# UNIVERSITI KUALA LUMPUR
## MALAYSIAN INSTITUTE OF INDUSTRIAL TECHNOLOGY

## FINAL EXAMINATION
## JANUARY 2016 SEMESTER

| | | |
|---|---|---|
| COURSE CODE | : | JGD 10203 |
| COURSE TITLE | : | BASIC STATISTICS |
| PROGRAMME LEVEL | : | DIPLOMA |
| DATE | : | 23 MAY 2016 |
| TIME | : | 2:30 PM – 5:30 PM |
| DURATION | : | 3 HOURS |

### INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consists of TWO (2) sections.
4. Answer ALL questions in Section A. Choose TWO (2) questions in section B.
5. Please write your answers on the answer booklet and graph paper provided.
6. Table and formula are enclosed as reference.
7. Please answer all questions in English only.

THERE ARE 7 PAGES OF QUESTIONS EXCLUDING THIS PAGE.

**SECTION A (Total: 60 marks)**

**INSTRUCTION: Answer ALL questions.**
**Please use the answer booklet provided.**

**Question 1**

For each of the following statement, state True or False.

(a) Inferential statistics are used to help the researcher *infer* whether observations made with samples are reflective of the population.

(b) An experiment is the only method that can demonstrate cause-and-effect relationships between variables.

(c) The types of data researchers measure fall into two categories: (1) continuous or discrete and (2) quantitative or qualitative.

(d) Graphs, tables, and summary statistics all illustrate the application of inferential statistics.

(e) Inferential statistics are procedures used to make inferences about a population, given only a limited amount of data.

(f) Descriptive statistics can be used to describe populations and samples of data.

(g) No matter how few elements are included in a statistical population, however, a sample taken from that population can be larger than the population itself.

(h) Inferential statistics are techniques used to summarize or describe numeric data.

(i) In 2010, *Fortune 500* magazine ranked Apple as the most admired company in the world. This ranking is on an ordinal scale of measurement.

(j) Qualitative variables can be continuous or discrete.

(10 marks)

**Question 2**

The local manager of Food Queen is interested in the number of times a customer shops at her store during a two-week period. The responses of 51 customers were in Table 1.

Table 1: Number of times customer shops

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 3 | 3 | 1 | 4 | 4 | 5 | 6 | 4 | 2 | 6 | 6 | 6 | 7 | 1 | 1 | 14 | 1 | 2 | 4 |
| 8 | 4 | 7 | 6 | 5 | 9 | 11 | 3 | 12 | 4 | 4 | 4 | 5 | 6 | 3 | 5 | 3 | 4 | 5 | 6 |
| | | | | 7 | 6 | 5 | 15 | 1 | 1 | 10 | 8 | 9 | 2 | 12 | | | | | |

(a) Starting with 0 as the lower limit of the first class and using a class width of 3, organize the data into a frequency distribution.

(2 marks)

(b) Convert the distribution to a relative frequency distribution, hence represent the data as an ogive.

(8 marks)

**Question 3**

(a) Fill in the blanks.

Stem and leaf plots is a statistical technique to present a set of data. Each numerical value is divided into _____ parts. The leading digit(s) become(s) the _____ and the trailing digit(s) become(s) the _____. The stems are located along the _____ axis and the leaf values are stacked against one another along the _____ axis.

(5 marks)

(b) Table 2 shows the number of advertising spots purchased during 2001 by Members of the Toronto Automobile Dealers' Association. Organize the data into an ordered stem-and-leaf plots and make a conclusion.

Table 2: Advertising spots purchased

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 96 | 93 | 88 | 117 | 127 | 95 | 113 | 96 | 108 | 94 |
| 148 | 156 | 139 | 142 | 94 | 107 | 125 | 155 | 155 | 103 |
| 112 | 127 | 117 | 120 | 112 | 135 | 132 | 111 | 125 | 104 |
| 106 | 139 | 134 | 119 | 97 | 89 | 118 | 136 | 125 | 143 |
| 120 | 103 | 113 | 124 | 138 | | | | | |

(5 marks)

**Question 4**

The ages of the people at Zain's family are given in the stem and leaf plot in Figure 1.

| | |
|---|---|
| 0 | 2 5 5 7 9 |
| 1 | 1 1 3 4 7 9 |
| 2 | 2 5 7 8 |
| 3 | 2 3 4 4 9 |
| 4 | 0 2 |
| 5 | 3 7 |

Figure 1: Ages of Zain's family

Refer to the Figure 1, determine for the Zain's family:

(a) the number of family members

(1 mark)

(b) the average age

(2 marks)

(c) the $Q_1$, $Q_2$ and $Q_3$

(3 marks)

(d) the variance

(3 marks)

(e) the standard deviation

(1 mark)

**Question 5**

The double box-and-whisker plot in Figure 2 compares the battery life (in hours) of two brands of cell phones. Compare and contrast between them.

