

UNIVERSITI SAINS MALAYSIA

**Peperiksaan Semester Pertama
Sidang Akademik 1996/97**

Oktober/November 1996

FMS 161 - Matematik & Statistik untuk Farmasi

Masa: 3 jam

Kertas ini mengandungi **ENAM (6)** soalan dan 27 muka surat yang bertaip.

Jawab **LIMA (5)** soalan sahaja.

Semua soalan mesti dijawab di dalam Bahasa Malaysia.

.....2/-

II. (A) Terangkan berserta contoh bagaimana aspek-aspek berikut dapat mempengaruhi aplikasi hasil percubaan klinikal (clinical trial) yang dijalankan untuk menilai terapi ubat sesuatu penyakit.

- (i) Pemilihan populasi kajian
- (ii) Kumpulan kawalan
- (iii) Intervensi atau rawatan yang diberikan

(10 markah)

(B) Tentukan $\frac{dy}{dx}$ untuk fungsi berikut:

(i) $y = \frac{x^3}{1 - x^4}$

(ii) $y = 3x^2(1 - x^4)$

(iii) $y = \frac{2x + 3}{x^2 + 1}$

(iv) $y = \frac{x + 1}{\sqrt{x}}$

(v) $y = \left(\frac{x}{x + 1} \right)^2$

(5 markah)

(C) Lakarkan fungsi berikut:

$$y = 5 + 8x^2 + 4x^3 - x^4$$

(5 markah)

.....4/-

IV. (A) Bincangkan ciri-ciri taburan normal dan kaitannya dengan paras signifikan dalam statistik.

(5 markah)

(B) Berikan klasifikasi rekabentuk kajian dan jenis-jenis kajian yang terlibat

(5 markah)

(C) Jika dos purata orang dewasa bagi drug x ialah 50 mg., kirakan dos kanak-kanak yang mempunyai luas permukaan badan 0.57 meter persegi.
(Diberi luas permukaan badan orang dewasa ialah 1.73 meter persegi)

(3 markah)

(D) Kirakan amaun yang diperlukan untuk menyediakan 100 gm serbuk antiseptik. Diberi:

| | | |
|-----------|---|---------------|
| Pepejal A | - | 2 gm |
| Pepejal B | - | 1 gm |
| Pepejal C | - | 7 gm |
| Pepejal D | - | 25 gm |
| Pepejal E | - | <u>115 gm</u> |
| | | <u>150 gm</u> |

(2 markah)

(E) Berikan arahan pencairan untuk 500 ml larutan 1 dalam 5000 larutan kalium permanganat daripada 0.25% larutan.

(5 markah)

.....6/-

- V. (B) Satu kajian kes-kontrol untuk mengkaji perhubungan di antara penggunaan alkohol dengan penyakit jantung telah dijalankan dan menghasilkan keputusan seperti dalam jadual 1.0 berikut:

Jadual 1.0: Penggunaan Alkohol Harian Oleh Pesakit Jantung dan Kontrol

| Bilangan Minum Alkohol/ Hari | Sakit Jantung | | Kontrol | |
|------------------------------|---------------|------|---------|------|
| | Bil. | % | Bil. | % |
| 0 (tidak minum) | 136 | 34.8 | 110 | 26.3 |
| ≤ 2 | 202 | 51.7 | 238 | 56.9 |
| 3 - 5 | 42 | 10.7 | 46 | 11.0 |
| > 6 | 11 | 2.8 | 24 | 5.7 |
| Total | 391 | 100 | 418 | 100 |

Soalan:

Hitung nilai risiko relatif bagi kumpulan berikut:

- (i) Kumpulan yang minum dua kali sehari atau kurang daripada dua kali sehari (≤ 2 /hari)
- (ii) Kumpulan yang minum 3 - 5 kali sehari.
- (iii) Kumpulan yang minum > 6 kali sehari

Anda diberikan:

$$\begin{aligned} \text{Risiko relatif} &= \frac{\text{kadar penyakit bagi subjek dengan faktor}}{\text{kadar penyakit bagi subjek tanpa faktor}} \\ &= \frac{A \times D}{B \times C} \end{aligned}$$

(10 markah)

.....8/-

(FMS 161)

- (C) i. Suatu kajian melibatkan drug baru A dilakukan untuk menentukan jangkamasa drug tersebut berada di dalam darah. Amaun $Q(t)$ yang disukat dalam milligram pada masa t ialah

$$Q(t) = 40 - \frac{t^2}{120}$$

dengan masa t diukur dalam unit minit. Tentukan kadar perubahan $Q(t)$ apabila $t = 30$ minit.

