UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 1998/99

Ogos/September 1998-07-16

APW300 – KAEDAH STATISTIKS

Masa: [3 jam]

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**ARAHAN**

Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEBELAS (11)** muka surat yang bercetak sebelum anda memulakan peperiksaan.

Jawab **LIMA (5)** soalan. Soalan 1 dan 2 adalah **WAJIB** dan pilih **TIGA (3)** soalan lain.

Soalan 1 (WAJIB)

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. JSAT Job Satisfaction

Block Number 1. Method: Enter
PAY PROMO SUPER WORK COWORK

Variable(s) Entered on Step Number
1.. COWORK Satisfaction with Co workers
2.. SUPER Satisfaction with Supervisors
3.. WORK Satisfaction with Nature of Work
4.. PAY Satisfaction with Pay
5.. PROMO Satisfaction with Promotional Opportuinities

| | |
|---|---|
| Multiple R | .67015 |
| R Square | .44910 |
| Adjusted R Square | .41949 |
| Standard Error | .74186 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square |
|---|---|---|---|
| Regression | 5 | 41.72585 | 8.34517 |
| Residual | 93 | 51.18324 | .55036 |

F = 15.16318 Signif F = .0000

---------- variables in the Equation ----------

| Variable | B | SE B | Beta | Tolerance | VIF | T |
|---|---|---|---|---|---|---|
| PAY | .190842 | .134580 | .159744 | .466795 | 2.142 | 1.418 |
| PROMO | .384400 | .132755 | .327633 | .462675 | 2.161 | 2.896 |
| SUPER | -.337542 | .122098 | -.301635 | .497575 | 2.010 | -2.765 |
| WORK | .661613 | .173294 | .395496 | .552007 | 1.812 | 3.818 |
| COWORK | .161096 | .130592 | .115025 | .681301 | 1.468 | 1.234 |
| Constant | 1.582698 | .306415 | | | | 5.165 |

------ in -------

| Variable | Sig T |
|---|---|
| PAY | .1595 |
| PROMO | .0047 |
| SUPER | .0069 |
| WORK | .0002 |
| COWORK | .2205 |
| Constant | .0000 |

Residuals Statistics:

| | Min | Max | Mean | Std Dev | N |
|---|---|---|---|---|---|
| *PRED | 1.6835 | 4.2565 | 2.9697 | .6525 | 99 |
| *RESID | -1.1206 | 1.7947 | .0000 | .7227 | 99 |
| *ZPRED | -1.9712 | 1.9720 | .0000 | 1.0000 | 99 |
| *ZRESID | -1.5106 | 2.4191 | .0000 | .9742 | 99 |

Total Cases = 129

Durbin-Watson Test = 2.07897

(a) Bentukkan persamaan regresi berganda yang bersesuaian.
(b) Tafsirkan koefisien penentuan.
(c) Ramalkan paras kepuasan kerja sekiranya diberikan PAY=2, PROMO=3, SUPER=5, WORK=1 dan COWORK=1.
(d) Dapatkah kelima-lima pembolehubah di atas menjelaskan variasi dalam kepuasan kerja secara bererti?
(e) Tentukan sama ada setiap pembolehubah mempunyai kesan terhadap kepuasan kerja.
(f) Terangkan fungsi statistik Durbin-Watson.
(g) Tulis satu laporan ringkas mengenai kegunaan dan had analisis ini?

[20 markah]

...3/-

Soalan 2 (WAJIB)

(a) Seorang penyelidik ingin mengkaji sama ada jualan cip adalah bersandar atau tidak bersandar pada kitaran ekonomi. Data dikutip mengenai jualan mingguan bersama dengan data mengenai kitaran ekonomi. Hasil adalah seperti berikut:

Jualan cip mingguan

| Ekonomi | Tinggi | Sederhana | Rendah | Jumlah |
|---|---|---|---|---|
| Puncak | 20 | 7 | 3 | 30 |
| Paling rendah | 30 | 40 | 30 | 100 |
| Meningkat | 20 | 8 | 2 | 30 |
| Menurun | 30 | 5 | 5 | 40 |
| Jumlah | 100 | 60 | 40 | 200 |

Gunakan ujian khi kuasa dua dan uji pada aras keertian 0.10, sama ada mereka bersandar atau tidak?

(b) Syarikat XYZ menggunakan proses pengeluaran secara kelompok untuk pengeluaran disket mereka. Setiap kelompok mengambil masa 8 jam untuk pengeluran dan kos bahan dan buruh adalah RM8,476. Oleh kerana variasi dalam kecekapan mesin dan kualiti bahan maka bilangan disket yang dikeluaran adalah secara rawak. Semua disket yang dikeluarakan boleh dijual dengan harga RM2.50 sekeping, pengeluaran kelompok adalah menguntungkan selagi julan melebihi RM12,500 secara purata. XYZ mengambil sampel 16 kelompok dan didapati purata adalah 5,040 disket dengan sisihan piawai 41.3 disket. Pada aras keertian 0.025, bolehkan XYZ simpulkan bahawa operasi secara kelompok ini menguntungkan?

