	.9596	.9249	.8658	.7684	1.0000	1.0000
	8	.9980	.9954	.9899	1.0000	1.0000	1.0000	1.0000	1.0000	.0000	.0000
	9	1.0000	1.0000	1.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
10	0	.0010	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0107	.0045	.0017	.0005	.0001	.0000	.0001	.0000	.0000	.0000
	2	.0547	.0274	.0123	.0048	.0016	.0035	.0009	.0001	.0000	.0000
	3	.1719	.1020	.0548	.0260	.0106	.0197	.0064	.0014	.0001	.0000
	4	.3770	.2616	.1662	.0949	.0473	.0781	.0328	.0099	.0016	.0001
	5	.6230	.4956	.3669	.2485	.1503	.2241	.1209	.0500	.0128	.0010
	6	.8281	.7340	.6177	.4862	.3504	.4744	.3222	.1798	.0702	.0115
	7	.9453	.9004	.8327	.7184	.6172	.7560	.6242	.4557	.2639	.0861
	8	.9893	.9767	.9536	.9140	.8507	.9437	.8926	.8031	.6513	.4013
	9	.9990	.9975	.9940	.9865	.9718	1.0000	1.0000	1.0000	1.0000	1.0000
	10	1.0000	1.0000	1.0000	1.0000	1.0000					
11	0	.0005	.0002	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0059	.0022	.0007	.0002	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0327	.0148	.0059	.0020	.0006	.0001	.0000	.0000	.0000	.0000
	3	.1133	.0610	.0293	.0122	.0043	.0012	.0002	.0003	.0000	.0000
	4	.2744	.1738	.0994	.0501	.0216	.0076	.0117	.0027	.0003	.0000
	5	.5000	.3669	.2465	.1487	.0782	.0343	.0504	.0159	.0028	.0001
	6	.7256	.6029	.4672	.3317	.2103	.1146	.1611	.0694	.0185	.0016
	7	.8867	.8089	.7037.	.5744	.4304	.2867	.3826	.2212	.0896	.0152
	8	.9673	.9348	.8811	.7999	.6873	.5448	.6779	.5078	.3026	.1019
	9	.9941	.9861	.9698	.9394	.8870	.8029	.9141	.8327	.6862	.4312
	10	.9995	.9986	.9964	.9912	.9802	.0578	1.0000	1.0000	1.0000	1.0000
	11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000				

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
12	0	.0002	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0032	.0011	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0193	.0079	.0028	.0008	.0002	.0000	.0000	.0000	.0000	.0000
	3	.0730	.0356	.0153	.0056	.0017	.0004	.0001	.0000	.0000	.0000
	4	.1938	.1117	.0573	.0255	.0095	.0028	.0006	.0001	.0000	.0000
	5	.3872	.2607	.1582	.0846	.0386	.0143	.0039	.0007	.0001	.0000
	6	.6128	.4731	.3348	.2127	.1178	.0544	.0194	.0046	.0005	.0000
	7	.8062	.6956	.5618	.4167	.2763	.1576	.0726	.0239	.0043	.0002
	8	.9270	.8655	.7747	.6533	.5075	.3512	.2054	.0922	.0256	.0022
	9	.9807	.9579	.9166	.8487	.7472	.6093	.4417	.2642	.1109	.0196
	10	.9968	.9917	.9804	.9576	.9150	.8416	.7251	.5565	.3410	.1184
	11	.9998	.9992	.9978	.9943	.9862	.9683	.9313	.8578	.7176	.4596
	12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	0	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0017	.0005	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0112	.0041	.0013	.0003	.0001	.0000	.0000	.0000	.0000	.0000
	3	.0461	.0203	.0078	.0025	.0007	.0001	.0000	.0000	.0000	.0000