- ii. Jika kepekatan (C) untuk suatu drug di dalam darah selepas diberikan pada selang masa t jam diberikan sebagai

$$C = \frac{5t}{t^2 + 3} \quad t \geq 0$$

Tentukan masa untuk kepekatan drug mencapai paras maksimum.

(5 markah)

.....10/-

TABLE X Critical values of F_{max}

| $p =$ | 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.

11. Ujian Kruskal-Wallis

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

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

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

Ujian perbandingan berganda:

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

12. Ujian Friedman

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

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

Ujian perbandingan berganda:

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

13. Formula Sturges

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

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 IX Critical values of U

| 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 |
|-------|-------|------|------|-------|------|-------|-------|-------|-------|------|------|-------|------|-------|-------|
| 3 | 2 | 6 | - | - | - | - | - | 10 | 5 | 37 | 39 | 42 | 44 | 46 | 49 |
| | 3 | 8 | 9 | - | - | - | - | | 6 | 43 | 46 | 49 | 52 | 54 | 57 |
| 4 | 2 | 8 | - | - | - | - | - | | 7 | 49 | 53 | 56 | 59 | 61 | 65 |
| | 3 | 11 | 12 | - | - | - | - | | 8 | 56 | 60 | 63 | 67 | 69 | 74 |
| | 4 | 13 | 15 | 16 | - | - | - | | 9 | 62 | 66 | 70 | 74 | 77 | 82 |
| 5 | 2 | 9 | 10 | - | - | - | - | 10 | 10 | 68 | 73 | 77 | 81 | 84 | 90 |
| | 3 | 13 | 14 | 15 | - | - | - | 11 | 1 | 11 | - | - | - | - | - |
| | 4 | 16 | 18 | 19 | 20 | - | - | | 2 | 19 | 21 | 22 | - | - | - |
| | 5 | 20 | 21 | 23 | 24 | 25 | - | | 3 | 26 | 28 | 30 | 32 | 33 | - |
| 6 | 2 | 11 | 12 | - | - | - | - | | 4 | 33 | 36 | 38 | 40 | 42 | 44 |
| 6 | 3 | 15 | 16 | 17 | - | - | - | 11 | 5 | 40 | 43 | 46 | 48 | 50 | 53 |
| | 4 | 19 | 21 | 22 | 23 | 24 | - | | 6 | 47 | 50 | 53 | 57 | 59 | 62 |
| | 5 | 23 | 25 | 27 | 28 | 29 | - | | 7 | 54 | 58 | 61 | 65 | 67 | 71 |
| | 6 | 27 | 29 | 31 | 33 | 34 | - | | 8 | 61 | 65 | 69 | 73 | 75 | 80 |
| 7 | 2 | 13 | 14 | - | - | - | - | | 9 | 68 | 72 | 76 | 81 | 83 | 89 |
| 7 | 3 | 17 | 19 | 20 | 21 | - | - | 11 | 10 | 74 | 79 | 84 | 88 | 92 | 98 |
| | 4 | 22 | 24 | 25 | 27 | 28 | - | | 11 | 81 | 87 | 91 | 96 | 100 | 106 |
| | 5 | 27 | 29 | 30 | 32 | 34 | - | 12 | 1 | 12 | - | - | - | - | - |
| | 6 | 31 | 34 | 36 | 38 | 39 | 42 | | 2 | 20 | 22 | 23 | - | - | - |
| | 7 | 36 | 38 | 41 | 43 | 45 | 48 | | 3 | 28 | 31 | 32 | 34 | 35 | - |
| 8 | 2 | 14 | 15 | 16 | - | - | - | 12 | 4 | 36 | 39 | 41 | 43 | 45 | 48 |
| | 3 | 19 | 21 | 22 | 24 | - | - | | 5 | 43 | 47 | 49 | 52 | 54 | 58 |
| | 4 | 25 | 27 | 28 | 30 | 31 | - | | 6 | 51 | 55 | 58 | 61 | 63 | 68 |
| | 5 | 30 | 32 | 34 | 36 | 38 | 40 | | 7 | 58 | 63 | 66 | 70 | 72 | 77 |
| | 6 | 35 | 38 | 40 | 42 | 44 | 47 | | 8 | 66 | 70 | 74 | 79 | 81 | 87 |
| 8 | 7 | 40 | 43 | 46 | 49 | 50 | 54 | 12 | 9 | 73 | 78 | 82 | 87 | 90 | 96 |
| | 8 | 45 | 49 | 51 | 55 | 57 | 60 | | 10 | 81 | 86 | 91 | 96 | 99 | 106 |
| 9 | 1 | 9 | - | - | - | - | - | | 11 | 88 | 94 | 99 | 104 | 108 | 115 |
| | 2 | 16 | 17 | 18 | - | - | - | | 12 | 95 | 102 | 107 | 113 | 117 | 124 |
| | 3 | 22 | 23 | 25 | 26 | 27 | - | 13 | 1 | 13 | - | - | - | - | - |
| 9 | 4 | 27 | 30 | 32 | 33 | 35 | - | 13 | 2 | 22 | 24 | 25 | 26 | - | - |
| | 5 | 33 | 36 | 38 | 40 | 42 | 44 | | 3 | 30 | 33 | 35 | 37 | 38 | - |
| | 6 | 39 | 42 | 44 | 47 | 49 | 52 | | 4 | 39 | 42 | 44 | 47 | 49 | 51 |
| | 7 | 45 | 48 | 51 | 54 | 56 | 60 | | 5 | 47 | 50 | 53 | 56 | 58 | 62 |
| | 8 | 50 | 54 | 57 | 61 | 63 | 67 | | 6 | 55 | 59 | 62 | 66 | 68 | 73 |
| 9 | 9 | 56 | 60 | 64 | 67 | 70 | 74 | 13 | 7 | 63 | 67 | 71 | 75 | 78 | 83 |
| 10 | 1 | 10 | - | - | - | - | - | | 8 | 71 | 76 | 80 | 84 | 87 | 93 |
| | 2 | 17 | 19 | 20 | - | - | - | | 9 | 79 | 84 | 89 | 94 | 97 | 103 |
| | 3 | 24 | 26 | 27 | 29 | 30 | - | | 10 | 87 | 93 | 97 | 103 | 106 | 113 |
| | 4 | 30 | 33 | 35 | 37 | 38 | 40 | | 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 |
|-------|-------|------|------|-------|------|-------|-------|
| 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.