[20 markah]

Pilih dan jawab TIGA (3) soalan.

Soalan 3

(a) Terangkan jenis-jenis pensampelan yang boleh digunakan dengan memberikan contoh yang sesuai.

(b) Gunakan ujian tanda untuk menentukan sama ada terdapat perbezaan antara bilangan hari yang diperlukan untuk mengutip akaun belum terima sebelum dan selepas pengenalan polisi kutipan baru. Gunakan aras keertian 0.05.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sebelum | 33 | 36 | 41 | 32 | 39 | 47 | 34 | 29 | 32 | 34 | 40 | 42 | 33 | 36 | 29 |
| Selepas | 35 | 29 | 38 | 34 | 37 | 47 | 36 | 32 | 30 | 34 | 41 | 38 | 37 | 35 | 28 |

Soalan 4

(a) (i) Bezakan antara statistik perihalan dan taabiran.
(ii) Bezakan antara ujian t dan z.
(iii) Mengapa pensampelan penting?
(iv) Bezakan antara taburan Binomial, Poisson dan Normal.

(b) Annie, Dekan Sekolah Pengurusan sedang memikirkan mengenai taburan gred di pusatnya. Dia telah mendengar keluhan bahawa GPA di Sekolah pengurusan adalah 0.25 lebih rendah dari mereka dari Kolej Seni. Suatu sampel rawak menghasilkan data berikut: Adakah data ini menyokong keluhan di atas. Uji pada aras keertian 0.02.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pengurusan | 2.86 | 2.77 | 3.18 | 3.14 | 2.87 | 3.19 | 3.24 | 2.91 |
| | 3.00 | 2.83 | 2.80 | | | | | |
| Kolej Seni | 3.35 | 3.32 | 3.63 | 3.41 | 3.37 | 3.45 | 3.43 | 3.44 |
| | 3.17 | 3.26 | 3.18 | 3.41 | 3.36 | | | |

[20 markah]

Soalan 5

(a) Ahmad seorang jurujual di ABC Company melawat 5 buah kedai setiap hari. Diandaikan bahawa pembolehubah jualan adalah mengikut taburan binomail dengan kebarangkalian jualan sama dengan 0.4. Dari taburan kekerapan yang diberikan di bawah mengenai jualan harian Encik Ahmad, bolehkah kita simpulkan bahawa data ini mengikut taburan binomial pada aras keertian 0.05?

| Bil. Jualan sehari | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Kekerapan jualan | 100 | 410 | 600 | 300 | 60 | 30 |

(b) Block Enterprise sedang menimbangkan sama ada untuk menggantikan proses pemasangan sekarang yang separa automatik dengan proses automatik sepenuhnya. Mereka mengumpul data mengenai pengeluaran sejam dan data di berikan seperti di bawah, dan mereka ingin memastikan untuk menukar atau tidak kepada proses baru. Uji pada aras keertian 0.02.

| | $\bar{x}$ | s | N |
|---|---|---|---|
| Separa automatik | 198 | 32 | 150 |
| Automatik | 206 | 29 | 200 |

[20 markah]

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Soalan 6

(a) Syarikat Zippy Cola sedang mengkaji kesan kempen pengiklanan mereka baru-baru ini. Pengguna di pilih secara rawak dan ditanya berapa banyak tin Zippy Cola mereka beli minggu lepas dan berapa banyak iklan Zippy Cola yang telah mereka lihat atau baca minggu lepas.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| X (Bil iklan) | 3 | 7 | 4 | 2 | 0 | 4 | 1 | 2 |
| Y (Bil tin dibeli) | 11 | 18 | 9 | 4 | 7 | 6 | 3 | 8 |

(i) Bentuk persamaan yang paling baik untuk data berikut.
(ii) Kira koefisien penentuan dan koefisien korelasi bagi data tersebut.

(b) Dari 10,200 pinjaman yang diberikan oleh koperasi dalam 5 tahun kebelakangan ini, satu sampel 350 orang diambil untuk menentukan peratus pinjaman diberikan kepada wanita. Sampel ini mennujukkan bahawa 39% pinjaman diberikan kepada wanita. Suatu banci 5 tahun lepas menunjukkan bahawa 41% peminjam adalah wanita. Pada aras keertian 0.02, bolehkan kita simpulkan bahawa kadaran pinjaman kepada wanita telah berubah secara bererti?