	4	.1334	.0698	.0321	.0126	.0040	.0010	.0002	.0000	.0000	.0000
	5	.2905	.1788	.0977	.0462	.0182	.0056	.0012	.0002	.0000	.0000
	6	.5000	.3563	.2288	.1295	.0624	.0243	.0070	.0013	.0001	.0000
	7	.7095	.5732	.4256	.2841	.1654	.0802	.0300	.0053	.0009	.0000
	8	.8666	.7721	.6470	.4995	.3457	.2060	.0991	.0260	.0065	.0003
	9	.9539	.9071	.8314	.7217	.5794	.4157	.2527	.0967	.0342	.0031
	10	.9888	.9731	.9421	.8868	.7975	.6674	.4983	.2704	.1339	.0245
	11	.9983	.9951	.9874	.9704	.9363	.8733	.7664	.6017	.3787	.1354
	12	.9999	.9996	.9987	.9963	.9903	.9762	.9450	.8791	.7458	.4867
	13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0009	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0065	.0022	.0006	.0001	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0287	.0114	.0039	.0011	.0002	.0000	.0000	.0000	.0000	.0000
	4	.0898	.0462	.0175	.0060	.0017	.0003	.0000	.0000	.0000	.0000
	5	.2120	.1189	.0583	.0243	.0083	.0022	.0004	.0000	.0000	.0000
	6	.3953	.2586	.1501	.0753	.0315	.0108	.0024	.0003	.0000	.0000
	7	.6047	.4539	.3075	.1836	.0933	.0383	.0116	.0022	.0002	.0000
	8	.7880	.6627	.5141	.3595	.2195	.1117	.0439	.0115	.0015	.0000
	9	.9102	.8328	.7207	.5773	.4158	.2585	.1298	.0467	.0092	.0004
	10	.9713	.9368	.8757	.7795	.6448	.4787	.3018	.1465	.0441	.0042
	11	.9935	.9830	.9602	.9161	.8392	.7189	.5519	.3521	.1584	.0301
	12	.9991	.9971	.9919	.9795	.9525	.8990	.8021	.6433	.4154	.1530
	13	.9999	.9998	.9992	.9976	.9932	.9822	.9560	.8972	.7712	.5123
	14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
15	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0005	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0037	.0011	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0176	.0063	.0019	.0005	.0001	.0000	.0000	.0000	.0000	.0000
	4	.0592	.0255	.0093	.0028	.0007	.0001	.0000	.0000	.0000	.0000
	5	.1509	.0769	.0338	.0124	.0037	.0008	.0001	.0000	.0000	.0000
	6	.3036	.1818	.0950	.0422	.0152	.0042	.0008	.0001	.0000	.0000
	7	.5000	.3465	.2131	.1132	.0500	.0173	.0042	.0006	.0003	.0000
	8	.6964	.5478	.3902	.2452	.1311	.0566	.0181	.0036	.0022	.0001
	9	.8491	.7392	.5968	.4357	.2784	.1484	.0611	.0168	.0127	.0006
	10	.9408	.8796	.7827	.6481	.4845	.3135	.1642	.0617	.0556	.0055
	11	.9824	.9576	.9095	.8273	.7031	.5387	.3518	.1773	.1841	.0362
	12	.9963	.9893	.9729	.9383	.8732	.7639	.6020	.3958	.4510	.1710
	13	.9995	.9983	.9948	.9858	.9647	.9198	.8329	.6814	.7941	.5367
	14	1.0000	.9999	.9995	.9984	.9953	.9866	.9648	.9126	1.0000	1.0000
	15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0021	.0006	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0106	.0035	.0009	.0002	.0000	.0000	.0000	.0000	.0000	.0000
	4	.0384	.0149	.0049	.0013	.0003	.0000	.0000	.0000	.0000	.0000
	5	.1051	.0486	.0191	.0062	.0016	.0003	.0000	.0000	.0000	.0000