TABLE V Chi square

Column headings indicate probability of chance
deviation between O and E.

| D.F. \ P | 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.

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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 | | | | | | | | | | | | | | | | | | | | | | | |
|----|------|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 16 | 20 | 24 | 30 | 40 | 50 | 75 | 100 | 200 | 500 | ∞ |
| 16 | 0.05 | 4.49 | 3.63 | 3.24 | 3.01 | 2.85 | 2.74 | 2.66 | 2.59 | 2.54 | 2.49 | 2.45 | 2.42 | 2.37 | 2.33 | 2.28 | 2.24 | 2.20 | 2.16 | 2.13 | 2.09 | 2.07 | 2.04 | 2.02 | 2.01 |
| | 0.01 | 8.53 | 6.23 | 5.29 | 4.77 | 4.44 | 4.20 | 4.03 | 3.89 | 3.78 | 3.69 | 3.61 | 3.55 | 3.45 | 3.37 | 3.25 | 3.18 | 3.10 | 3.01 | 2.96 | 2.89 | 2.86 | 2.80 | 2.77 | 2.75 |
| 17 | 0.05 | 4.45 | 3.59 | 3.20 | 2.96 | 2.81 | 2.70 | 2.62 | 2.55 | 2.50 | 2.45 | 2.41 | 2.38 | 2.33 | 2.29 | 2.23 | 2.19 | 2.15 | 2.11 | 2.08 | 2.04 | 2.02 | 1.99 | 1.97 | 1.96 |
| | 0.01 | 8.40 | 6.11 | 5.18 | 4.67 | 4.34 | 4.10 | 3.93 | 3.79 | 3.68 | 3.59 | 3.52 | 3.45 | 3.35 | 3.27 | 3.16 | 3.08 | 3.00 | 2.92 | 2.86 | 2.79 | 2.76 | 2.70 | 2.67 | 2.65 |
| 18 | 0.05 | 4.41 | 3.55 | 3.16 | 2.93 | 2.77 | 2.66 | 2.58 | 2.51 | 2.46 | 2.41 | 2.37 | 2.34 | 2.29 | 2.25 | 2.19 | 2.15 | 2.11 | 2.07 | 2.04 | 2.00 | 1.98 | 1.95 | 1.93 | 1.92 |
| | 0.01 | 8.28 | 6.01 | 5.09 | 4.58 | 4.25 | 4.01 | 3.85 | 3.71 | 3.60 | 3.51 | 3.44 | 3.37 | 3.27 | 3.19 | 3.07 | 3.00 | 2.91 | 2.83 | 2.78 | 2.71 | 2.68 | 2.62 | 2.59 | 2.57 |
| 19 | 0.05 | 4.38 | 3.52 | 3.13 | 2.90 | 2.74 | 2.63 | 2.55 | 2.48 | 2.43 | 2.38 | 2.34 | 2.31 | 2.26 | 2.21 | 2.15 | 2.11 | 2.07 | 2.02 | 2.00 | 1.96 | 1.94 | 1.91 | 1.90 | 1.88 |
| | 0.01 | 8.18 | 5.93 | 5.01 | 4.50 | 4.17 | 3.94 | 3.77 | 3.63 | 3.52 | 3.43 | 3.36 | 3.30 | 3.19 | 3.12 | 3.00 | 2.92 | 2.84 | 2.76 | 2.70 | 2.63 | 2.60 | 2.54 | 2.51 | 2.49 |