[20 markah]

$$\chi^2 = \sum_{\text{all cells}} \frac{(f_0 - f_e)^2}{f_e}$$

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

$$\bar{X} = \frac{\Sigma X}{n} \qquad \bar{Y} = \frac{\Sigma Y}{n} \qquad b = \frac{\sum XY - n\bar{X}\bar{Y}}{\sum X^2 - n\bar{X}^2}$$

$$a = \bar{Y} - b\,\bar{X}$$

$$r^2 = \frac{a\Sigma Y - b\Sigma XY - n\bar{Y}^2}{\Sigma Y^2 - n\bar{Y}^2}$$

$$\hat{\sigma}_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}$$

$$z = \frac{\bar{p} - p_{H_0}}{\sigma_{\bar{p}}}$$

$$z = \frac{\bar{x}_1 - \bar{x}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}}$$

$$\sigma_{\bar{p}} = \sqrt{\frac{pq}{n}}$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$s_p^2 = \frac{(n_1 - 1)\,s_1^2 + (n_2 - 1)\,s_2^2}{n_1 - 1 + n_2 - 1}$$

$$s_p = \sqrt{s_p^2}$$

$$df = n_1 + n_2 - 2$$

# APPENDIX TABLES

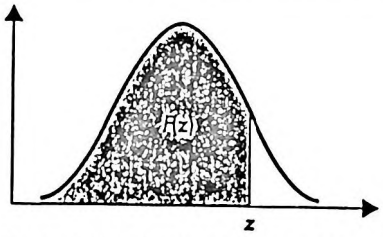
## TABLE 1 Probability function of the binomial distribution

The table shows the probability of $x$ successes in $n$ independent trials, each with probability of success $p$. For example, the probability of four successes in eight independent trials, each with probability of success .35, is .1875.

| n | x | p = .05 | .10 | .15 | .20 | .25 | .30 | .35 | .40 | .45 | .50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | .9500 | .9000 | .8500 | .8000 | .7500 | .7000 | .6500 | .6000 | .5500 | .5000 |
| | 1 | .0500 | .1000 | .1500 | .2000 | .2500 | .3000 | .3500 | .4000 | .4500 | .5000 |
| 2 | 0 | .9025 | .8100 | .7225 | .6400 | .5625 | .4900 | .4225 | .3600 | .3025 | .2500 |
| | 1 | .0950 | .1800 | .2550 | .3200 | .3750 | .4200 | .4550 | .4800 | .4950 | .5000 |
| | 2 | .0025 | .0100 | .0225 | .0400 | .0625 | .0900 | .1225 | .1600 | .2025 | .2500 |
| 3 | 0 | .8574 | .7290 | .6141 | .5120 | .4219 | .3430 | .2746 | .2160 | .1664 | .1250 |
| | 1 | .1354 | .2430 | .3251 | .3840 | .4219 | .4410 | .4436 | .4320 | .4084 | .3750 |
| | 2 | .0071 | .0270 | .0574 | .0960 | .1406 | .1890 | .2389 | .2880 | .3341 | .3750 |
| | 3 | .0001 | .0010 | .0034 | .0080 | .0156 | .0270 | .0429 | .0640 | .0911 | .1250 |
| 4 | 0 | .8145 | .6561 | .5220 | .4096 | .3164 | .2401 | .1785 | .1296 | .0915 | .0625 |
| | 1 | .1715 | .2916 | .3685 | .4096 | .4219 | .4116 | .3845 | .3456 | .2995 | .2500 |
| | 2 | .0135 | .0486 | .0975 | .1536 | .2109 | .2646 | .3105 | .3456 | .3675 | .3750 |
| | 3 | .0005 | .0036 | .0115 | .0256 | .0469 | .0756 | .1115 | .1536 | .2005 | .2500 |
