UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Tambahan
Sidang 1989/90

Jun 1990

FMT 202 Statistik

Masa: (2 jam)

Kertas ini mengandungi ENAM soalan.

Jawab LIMA (5) soalan sahaja.

Semua soalan mesti dijawab di dalam Bahasa Malaysia.

...2/-

1. Dengan menggunakan data yang berikut, kirakan <u>purata</u> (mean), <u>trimean</u> dan <u>median</u>.

Kelas	Frekuensi
10-24	13
25-39	15
40-54	30
55-69	42
70-84	60
85-99	40

(20 markah)

2. (A) Di dalam sebuah kotak ada 30 biji tablet aspirin dan 10 biji tablet parasetamol. Sekiranya 4 biji tablet dikeluarkan dari kotak itu secara rawak, apakah kebarangkalian X di dalam 4 biji tablet itu? (X = bilangan aspirin di dalam 4 biji tablet itu).

(B) (i) Apakah kebarangkalian apabila X bernilai ganjil?

(ii) Apakah kebarangkalian apabila X bernilai $>$ 2?

(20 markah)

3. (A) Diberikan taburan frekuensi yang menunjukkan berat pencemar (mg) di dalam tablet penisilin. Gunakan kaedah transformasi linear, kirakan kevarinan dan sisihan piawainya.

Berat Pencemar (mg)	Frekuensi
0.018-0.032	5
0.033-0.037	10
0.038-0.042	10
0.043-0.047	30
0.048-0.052	35
0.053-0.067	10

(10 markah)

(B) Satu kajian dijalankan untuk menentukan hubungan paras kolesterol dengan pendapatan bulanan. Keputusan kajian ini disenaraikan di bawah.

	Paras Kolesterol		
Pendapatan	Tinggi	Biasa	Rendah
> $1000	45	20	15
$500-$1000	32	25	31
< $500	20	20	31

Pilih satu ujian statistik yang sesuai untuk menentukan sama ada kedua-dua pembolehubah ini bersandar atau tidak pada paras kesignifikanan 95%.

(10 markah)

4. Satu kajian kebioperolehan dijalankan untuk membanding amaun drug yang diserap dari dua formulasi, A dan B.

Dua belas subjek manusia dipilih dan dibahagikan secara rawak kepada dua kumpulan, di mana satu kumpulan diberi formulasi A dan yang lain diberikan B. Data berikut diperolehi.

Amaun Yang Diserap (mg)	
Formulasi A	Formulasi B
99.0	102.5
117.5	100.5
90.0	77.5
105	70.5
130	76
101.5	81.2

(A) Pilih satu ujian parametrik yang sesuai untuk menentukan sama ada terdapat perbezaan yang signifikan di antara dua formulasi ini.

(10 markah)

(B) Pilih satu ujian bukan parametrik yang sesuai untuk menentukan sama ada terdapat perbezaan yang signifikan di antara dua formulasi ini.

(10 markah)

5. Seorang saintis ingin membanding kesan 3 jenis ubat tradisional ke atas berat badan manusia. Lapan belas subjek dengan berat badan 65-70 kg dipilih dan dibahagikan secara rawak kepada 3 kumpulan. Setiap kumpulan diberikan salah satu jenis ubat tradisional selama 3 bulan. Selepas rawatan ini peratus penambahan berat badan dihitungkan.

Jenis Ubat		
A	B	C
7.1	7.5	7.6
7.9	8.2	7.0
8.0	6.0	8.0
7.2	6.6	9.0
8.8	7.4	8.2
6.4	5.8	7.5

(A) Bandingkan kesan ubat-ubat ini dan pilih satu ujian statistik yang sesuai untuk menentukan sama ada terdapat perbezaan yang signifikan.

(15 markah)

(B) Beri alasan-alasan mengapa anda memilih ujian statistik tersebut.

(5 markah)

...6/-

6. Satu kajian dijalankan untuk menentukan hubungan umur dan kadar jantung dalam kanak-kanak yang berumur satu hingga lima belas tahun. Data berikut diperolehi

Subjek	Umur	Kadar Jantung
A	1	111
B	2	108
C	3	108
D	4	102
E	5	99
F	6	92
G	7	93
H	8	88
I	9	90
J	10	90
K	11	88
L	12	86
M	13	84
N	14	83
O	15	82

(A) Hitungkan pekali regresi.

(B) Lukiskan garisan penyesuaian terbaik.

(C) Hitungkan pekali penentuan.

(D) Ujikan pekali regresi bagi kesignifikanan.

(20 markah)

...7/-

FORMULA

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

2. $u_i = Ax_i + B$.