| 20 | 0.05 | 4.35 | 3.49 | 3.10 | 2.87 | 2.71 | 2.60 | 2.52 | 2.45 | 2.40 | 2.35 | 2.31 | 2.28 | 2.23 | 2.18 | 2.12 | 2.08 | 2.04 | 1.99 | 1.96 | 1.92 | 1.90 | 1.87 | 1.85 | 1.84 |
| | 0.01 | 8.10 | 5.85 | 4.94 | 4.43 | 4.10 | 3.87 | 3.71 | 3.56 | 3.45 | 3.37 | 3.30 | 3.23 | 3.13 | 3.05 | 2.94 | 2.86 | 2.77 | 2.69 | 2.63 | 2.56 | 2.53 | 2.47 | 2.44 | 2.42 |
| 21 | 0.05 | 4.32 | 3.47 | 3.07 | 2.84 | 2.68 | 2.57 | 2.49 | 2.42 | 2.37 | 2.32 | 2.28 | 2.25 | 2.20 | 2.15 | 2.09 | 2.05 | 2.00 | 1.96 | 1.93 | 1.88 | 1.87 | 1.84 | 1.82 | 1.81 |
| | 0.01 | 8.02 | 5.78 | 4.87 | 4.37 | 4.04 | 3.81 | 3.65 | 3.51 | 3.40 | 3.31 | 3.24 | 3.17 | 3.07 | 2.99 | 2.88 | 2.80 | 2.72 | 2.63 | 2.58 | 2.51 | 2.47 | 2.42 | 2.38 | 2.36 |
| 22 | 0.05 | 4.30 | 3.44 | 3.05 | 2.82 | 2.66 | 2.55 | 2.47 | 2.40 | 2.35 | 2.30 | 2.26 | 2.23 | 2.18 | 2.13 | 2.07 | 2.03 | 1.98 | 1.93 | 1.91 | 1.87 | 1.84 | 1.81 | 1.80 | 1.78 |
| | 0.01 | 7.94 | 5.72 | 4.82 | 4.31 | 3.99 | 3.76 | 3.59 | 3.45 | 3.35 | 3.26 | 3.18 | 3.12 | 3.02 | 2.94 | 2.83 | 2.75 | 2.67 | 2.58 | 2.53 | 2.46 | 2.42 | 2.37 | 2.33 | 2.31 |
| 23 | 0.05 | 4.28 | 3.42 | 3.03 | 2.80 | 2.64 | 2.53 | 2.45 | 2.38 | 2.32 | 2.28 | 2.24 | 2.20 | 2.14 | 2.10 | 2.04 | 2.00 | 1.96 | 1.91 | 1.88 | 1.84 | 1.82 | 1.79 | 1.77 | 1.76 |
| | 0.01 | 7.88 | 5.66 | 4.76 | 4.26 | 3.94 | 3.71 | 3.54 | 3.41 | 3.30 | 3.21 | 3.14 | 3.07 | 2.97 | 2.89 | 2.78 | 2.70 | 2.62 | 2.53 | 2.48 | 2.41 | 2.37 | 2.32 | 2.28 | 2.26 |
| 24 | 0.05 | 4.26 | 3.40 | 3.01 | 2.78 | 2.62 | 2.51 | 2.43 | 2.36 | 2.30 | 2.26 | 2.22 | 2.18 | 2.13 | 2.09 | 2.02 | 1.98 | 1.94 | 1.89 | 1.86 | 1.82 | 1.80 | 1.76 | 1.74 | 1.73 |
| | 0.01 | 7.82 | 5.61 | 4.72 | 4.22 | 3.90 | 3.67 | 3.50 | 3.36 | 3.25 | 3.17 | 3.09 | 3.03 | 2.93 | 2.85 | 2.74 | 2.66 | 2.58 | 2.49 | 2.44 | 2.36 | 2.33 | 2.27 | 2.23 | 2.21 |
| 25 | 0.05 | 4.24 | 3.38 | 2.99 | 2.76 | 2.60 | 2.49 | 2.41 | 2.34 | 2.28 | 2.24 | 2.20 | 2.16 | 2.11 | 2.06 | 2.00 | 1.96 | 1.92 | 1.87 | 1.84 | 1.80 | 1.77 | 1.74 | 1.72 | 1.71 |