	6	.2272	.1241	.0583	.0229	.0071	.0016	.0002	.0000	.0000	.0000
	7	.4018	.2559	.1423	.0671	.0257	.0075	.0015	.0002	.0000	.0000
	8	.5982	.4371	.2839	.1594	.0744	.0271	.0070	.0011	.0001	.0000
	9	.7228	.6340	.4728	.3119	.1753	.0796	.0267	.0056	.0005	.0001
	10	.8949	.8024	.6712	.5100	.3402	.1897	.0817	.0235	.0033	.0009
	11	.9616	.9147	.8334	.7108	.5501	.3698	.2018	.0791	.0170	.0070
	12	.9894	.9719	.9349	.8661	.7541	.5950	.4019	.2101	.0684	.0429
	13	.9979	.9934	.9817	.9549	.9006	.8729	.6482	.4386	.2108	.1892
	14	.9997	.9990	.9967	.9902	.9739	.9365	.8593	.7176	.4853	.5599
	15	1.0000	.9999	.9997	.9990	.9967	.9900	.9719	.9257	.8147	1.0000
	16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
17	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0012	.0003	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0064	.0019	.0005	.0001	.0000	.0000	.0000	.0000	.0000	.0000
	4	.0245	.0086	.0025	.0006	.0001	.0000	.0000	.0000	.0000	.0000
	5	.0717	.0301	.0106	.0030	.0007	.0001	.0000	.0000	.0000	.0000
	6	.1662	.0826	.0348	.0120	.0032	.0006	.0001	.0000	.0000	.0000
	7	.3145	.1834	.0919	.0383	.0127	.0031	.0005	.0000	.0000	.0000
	8	.5000	.3374	.1989	.0994	.0403	.0124	.0026	.0003	.0000	.0000
	9	.6855	.5257	.3595	.2128	.1046	.0402	.0109	.0017	.0001	.0000
	10	.8338	.7098	.5522	.3812	.2248	.1071	.0377	.0083	.0008	.0000
	11	.9283	.8529	.7361	.5803	.4032	.2347	.1057	.0319	.0047	.0001
	12	.9755	.9404	.8740	.7652	.6113	.4261	.2418	.0987	.0221	.0012
	13	.9936	.9816	.9536	.8972	.7981	.6470	.4511	.2444	.0826	.0088
	14	.9988	.9959	.9877	.9673	.9226	.8363	.6904	.4802	.2382	.0503
	15	.9999	.9994	.9979	.9933	.9807	.9499	.8818	.7475	.5182	.2078
	16	1.0000	1.0000	.9998	.9993	.9977	.9925	.9775	.9369	.8332	.5819
	17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0007	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0038	.0010	.0002	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	4	.0154	.0049	.0013	.0003	.0000	.0000	.0000	.0000	.0000	.0000
	5	.0481	.0183	.0058	.0014	.0003	.0000	.0000	.0000	.0000	.0000
	6	.1189	.0537	.0203	.0062	.0014	.0002	.0000	.0000	.0000	.0000
	7	.2403	.1280	.0576	.0212	.0061	.0012	.0002	.0000	.0000	.0000
	8	.4073	.2527	.1347	.0597	.0210	.0054	.0009	.0001	.0000	.0000
	9	.5927	.4222	.2632	.1391	.0596	.0163	.0031	.0003	.0002	.0000
	10	.7597	.6085	.4366	.2717	.1407	.0569	.0163	.0027	.0002	.0000
	11	.8811	.7742	.6457	.4509	.2783	.1390	.0513	.0118	.0012	.0000
	12	.9519	.8923	.7912	.6450	.4656	.2825	.1329	.0419	.0064	.0002
	13	.9846	.9589	.9058	.8114	.6673	.4813	.2836	.1206	.0282	.0015
	14	.9962	.9880	.9672	.9217	.8354	.6943	.4990	.2798	.0982	.0109
	15	.9993	.9975	.9918	.9764	.9400	.8647	.7287	.5203	.2662	.0581
	16	.9999	.9997	.9987	.9954	.9858	.9605	.9009	.7759	.5497	.2265
	17	1.0000	1.0000	.9999	.9996	.9984	.9944	.9820	.9464	.8499	.6028