| | 4 | .0000 | .0001 | .0005 | .0016 | .0039 | .0081 | .0150 | .0256 | .0410 | .0625 |
| 5 | 0 | .7738 | .5905 | .4437 | .3277 | .2373 | .1681 | .1160 | .0778 | .0503 | .0312 |
| | 1 | .2036 | .3280 | .3915 | .4096 | .3955 | .3602 | .3124 | .2592 | .2059 | .1562 |
| | 2 | .0214 | .0729 | .1382 | .2048 | .2637 | .3087 | .3364 | .3456 | .3369 | .3125 |
| | 3 | .0011 | .0081 | .0244 | .0512 | .0879 | .1323 | .1811 | .2304 | .2757 | .3125 |
| | 4 | .0000 | .0004 | .0022 | .0064 | .0146 | .0284 | .0488 | .0768 | .1128 | .1562 |
| | 5 | .0000 | .0000 | .0001 | .0003 | .0010 | .0024 | .0053 | .0102 | .0185 | .0312 |
| 6 | 0 | .7351 | .5314 | .3771 | .2621 | .1780 | .1176 | .0754 | .0467 | .0277 | .0156 |
| | 1 | .2321 | .3543 | .3993 | .3932 | .3560 | .3025 | .2437 | .1866 | .1359 | .0938 |
| | 2 | .0305 | .0984 | .1762 | .2458 | .2966 | .3241 | .3280 | .3110 | .2780 | .2344 |
| | 3 | .0021 | .0146 | .0415 | .0819 | .1318 | .1852 | .2355 | .2765 | .3032 | .3125 |
| | 4 | .0001 | .0012 | .0055 | .0154 | .0330 | .0595 | .0951 | .1382 | .1861 | .2344 |
| | 5 | .0000 | .0001 | .0004 | .0015 | .0044 | .0102 | .0205 | .0369 | .0609 | .0938 |
| | 6 | .0000 | .0000 | .0000 | .0001 | .0002 | .0007 | .0018 | .0041 | .0083 | .0156 |
| 7 | 0 | .6983 | .4783 | .3206 | .2097 | .1335 | .0824 | .0490 | .0280 | .0152 | .0078 |
| | 1 | .2573 | .3720 | .3960 | .3670 | .3115 | .2471 | .1848 | .1306 | .0872 | .0547 |
| | 2 | .0406 | .1240 | .2097 | .2753 | .3115 | .3177 | .2985 | .2613 | .2140 | .1641 |
| | 3 | .0036 | .0230 | .0617 | .1147 | .1730 | .2269 | .2679 | .2903 | .2918 | .2734 |
| | 4 | .0002 | .0026 | .0109 | .0287 | .0577 | .0972 | .1442 | .1935 | .2388 | .2734 |
| | 5 | .0000 | .0002 | .0012 | .0043 | .0115 | .0250 | .0466 | .0774 | .1172 | .1641 |
| | 6 | .0000 | .0000 | .0001 | .0004 | .0013 | .0036 | .0084 | .0172 | .0320 | .0547 |
| | 7 | .0000 | .0000 | .0000 | .0000 | .0001 | .0002 | .0006 | .0016 | .0037 | .0078 |
| 8 | 0 | .6634 | .4305 | .2725 | .1678 | .1001 | .0576 | .0319 | .0168 | .0084 | .0039 |
| | 1 | .2793 | .3826 | .3847 | .3355 | .2670 | .1977 | .1373 | .0896 | .0548 | .0312 |
| | 2 | .0515 | .1488 | .2376 | .2936 | .3115 | .2965 | .2587 | .2090 | .1569 | .1094 |
| | 3 | .0054 | .0331 | .0839 | .1468 | .2076 | .2541 | .2786 | .2787 | .2568 | .2188 |
| | 4 | .0004 | .0046 | .0185 | .0459 | .0865 | .1361 | .1875 | .2322 | .2627 | .2734 |