| | 0.01 | 7.77 | 5.57 | 4.68 | 4.18 | 3.86 | 3.63 | 3.46 | 3.32 | 3.21 | 3.13 | 3.05 | 2.99 | 2.89 | 2.81 | 2.70 | 2.62 | 2.54 | 2.45 | 2.40 | 2.32 | 2.29 | 2.23 | 2.19 | 2.17 |
| 26 | 0.05 | 4.22 | 3.37 | 2.89 | 2.74 | 2.59 | 2.47 | 2.39 | 2.32 | 2.27 | 2.22 | 2.18 | 2.15 | 2.10 | 2.05 | 1.99 | 1.95 | 1.90 | 1.85 | 1.82 | 1.78 | 1.76 | 1.72 | 1.70 | 1.69 |
| | 0.01 | 7.72 | 5.53 | 4.64 | 4.14 | 3.82 | 3.59 | 3.42 | 3.29 | 3.17 | 3.09 | 3.02 | 2.96 | 2.86 | 2.77 | 2.66 | 2.58 | 2.50 | 2.41 | 2.36 | 2.28 | 2.25 | 2.19 | 2.15 | 2.13 |
| 27 | 0.05 | 4.21 | 3.35 | 2.96 | 2.73 | 2.57 | 2.46 | 2.37 | 2.30 | 2.25 | 2.20 | 2.16 | 2.13 | 2.08 | 2.03 | 1.97 | 1.93 | 1.88 | 1.84 | 1.80 | 1.76 | 1.74 | 1.71 | 1.68 | 1.67 |
| | 0.01 | 7.68 | 5.49 | 4.60 | 4.11 | 3.79 | 3.56 | 3.39 | 3.26 | 3.14 | 3.06 | 2.98 | 2.93 | 2.83 | 2.74 | 2.63 | 2.55 | 2.47 | 2.38 | 2.33 | 2.25 | 2.21 | 2.16 | 2.12 | 2.10 |
| 28 | 0.05 | 4.20 | 3.34 | 2.95 | 2.71 | 2.56 | 2.44 | 2.36 | 2.29 | 2.24 | 2.19 | 2.15 | 2.12 | 2.06 | 2.02 | 1.96 | 1.91 | 1.87 | 1.81 | 1.78 | 1.75 | 1.72 | 1.69 | 1.67 | 1.65 |
| | 0.01 | 7.64 | 5.45 | 4.57 | 4.07 | 3.76 | 3.53 | 3.36 | 3.23 | 3.11 | 3.03 | 2.95 | 2.90 | 2.80 | 2.71 | 2.60 | 2.52 | 2.44 | 2.35 | 2.30 | 2.22 | 2.18 | 2.13 | 2.09 | 2.06 |
| 29 | 0.05 | 4.18 | 3.33 | 2.93 | 2.70 | 2.54 | 2.43 | 2.35 | 2.28 | 2.22 | 2.18 | 2.14 | 2.10 | 2.05 | 2.00 | 1.94 | 1.90 | 1.85 | 1.80 | 1.77 | 1.73 | 1.71 | 1.68 | 1.65 | 1.64 |
| | 0.01 | 7.60 | 5.52 | 4.54 | 4.04 | 3.73 | 3.50 | 3.32 | 3.20 | 3.08 | 3.00 | 2.92 | 2.87 | 2.77 | 2.68 | 2.57 | 2.49 | 2.41 | 2.32 | 2.27 | 2.19 | 2.15 | 2.10 | 2.06 | 2.03 |
| 30 | 0.05 | 4.17 | 3.32 | 2.92 | 2.69 | 2.53 | 2.42 | 2.34 | 2.27 | 2.21 | 2.16 | 2.12 | 2.09 | 2.04 | 1.99 | 1.93 | 1.89 | 1.84 | 1.79 | 1.76 | 1.72 | 1.69 | 1.66 | 1.64 | 1.62 |
| | 0.01 | 7.56 | 5.39 | 4.51 | 4.02 | 3.70 | 3.47 | 3.30 | 3.17 | 3.06 | 2.98 | 2.90 | 2.84 | 2.74 | 2.66 | 2.55 | 2.47 | 2.38 | 2.29 | 2.24 | 2.16 | 2.13 | 2.07 | 2.03 | 2.01 |