	18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

n	k	p = .50	.55	.60	.65	.70	.75	.80	.85	.90	.95
19	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0004	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0022	.0005	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	4	.0096	.0028	.0006	.0001	.0000	.0000	.0000	.0000	.0000	.0000
	5	.0318	.0109	.0031	.0007	.0001	.0000	.0000	.0000	.0000	.0000
	6	.0835	.0342	.0116	.0031	.0006	.0001	.0000	.0000	.0000	.0000
	7	.1796	.0871	.0352	.0114	.0028	.0005	.0000	.0000	.0000	.0000
	8	.3238	.1841	.0885	.0347	.0105	.0023	.0003	.0000	.0000	.0000
	9	.5000	.3290	.1861	.0875	.0326	.0287	.0067	.0008	.0000	.0000
	10	.6762	.5060	.3325	.1855	.0839	.0287	.0233	.0041	.0008	.0000
	11	.8204	.6831	.5122	.3144	.1820	.0775	.0233	.0041	.0008	.0000
	12	.9165	.8273	.6919	.5188	.3345	.1749	.0676	.0163	.0017	.0000
	13	.9682	.9223	.8371	.7032	.5261	.3322	.1631	.0537	.0086	.0002
	14	.9904	.9720	.9304	.8500	.7178	.5346	.3267	.1444	.0352	.0020
	15	.9978	.9923	.9770	.9409	.8668	.7369	.5449	.3159	.1150	.0132
	16	.9996	.9985	.9945	.9830	.9538	.8887	.7631	.5587	.2946	.0665
	17	1.0000	.9998	.9992	.9969	.9896	.9690	.9171	.8015	.5797	.2453
	18	1.0000	1.0000	.9999	.9997	.9989	.9958	.9856	.9544	.8649	.6226
	19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	2	.0002	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	3	.0013	.0003	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	4	.0059	.0015	.0003	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	5	.0207	.0064	.0016	.0003	.0000	.0000	.0000	.0000	.0000	.0000
	6	.0577	.0214	.0065	.0015	.0003	.0000	.0000	.0000	.0000	.0000
	7	.1316	.0580	.0210	.0060	.0013	.0002	.0000	.0000	.0000	.0000
	8	.2517	.1308	.0565	.0196	.0051	.0009	.0001	.0000	.0000	.0000
	9	.4119	.2493	.1275	.0532	.0171	.0039	.0006	.0000	.0000	.0000
	10	.5881	.4086	.2447	.1218	.0480	.0139	.0026	.0002	.0000	.0000
	11	.7483	.5857	.4044	.2376	.1133	.0409	.0100	.0013	.0001	.0000
	12	.8684	.7480	.5841	.3990	.2277	.1018	.0321	.0059	.0004	.0000
	13	.9423	.8701	.7500	.5834	.3920	.2142	.0867	.0219	.0024	.0000
	14	.9793	.9447	.8744	.7546	.5836	.3828	.1958	.0673	.0113	.0003
	15	.9941	.9811	.9490	.8818	.7625	.5852	.3704	.1702	.0432	.0026
	16	.9987	.9951	.9840	.9556	.8929	.7748	.5886	.3523	.1330	.0159
	17	.9998	.9991	.9964	.9879	.9645	.9087	.7939	.5951	.3231	.0755
	18	1.0000	.9999	.9995	.9979	.9924	.9757	.9308	.8244	.6083	.2642
	19	1.0000	1.0000	1.0000	.9998	.9992	.9968	.9885	.9612	.8784	.6415
	20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

TABLE X   Critical values of F_{max}

p \ a	2	3	4	5	6	7	8	9	10	11	12
2	39.0	87.5	142.	202.	266.	333.	403.	475.	550.	626.	704.
	199.	448.	729.	1036.	1362.	1705.	2063.	2432.	2813.	3204.	3605.
3	15.4	27.8	39.2	50.7	62.0	72.9	83.5	93.9	104.	114.	124.