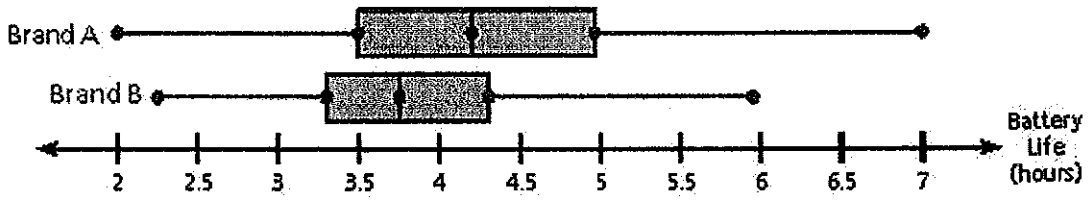



Figure 2: Battery life (in hours) of cell phones

(10 marks)

**Question 6**

A movie theater recorded the number of tickets sold for each showing of a movie during its opening weekend. Make a box-and whisker plot of the ticket data listed in Table 3.

Table 3: Tickets sold on opening weekend

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 497 | 429 | 746 | 469 | 504 | 464 | 326 | 302 | 509 | 467 | 401 | 499 |

(10 marks)

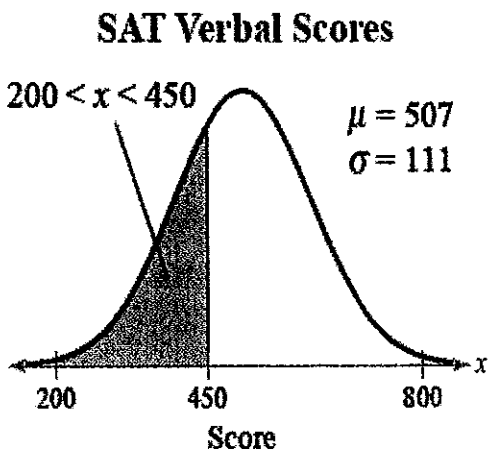
**SECTION B (Total: 40 marks)**

**INSTRUCTION: Answer TWO (2) questions.**
**Please use the answer booklet provided.**

**Question 1**

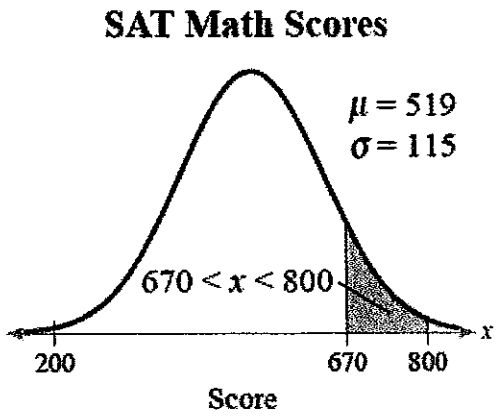
Assume a member is selected at random from the population represented by the Figure (a) – (e). Find the probability that the member selected at random is from the shaded area of the graph. Assume the variable $x$ is normally distributed.

(a)



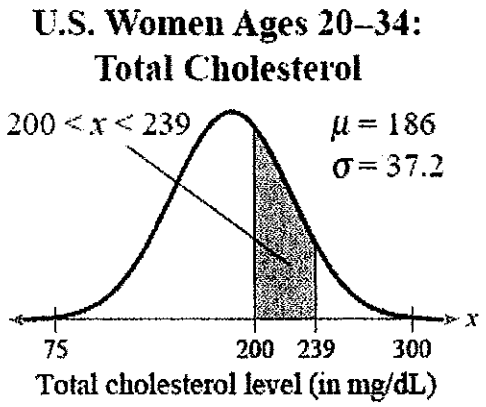

(4 marks)

(b)



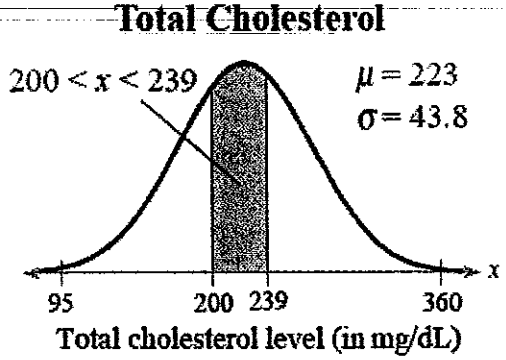

(4 marks)