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

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

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

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

7. Ujian-t

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

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

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

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

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

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

...8/-

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)

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

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

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

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

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

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

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

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

...9/-

11. **Ujian Kruskal-Wallis**

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

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

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**

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

d.f. = k - 1

Ujian perbandingan berganda:

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

13: **Formula Sturges**

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

... 10/-

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

$$y = mx + c$$

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

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

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

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

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

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 <u>greater than</u> 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.**

...12/-

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
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
12	58	.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
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									

...14/-

TABLE VII Critical Values of F

The obtained F is significant at a given level if it is equal to or <u>greater than</u> 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 lesser mean square	Degrees of freedom for greater mean square																							
	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

...15/-

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																							
Degrees of freedom for lesser mean square	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 3.37	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	1.80 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	2.32 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	2.39 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	3.24 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 5.52	2.93 4.54	2.70 4.04	2.54 3.73	2.43 3.50	2.35 3.32	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)

...16/-

TABLE VII *(continued)*

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

Degrees of freedom for lesser mean square	Degrees of freedom for greater mean square																						
	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
36	4.11 7.39	3.26 5.25	2.86 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	1.89 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	1.90 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 2.09	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	2.32 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 lesser mean square	Degrees of freedom for greater mean square																							
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞
100	3.94 6.90	3.09 4.82	2.70 3.98	2.46 3.51	2.30 3.20	2.19 2.99	2.10 2.82	2.03 2.69	1.97 2.59	1.92 2.51	1.88 2.43	1.85 2.36	1.79 2.26	1.75 2.19	1.68 2.06	1.63 1.98	1.57 1.89	1.51 1.79	1.48 1.73	1.42 1.64	1.39 1.59	1.34 1.51	1.30 1.46	1.28 1.43
125	3.92 6.84	3.07 4.73	2.68 3.94	2.44 3.47	2.29 3.17	2.17 2.95	2.08 2.79	2.01 2.65	1.95 2.56	1.90 2.47	1.86 2.40	1.83 2.33	1.77 2.23	1.72 2.15	1.65 2.03	1.60 1.94	1.55 1.85	1.49 1.75	1.45 1.68	1.39 1.59	1.36 1.54	1.31 1.46	1.27 1.40	1.25 1.37
150	3.91 6.81	3.06 4.75	2.67 3.91	2.43 3.44	2.27 3.13	2.16 2.92	2.07 2.76	2.00 2.62	1.94 2.53	1.89 2.44	1.85 2.37	1.82 2.30	1.76 2.20	1.71 2.12	1.64 2.00	1.59 1.91	1.54 1.83	1.47 1.72	1.44 1.66	1.37 1.56	1.34 1.51	1.29 1.43	1.25 1.37	1.22 1.33
200	3.89 6.76	3.04 4.71	2.65 3.38	2.41 3.41	2.26 3.11	2.14 2.90	2.05 2.73	1.98 2.60	1.92 2.50	1.87 2.41	1.83 2.34	1.80 2.28	1.74 1.17	1.69 2.09	1.62 1.97	1.57 1.88	1.52 1.79	1.45 1.69	1.42 1.62	1.35 1.53	1.32 1.48	1.26 1.39	1.22 1.33	1.19 1.28
400	3.86 6.70	3.02 4.66	2.62 3.83	2.39 3.36	2.23 3.06	2.12 2.85	2.03 2.69	1.96 2.55	1.90 2.46	1.85 2.37	1.81 2.29	1.78 2.23	1.72 2.12	1.67 2.04	1.60 1.92	1.54 1.84	1.49 1.74	1.42 1.64	1.38 1.57	1.32 1.47	1.28 1.42	1.22 1.32	1.16 1.24	1.13 1.19
1000	3.85 6.66	3.00 4.62	2.61 3.80	2.38 3.34	2.22 3.04	2.10 2.82	2.02 2.66	1.95 2.53	1.89 2.43	1.84 2.34	1.80 2.26	1.76 2.20	1.70 2.09	1.65 2.01	1.58 1.89	1.53 1.81	1.47 1.71	1.41 1.61	1.36 1.54	1.30 1.44	1.26 1.38	1.19 1.28	1.13 1.19	1.08 1.11
∞	3.84 6.64	2.99 4.60	2.60 3.78	2.37 3.32	2.21 3.02	2.09 2.80	2.01 2.64	1.94 2.51	1.88 2.41	1.83 2.32	1.79 2.24	1.75 2.18	1.69 2.07	1.64 1.99	1.57 1.87	1.52 1.79	1.46 1.69	1.40 1.59	1.35 1.52	1.28 1.41	1.24 1.36	1.17 1.25	1.11 1.15	1.00 1.00

From G. W. Snedecor, *Statistical Methods*, 5th edition. Copyright © 1956 by the Iowa State University Press, Ames, Iowa. Reprinted by permission of the publisher.

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
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

...19/-

TABLE IX (*continued*)

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

...20/-

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

From D. B. Owen, *Handbook of Statistical Tables*. Reading, MA: Addison-Wesley, 1962. Reprinted by permission.

...21/-

TABLE X Critical values of F_{max}

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

From H. A. David, *Biometrika*, 39, 422-4. Reprinted by permission of the Biometrika trustees.

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

Adapted from table of χ^2 appearing in *Handbook of Statistical Tables* by D. B. Owen, Addison-Wesley, 1962, p. 50. Reprinted by permission of the U.S. Atomic Energy Commission.

-ooOoo-