(continued)

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 | | | | | | | | | | | | | | | | | | | | | | | |
|----------|---|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 16 | 20 | 24 | 30 | 40 | 50 | 75 | 100 | 200 | 500 | ∞ |
| 100 | Degrees of freedom for lesser mean square | 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 |
| | | 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 | 1.81 | 1.77 | 1.73 | 1.64 | 1.59 | 1.51 | 1.46 |
| 125 | Degrees of freedom for lesser mean square | 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 |
| | | 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 | 1.72 | 1.68 | 1.59 | 1.46 | 1.40 | 1.37 |
| 150 | Degrees of freedom for lesser mean square | 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 |
| | | 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 | 1.69 | 1.66 | 1.56 | 1.43 | 1.37 | 1.33 |
| 200 | Degrees of freedom for lesser mean square | 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 |
| | | 6.76 | 4.71 | 3.38 | 3.41 | 3.11 | 2.90 | 2.73 | 2.60 | 2.50 | 2.41 | 2.34 | 2.28 | 1.17 | 2.09 | 1.97 | 1.88 | 1.79 | 1.69 | 1.62 | 1.62 | 1.53 | 1.39 | 1.33 | 1.28 |
| 400 | Degrees of freedom for lesser mean square | 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 |
| | | 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 | Degrees of freedom for lesser mean square | 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 |
| | | 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 |
| ∞ | Degrees of freedom for lesser mean square | 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 |
| | | 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 |

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THE CORRELATION COEFFICIENT

Values of the correlation Coefficient for Different Levels of Significance (2 tail)

| d.f. | .1 | .05 | .02 | .01 | .001 |
|------|--------|--------|---------|---------|----------|
| 1. | .98769 | .99692 | .999507 | .999877 | .9999988 |
| 2. | .90000 | .95000 | .98000 | .990000 | .99900 |
| 3. | .8054 | .8783 | .93433 | .98573 | .99116 |
| 4. | .7293 | .8114 | .8822 | .91720 | .97406 |
| 5. | .6694 | .7545 | .8329 | .8745 | .95074 |
| 6. | .6215 | .7067 | .7887 | .8343 | .92493 |
| 7. | .5822 | .6664 | .7498 | .7977 | .8982 |
| 8. | .5494 | .6319 | .7155 | .7646 | .8721 |
| 9. | .5214 | .6021 | .6851 | .7348 | .8471 |
| 10. | .4973 | .5760 | .6581 | .7079 | .8233 |
| 11. | .4762 | .5529 | .6339 | .6835 | .8010 |
| 12. | .4575 | .5324 | .6120 | .6614 | .7800 |
| 13. | .4409 | .5139 | .5923 | .6411 | .7603 |
| 14. | .4259 | .4973 | .5742 | .6226 | .7420 |
| 15. | .4124 | .4821 | .5577 | .6055 | .7246 |

d.f. = degrees of freedom

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