(c)



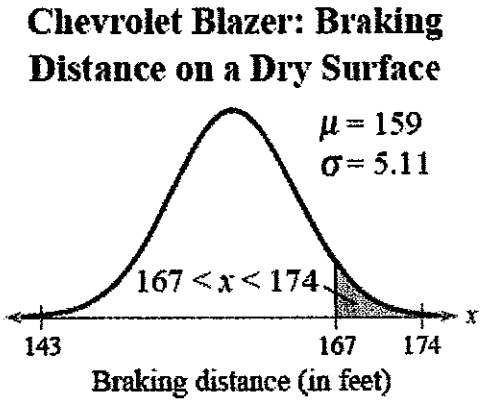

(4 marks)

(d)




(4 marks)

(e)




(4 marks)

**Question 2**

(a) Scores for a civil service exam are normally distributed, with a mean of 75 and a standard deviation of 6.5. To be eligible for civil service employment, they must score in the top 5%. Determine the lowest score they can earn and still be eligible for employment.

(5 marks)

(b) The braking distances of a sample of Ford F-150s are normally distributed. On a dry surface, the mean braking distance was 158 feet and the standard deviation was 6.51 feet. Find the distance range in the middle of 80%.

(5 marks)

(c) The Figure 3 shows the length of time people spend driving each day. A researcher randomly select 50 drivers ages 15 to 19. Determine the probability that the mean time they spend driving each day is between 24.7 and 25.5 minutes. Assume that the standard deviation is 1.5 minutes.

(5 marks)

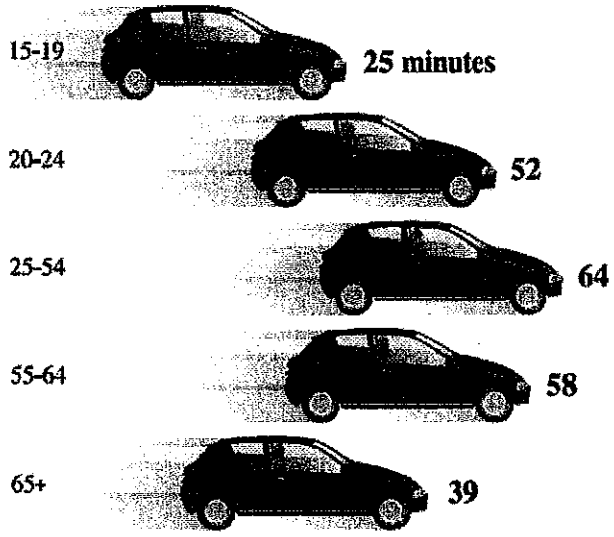



Figure 3: Average time spent driving each day by each group of age

(d) The mean room and board expense per year at a four-year college is $5850. You randomly select 9 four-year colleges. Determine probability that the mean room and board is (i) less than $6180 and (ii) greater than $4785. Assume that the room and board expenses are normally distributed, with a standard deviation of $1125.

(5 marks)

**Question 3**

(a) In the nursing home study mentioned in the chapter-opening "Statistics Today," the researchers found that 12 out of 34 small nursing homes had a resident vaccination rate of less than 80%. At $\alpha = 0.05$, discuss the evidence to reject the researchers' findings.

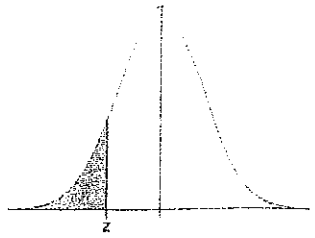
(10 marks)

(b) A sample of 50 randomly selected men with high triglyceride levels had consumed 2 tablespoons of oat bran daily for 6 weeks. After 6 weeks, 26 of the men had lowered their triglyceride level to 60%. At $\alpha = 0.01$, evaluate the validity of the reduced percentage.