**TABLE 3** Cumulative distribution function of the standard normal distribution

APW300




The table shows the probability, $F(z)$, that a standard normal random variable is less than the number $z$. For example, the probability is .9750 that a standard normal random variable is less than 1.96.

| z | F(z) | z | F(z) | z | F(z) | z | F(z) | z | F(z) | z | F(z) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .00 | .5000 | | | | | | | | | | |
| .01 | .5040 | .31 | .6217 | .61 | .7291 | .91 | .8186 | 1.21 | .8869 | 1.51 | .9345 |
| .02 | .5080 | .32 | .6255 | .62 | .7324 | .92 | .8212 | 1.22 | .8888 | 1.52 | .9357 |
| .03 | .5120 | .33 | .6293 | .63 | .7357 | .93 | .8238 | 1.23 | .8907 | 1.53 | .9370 |
| .04 | .5160 | .34 | .6331 | .64 | .7389 | .94 | .8264 | 1.24 | .8925 | 1.54 | .9382 |
| .05 | .5199 | .35 | .6368 | .65 | .7422 | .95 | .8289 | 1.25 | .8944 | 1.55 | .9394 |
| .06 | .5239 | .36 | .6406 | .66 | .7454 | .96 | .8315 | 1.26 | .8962 | 1.56 | .9406 |
| .07 | .5279 | .37 | .6443 | .67 | .7486 | .97 | .8340 | 1.27 | .8980 | 1.57 | .9418 |
| .08 | .5319 | .38 | .6480 | .68 | .7517 | .98 | .8365 | 1.28 | .8997 | 1.58 | .9429 |
| .09 | .5359 | .39 | .6517 | .69 | .7549 | .99 | .8389 | 1.29 | .9015 | 1.59 | .9441 |
| .10 | .5398 | .40 | .6554 | .70 | .7580 | 1.00 | .8413 | 1.30 | .9032 | 1.60 | .9452 |
| .11 | .5438 | .41 | .6591 | .71 | .7611 | 1.01 | .8438 | 1.31 | .9049 | 1.61 | .9463 |
| .12 | .5478 | .42 | .6628 | .72 | .7642 | 1.02 | .8461 | 1.32 | .9066 | 1.62 | .9474 |
| .13 | .5517 | .43 | .6664 | .73 | .7673 | 1.03 | .8485 | 1.33 | .9082 | 1.63 | .9484 |
| .14 | .5557 | .44 | .6700 | .74 | .7704 | 1.04 | .8508 | 1.34 | .9099 | 1.64 | .9495 |
| .15 | .5596 | .45 | .6736 | .75 | .7734 | 1.05 | .8531 | 1.35 | .9115 | 1.65 | .9505 |
| .16 | .5636 | .46 | .6772 | .76 | .7764 | 1.06 | .8554 | 1.36 | .9131 | 1.66 | .9515 |
| .17 | .5675 | .47 | .6803 | .77 | .7794 | 1.07 | .8577 | 1.37 | .9147 | 1.67 | .9525 |
| .18 | .5714 | .48 | .6844 | .78 | .7823 | 1.08 | .8599 | 1.38 | .9162 | 1.68 | .9535 |
| .19 | .5753 | .49 | .6879 | .79 | .7852 | 1.09 | .8621 | 1.39 | .9177 | 1.69 | .9545 |
| .20 | .5793 | .50 | .6915 | .80 | .7881 | 1.10 | .8643 | 1.40 | .9192 | 1.70 | .9554 |
| .21 | .5832 | .51 | .6950 | .81 | .7910 | 1.11 | .8665 | 1.41 | .9207 | 1.71 | .9564 |
| .22 | .5871 | .52 | .6985 | .82 | .7939 | 1.12 | .8686 | 1.42 | .9222 | 1.72 | .9573 |
| .23 | .5910 | .53 | .7019 | .83 | .7967 | 1.13 | .8708 | 1.43 | .9236 | 1.73 | .9582 |
| .24 | .5948 | .54 | .7054 | .84 | .7995 | 1.14 | .8729 | 1.44 | .9251 | 1.74 | .9591 |
| .25 | .5987 | .55 | .7088 | .85 | .8023 | 1.15 | .8749 | 1.45 | .9265 | 1.75 | .9599 |
| .26 | .6026 | .56 | .7123 | .86 | .8051 | 1.16 | .8770 | 1.46 | .9279 | 1.76 | .9608 |
| .27 | .6064 | .57 | .7157 | .87 | .8078 | 1.17 | .8790 | 1.47 | .9292 | 1.77 | .9616 |
| .28 | .6103 | .58 | .7190 | .88 | .8106 | 1.18 | .8810 | 1.48 | .9306 | 1.78 | .9625 |
| .29 | .6141 | .59 | .7224 | .89 | .8133 | 1.19 | .8830 | 1.49 | .9319 | 1.79 | .9633 |
| .30 | .6179 | .60 | .7257 | .90 | .8159 | 1.20 | .8849 | 1.50 | .9332 | 1.80 | .9641 |