	47.5	85.	120.	151.	184.	21(6)	24(9)	28(1)	31(0)	33(7)	36(1)
4	9.60	15.5	20.6	25.2	29.5	33.6	37.5	41.1	44.6	48.0	51.4
	23.2	37.	49.	59.	69.	79.	89.	97.	106.	113.	120.
5	7.15	10.8	13.7	16.3	18.7	20.8	22.9	24.7	26.5	28.2	29.9
	14.9	22.	28.	33.	38.	42.	46.	50.	54.	57.	60.
6	5.82	8.38	10.4	12.1	13.7	15.0	16.3	17.5	18.6	19.7	20.7
	11.1	15.5	19.1	22.	25.	27.	30.	32.	34.	36.	37.
7	4.99	6.94	8.44	9.70	10.8'	11.8	12.7	13.5	14.3	15.1	15.8
	8.89	12.1	14.5	16.5	18.4	20.	22.	23.	24.	26.	27.
8	4.43	6.00	7.18	8.12	9.03	9.78	10.5	11.1	11.7	12.2	12.7
	7.50	9.9	11.7	13.2	14.5	15.8	16.9	17.9	18.9	19.8	21.
9	4.03	5.34	6.31	7.11	7.80	8.41	8.95	9.45	9.91	10.3	10.7
	6.54	8.5	9.9	11.1	12.1	13.1	13.9	14.7	15.3	16.0	16.6
10	3.72	4.85	5.67	6.34	6.92	7.42	7.87	8.28	8.66	9.01	9.34
	5.85	7.4	8.6	9.6	10.4	11.1	11.8	12.4	12.9	13.4	13.9
12	3.28	4.16	4.79	5.30	5.72	6.09	6.42	6.72	7.00	7.25	7.48
	4.91	6.1	6.9	7.6	8.2	8.7	9.1	9.5	9.9	10.2	10.6
15	2.86	3.54	4.01	4.37	4.68	4.95	5.19	5.40	5.59	5.77	5.93
	4.07	4.9	5.5	6.0	6.4	6.7	7.1	7.3	7.5	7.8	8.0
20	2.46	2.95	3.29	3.54	3.76	3.94	4.10	4.24	4.37	4.49	4.59
	3.32	3.8	4.3	4.6	4.9	5.1	5.3	5.5	5.6	5.8	5.9
30	2.07	2.40	2.61	2.78	2.91	3.02	3.12	3.21	3.29	3.36	3.39
	2.63	3.0	3.3	3.4	3.6	3.7	3.8	3.9	4.0	4.1	4.2
60	1.67	1.85	1.96	2.04	2.11	2.17	2.22	2.26	2.30	2.33	2.36
	1.96	2.2	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7
∞	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

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TABLE V Chi square

Column headings indicate probability of chance

deviation between O and E.

P D.F.	0.25	0.10	0.05	0.025	0.01	0.005
1.	1.323	2.706	3.841	5.024	6.635	7.879
2.	2.773	4.605	5.991	7.378	9.210	10.597
3.	4.108	6.251	7.815	9.348	11.345	12.838
4.	5.385	7.779	9.488	11.143	13.277	14.860
5.	6.626	9.236	11.071	12.833	15.086	16.750
6.	7.841	10.645	12.592	14.449	16.812	18.548
7.	9.037	12.017	14.067	16.013	18.475	20.278
8.	10.219	13.362	15.507	17.535	20.090	21.955
9.	11.389	14.684	16.919	19.023	21.666	23.589
10.	12.549	15.987	18.307	20.483	23.209	25.188
11.	13.701	17.275	19.675	21.920	24.725	26.757
12.	14.845	18.549	21.026	23.337	26.217	28.299
13.	15.984	19.812	22.362	24.736	27.688	29.819
14.	17.117	21.064	23.685	26.119	29.141	31.319
15.	18.245	22.307	24.996	27.488	30.578	32.801