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.../-

**TABLE 3** Cumulative distribution function of the standard normal distribution (cont.)

| z | F(z) | z | F(z) | z | F(z) | z | F(z) | z | F(z) | z | F(z) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.81 | .9649 | 2.21 | .9864 | 2.61 | .9955 | 3.01 | .9987 | 3.41 | .9997 | 3.81 | .9999 |
| 1.82 | .9656 | 2.22 | .9868 | 2.62 | .9956 | 3.02 | .9987 | 3.42 | .9997 | 3.82 | .9999 |
| 1.83 | .9664 | 2.23 | .9871 | 2.63 | .9957 | 3.03 | .9988 | 3.43 | .9997 | 3.83 | .9999 |
| 1.84 | .9671 | 2.24 | .9875 | 2.64 | .9959 | 3.04 | .9988 | 3.44 | .9997 | 3.84 | .9999 |
| 1.85 | .9678 | 2.25 | .9878 | 2.65 | .9960 | 3.05 | .9989 | 3.45 | .9997 | 3.85 | .9999 |
| 1.86 | .9686 | 2.26 | .9881 | 2.66 | .9961 | 3.06 | .9989 | 3.46 | .9997 | 3.86 | .9999 |
| 1.87 | .9693 | 2.27 | .9884 | 2.67 | .9962 | 3.07 | .9989 | 3.47 | .9997 | 3.87 | .9999 |
| 1.88 | .9699 | 2.28 | .9887 | 2.68 | .9963 | 3.08 | .9990 | 3.48 | .9997 | 3.88 | .9999 |
| 1.89 | .9706 | 2.29 | .9890 | 2.69 | .9964 | 3.09 | .9990 | 3.49 | .9998 | 3.89 | 1.0000 |
| 1.90 | .9713 | 2.30 | .9893 | 2.70 | .9965 | 3.10 | .9990 | 3.50 | .9998 | 3.90 | 1.0000 |
| 1.91 | .9719 | 2.31 | .9896 | 2.71 | .9966 | 3.11 | .9991 | 3.51 | .9998 | 3.91 | 1.0000 |
| 1.92 | .9726 | 2.32 | .9898 | 2.72 | .9967 | 3.12 | .9991 | 3.52 | .9998 | 3.92 | 1.0000 |
| 1.93 | .9732 | 2.33 | .9901 | 2.73 | .9968 | 3.13 | .9991 | 3.53 | .9998 | 3.93 | 1.0000 |
| 1.94 | .9738 | 2.34 | .9904 | 2.74 | .9969 | 3.14 | .9992 | 3.54 | .9998 | 3.94 | 1.0000 |
| 1.95 | .9744 | 2.35 | .9906 | 2.75 | .9970 | 3.15 | .9992 | 3.55 | .9998 | 3.95 | 1.0000 |
| 1.96 | .9750 | 2.36 | .9909 | 2.76 | .9971 | 3.16 | .9992 | 3.56 | .9998 | 3.96 | 1.0000 |
| 1.97 | .9756 | 2.37 | .9911 | 2.77 | .9972 | 3.17 | .9992 | 3.57 | .9998 | 3.97 | 1.0000 |
| 1.98 | .9761 | 2.38 | .9913 | 2.78 | .9973 | 3.18 | .9993 | 3.58 | .9998 | 3.98 | 1.0000 |
| 1.99 | .9767 | 2.39 | .9916 | 2.79 | .9974 | 3.19 | .9993 | 3.59 | .9998 | 3.99 | 1.0000 |
| 2.00 | .9772 | 2.40 | .9918 | 2.80 | .9974 | 3.20 | .9993 | 3.60 | .9998 | | |
| 2.01 | .9778 | 2.41 | .9920 | 2.81 | .9975 | 3.21 | .9993 | 3.61 | .9998 | | |
| 2.02 | .9783 | 2.42 | .9922 | 2.82 | .9976 | 3.22 | .9994 | 3.62 | .9999 | | |
| 2.03 | .9788 | 2.43 | .9925 | 2.83 | .9977 | 3.23 | .9994 | 3.63 | .9999 | | |
| 2.04 | .9793 | 2.44 | .9927 | 2.84 | .9977 | 3.24 | .9994 | 3.64 | .9999 | | |
| 2.05 | .9798 | 2.45 | .9929 | 2.85 | .9978 | 3.25 | .9994 | 3.65 | .9999 | | |
| 2.06 | .9803 | 2.46 | .9931 | 2.86 | .9979 | 3.26 | .9994 | 3.66 | .9999 | | |
| 2.07 | .9808 | 2.47 | .9932 | 2.87 | .9979 | 3.27 | .9995 | 3.67 | .9999 | | |
| 2.08 | .9812 | 2.48 | .9934 | 2.88 | .9980 | 3.28 | .9995 | 3.68 | .9999 | | |
| 2.09 | .9817 | 2.49 | .9936 | 2.89 | .9981 | 3.29 | .9995 | 3.69 | .9999 | | |
| 2.10 | .9821 | 2.50 | .9938 | 2.90 | .9981 | 3.30 | .9995 | 3.70 | .9999 | | |
| 2.11 | .9826 | 2.51 | .9940 | 2.91 | .9982 | 3.31 | .9995 | 3.71 | .9999 | | |
| 2.12 | .9830 | 2.52 | .9941 | 2.92 | .9982 | 3.32 | .9996 | 3.72 | .9999 | | |
| 2.13 | .9834 | 2.53 | .9943 | 2.93 | .9983 | 3.33 | .9996 | 3.73 | .9999 | | |
| 2.14 | .9838 | 2.54 | .9945 | 2.94 | .9984 | 3.34 | .9996 | 3.74 | .9999 | | |
| 2.15 | .9842 | 2.55 | .9946 | 2.95 | .9984 | 3.35 | .9996 | 3.75 | .9999 | | |
| 2.16 | .9846 | 2.56 | .9948 | 2.96 | .9985 | 3.36 | .9996 | 3.76 | .9999 | | |
| 2.17 | .9850 | 2.57 | .9949 | 2.97 | .9985 | 3.37 | .9996 | 3.77 | .9999 | | |
| 2.18 | .9854 | 2.58 | .9951 | 2.98 | .9986 | 3.38 | .9996 | 3.78 | .9999 | | |
| 2.19 | .9857 | 2.59 | .9952 | 2.99 | .9986 | 3.39 | .9997 | 3.79 | .9999 | | |
| 2.20 | .9861 | 2.60 | .9953 | 3.00 | .9986 | 3.40 | .9997 | 3.80 | .9999 | | |

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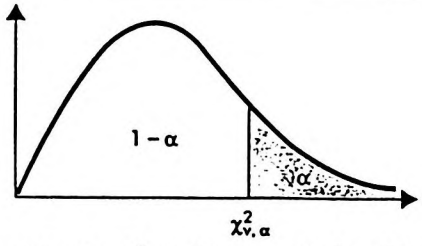
**TABLE 5** Cutoff points of the chi-square distribution function




For selected probabilities $\alpha$, the table shows the values $\chi^2_{\nu,\alpha}$ such that $\alpha = P(\chi_\nu^2 > \chi^2_{\nu,\alpha})$, where $\chi_\nu^2$ is a chi-square random variable with $\nu$ degrees of freedom. For example, the probability is .100 that a chi-square random variable with 10 degrees of freedom is greater than 15.99.

| | .995 | .990 | .975 | .950 | .900 | .100 | .050 | .025 | .010 | .005 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $0.0^4393$ | $0.0^3157$ | $0.0^3982$ | $0.0^2393$ | 0.0158 | 2.71 | 3.84 | 5.02 | 6.63 | 7.88 |
| 2 | 0.0100 | 0.0201 | 0.0506 | 0.103 | 0.211 | 4.61 | 5.99 | 7.38 | 9.21 | 10.60 |
| 3 | 0.072 | 0.115 | 0.216 | 0.352 | 0.584 | 6.25 | 7.81 | 9.35 | 11.34 | 12.84 |
| 4 | 0.207 | 0.297 | 0.484 | 0.711 | 1.064 | 7.78 | 9.49 | 11.14 | 13.28 | 14.86 |
| 5 | 0.412 | 0.554 | 0.831 | 1.145 | 1.61 | 9.24 | 11.07 | 12.83 | 15.09 | 16.75 |
| 6 | 0.676 | 0.872 | 1.24 | 1.64 | 2.20 | 10.64 | 12.59 | 14.45 | 16.81 | 18.55 |
| 7 | 0.989 | 1.24 | 1.69 | 2.17 | 2.83 | 12.02 | 14.07 | 16.01 | 18.48 | 20.28 |
| 8 | 1.34 | 1.65 | 2.18 | 2.73 | 3.49 | 13.36 | 15.51 | 17.53 | 20.09 | 21.96 |
| 9 | 1.73 | 2.09 | 2.70 | 3.33 | 4.17 | 14.68 | 16.92 | 19.02 | 21.67 | 23.59 |
| 10 | 2.16 | 2.56 | 3.25 | 3.94 | 4.87 | 15.99 | 18.31 | 20.48 | 23.21 | 25.19 |
| 11 | 2.60 | 3.05 | 3.82 | 4.57 | 5.58 | 17.28 | 19.68 | 21.92 | 24.73 | 26.76 |
| 12 | 3.07 | 3.57 | 4.40 | 5.23 | 6.30 | 18.55 | 21.03 | 23.34 | 26.22 | 28.30 |
| 13 | 3.57 | 4.11 | 5.01 | 5.89 | 7.04 | 19.81 | 22.36 | 24.74 | 27.69 | 29.82 |
| 14 | 4.07 | 4.66 | 5.63 | 6.57 | 7.79 | 21.06 | 23.68 | 26.12 | 29.14 | 31.32 |
| 15 | 4.60 | 5.23 | 6.26 | 7.26 | 8.55 | 22.31 | 25.00 | 27.49 | 30.58 | 32.80 |
| 16 | 5.14 | 5.81 | 6.91 | 7.96 | 9.31 | 23.54 | 26.30 | 28.85 | 32.00 | 34.27 |
| 17 | 5.70 | 6.41 | 7.56 | 8.67 | 10.09 | 24.77 | 27.59 | 30.19 | 33.41 | 35.72 |
| 18 | 6.26 | 7.01 | 8.23 | 9.39 | 10.86 | 25.99 | 28.87 | 31.53 | 34.81 | 37.16 |
| 19 | 6.84 | 7.63 | 8.91 | 10.12 | 11.65 | 27.20 | 30.14 | 32.85 | 36.19 | 38.58 |
| 20 | 7.43 | 8.26 | 9.59 | 10.85 | 12.44 | 28.41 | 31.41 | 34.17 | 37.57 | 40.00 |
| 21 | 8.03 | 8.90 | 10.28 | 11.59 | 13.24 | 29.62 | 32.67 | 35.48 | 38.93 | 41.40 |
| 22 | 8.64 | 9.54 | 10.98 | 12.34 | 14.04 | 30.81 | 33.92 | 36.78 | 40.29 | 42.80 |
| 23 | 9.26 | 10.20 | 11.69 | 13.09 | 14.85 | 32.01 | 35.17 | 38.08 | 41.64 | 44.18 |
| 24 | 9.89 | 10.86 | 12.40 | 13.85 | 15.66 | 33.20 | 36.42 | 39.36 | 42.98 | 45.56 |
| 25 | 10.52 | 11.52 | 13.12 | 14.61 | 16.47 | 34.38 | 37.65 | 40.65 | 44.31 | 46.93 |
| 26 | 11.16 | 12.20 | 13.84 | 15.38 | 17.29 | 35.56 | 38.89 | 41.92 | 45.64 | 48.29 |
| 27 | 11.81 | 12.88 | 14.57 | 16.15 | 18.11 | 36.74 | 40.11 | 43.19 | 46.96 | 49.64 |
| 28 | 12.46 | 13.56 | 15.31 | 16.93 | 18.94 | 37.92 | 41.34 | 44.46 | 48.28 | 50.99 |
| 29 | 13.12 | 14.26 | 16.05 | 17.71 | 19.77 | 39.09 | 42.56 | 45.72 | 49.59 | 52.34 |
| 30 | 13.79 | 14.95 | 16.79 | 18.49 | 20.60 | 40.26 | 43.77 | 46.98 | 50.89 | 53.67 |
| 40 | 20.71 | 22.16 | 24.43 | 26.51 | 29.05 | 51.81 | 55.76 | 59.34 | 63.69 | 66.77 |
| 50 | 27.99 | 29.71 | 32.36 | 34.76 | 37.69 | 63.17 | 67.50 | 71.42 | 76.15 | 79.49 |
| 60 | 35.53 | 37.48 | 40.48 | 43.19 | 46.46 | 74.40 | 79.08 | 83.30 | 88.38 | 91.95 |
| 70 | 43.28 | 45.44 | 48.76 | 51.74 | 55.33 | 85.53 | 90.53 | 95.02 | 100.4 | 104.2 |
| 80 | 51.17 | 53.54 | 57.15 | 60.39 | 64.28 | 96.58 | 101.9 | 106.6 | 112.3 | 116.3 |
| 90 | 59.20 | 61.75 | 65.65 | 69.13 | 73.29 | 107.6 | 113.1 | 118.1 | 124.1 | 128.3 |
| 100 | 67.33 | 70.06 | 74.22 | 77.93 | 82.36 | 118.5 | 124.3 | 129.6 | 135.8 | 140.2 |

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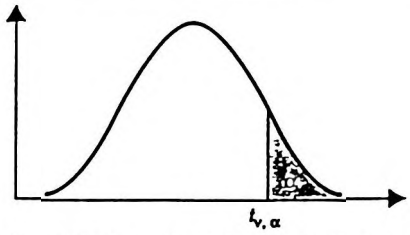
TABLE 6 Cutoff points for the Student's $t$ distribution




For selected probabilities, $\alpha$, the table shows the values $t_{\nu,\alpha}$ such that $P(t_\nu > t_{\nu,\alpha}) = \alpha$, where $t_\nu$ is a Student's $t$ random variable with $\nu$ degrees of freedom. For example, the probability is .10 that a Student's $t$ random variable with 10 degrees of freedom exceeds 1.372.

| $\nu$ | $\alpha$ | | | | |
|---|---|---|---|---|---|
| | .100 | .050 | .025 | .010 | .005 |
| 1 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 |
| 2 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 |
| 3 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 |
| 4 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 |
| 5 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 |
| 6 | 1.440 | 1.943 | 2.447 | 3.143 | 3.707 |
| 7 | 1.415 | 1.895 | 2.365 | 2.998 | 3.499 |
| 8 | 1.397 | 1.860 | 2.306 | 2.896 | 3.355 |
| 9 | 1.383 | 1.833 | 2.262 | 2.821 | 3.250 |
| 10 | 1.372 | 1.812 | 2.228 | 2.764 | 3.169 |
| 11 | 1.363 | 1.796 | 2.201 | 2.718 | 3.106 |
| 12 | 1.356 | 1.782 | 2.179 | 2.681 | 3.055 |
| 13 | 1.350 | 1.771 | 2.160 | 2.650 | 3.012 |
| 14 | 1.345 | 1.761 | 2.145 | 2.624 | 2.977 |
| 15 | 1.341 | 1.753 | 2.131 | 2.602 | 2.947 |
| 16 | 1.337 | 1.746 | 2.120 | 2.583 | 2.921 |
| 17 | 1.333 | 1.740 | 2.110 | 2.567 | 2.898 |
| 18 | 1.330 | 1.734 | 2.101 | 2.552 | 2.878 |
| 19 | 1.328 | 1.729 | 2.093 | 2.539 | 2.861 |
| 20 | 1.325 | 1.725 | 2.086 | 2.528 | 2.845 |
| 21 | 1.323 | 1.721 | 2.080 | 2.518 | 2.831 |
| 22 | 1.321 | 1.717 | 2.074 | 2.508 | 2.819 |
| 23 | 1.319 | 1.714 | 2.069 | 2.500 | 2.807 |
| 24 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 |
| 25 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 |
| 26 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 |
| 27 | 1.314 | 1.703 | 2.052 | 2.473 | 2.771 |
| 28 | 1.313 | 1.701 | 2.048 | 2.467 | 2.763 |
| 29 | 1.311 | 1.699 | 2.045 | 2.462 | 2.756 |
| 30 | 1.310 | 1.697 | 2.042 | 2.457 | 2.750 |
| 40 | 1.303 | 1.684 | 2.021 | 2.423 | 2.704 |
| 60 | 1.296 | 1.671 | 2.000 | 2.390 | 2.660 |
| $\infty$ | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 |

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