(10 marks)

**END OF EXAMINATION PAPER**

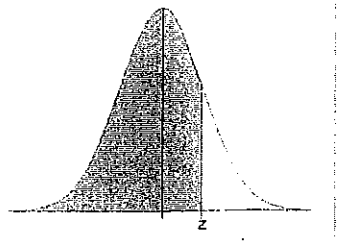
# Standard Normal Cumulative Probability Table




**Cumulative probabilities for NEGATIVE z-values are shown in the following table:**

| z | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 |
|---|---|---|---|---|---|---|---|---|---|---|
| -3.4 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0002 |
| -3.3 | 0.0005 | 0.0005 | 0.0005 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0003 |
| -3.2 | 0.0007 | 0.0007 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0006 | 0.0005 | 0.0005 | 0.0005 |
| -3.1 | 0.0010 | 0.0009 | 0.0009 | 0.0009 | 0.0008 | 0.0008 | 0.0008 | 0.0008 | 0.0007 | 0.0007 |
| -3.0 | 0.0013 | 0.0013 | 0.0013 | 0.0012 | 0.0012 | 0.0011 | 0.0011 | 0.0011 | 0.0010 | 0.0010 |
| -2.9 | 0.0019 | 0.0018 | 0.0018 | 0.0017 | 0.0016 | 0.0016 | 0.0015 | 0.0015 | 0.0014 | 0.0014 |
| -2.8 | 0.0026 | 0.0025 | 0.0024 | 0.0023 | 0.0023 | 0.0022 | 0.0021 | 0.0021 | 0.0020 | 0.0019 |
| -2.7 | 0.0035 | 0.0034 | 0.0033 | 0.0032 | 0.0031 | 0.0030 | 0.0029 | 0.0028 | 0.0027 | 0.0026 |
| -2.6 | 0.0047 | 0.0045 | 0.0044 | 0.0043 | 0.0041 | 0.0040 | 0.0039 | 0.0038 | 0.0037 | 0.0036 |
| -2.5 | 0.0062 | 0.0060 | 0.0059 | 0.0057 | 0.0055 | 0.0054 | 0.0052 | 0.0051 | 0.0049 | 0.0048 |
| -2.4 | 0.0082 | 0.0080 | 0.0078 | 0.0075 | 0.0073 | 0.0071 | 0.0069 | 0.0068 | 0.0066 | 0.0064 |
| -2.3 | 0.0107 | 0.0104 | 0.0102 | 0.0099 | 0.0096 | 0.0094 | 0.0091 | 0.0089 | 0.0087 | 0.0084 |
| -2.2 | 0.0139 | 0.0136 | 0.0132 | 0.0129 | 0.0125 | 0.0122 | 0.0119 | 0.0116 | 0.0113 | 0.0110 |
| -2.1 | 0.0179 | 0.0174 | 0.0170 | 0.0166 | 0.0162 | 0.0158 | 0.0154 | 0.0150 | 0.0146 | 0.0143 |
| -2.0 | 0.0228 | 0.0222 | 0.0217 | 0.0212 | 0.0207 | 0.0202 | 0.0197 | 0.0192 | 0.0188 | 0.0183 |
| -1.9 | 0.0287 | 0.0281 | 0.0274 | 0.0268 | 0.0262 | 0.0256 | 0.0250 | 0.0244 | 0.0239 | 0.0233 |
| -1.8 | 0.0359 | 0.0351 | 0.0344 | 0.0336 | 0.0329 | 0.0322 | 0.0314 | 0.0307 | 0.0301 | 0.0294 |
| -1.7 | 0.0446 | 0.0436 | 0.0427 | 0.0418 | 0.0409 | 0.0401 | 0.0392 | 0.0384 | 0.0375 | 0.0367 |
| -1.6 | 0.0548 | 0.0537 | 0.0526 | 0.0516 | 0.0505 | 0.0495 | 0.0485 | 0.0475 | 0.0465 | 0.0455 |
| -1.5 | 0.0668 | 0.0655 | 0.0643 | 0.0630 | 0.0618 | 0.0606 | 0.0594 | 0.0582 | 0.0571 | 0.0559 |
| -1.4 | 0.0808 | 0.0793 | 0.0778 | 0.0764 | 0.0749 | 0.0735 | 0.0721 | 0.0708 | 0.0694 | 0.0681 |
| -1.3 | 0.0968 | 0.0951 | 0.0934 | 0.0918 | 0.0901 | 0.0885 | 0.0869 | 0.0853 | 0.0838 | 0.0823 |
| -1.2 | 0.1151 | 0.1131 | 0.1112 | 0.1093 | 0.1075 | 0.1056 | 0.1038 | 0.1020 | 0.1003 | 0.0985 |
| -1.1 | 0.1357 | 0.1335 | 0.1314 | 0.1292 | 0.1271 | 0.1251 | 0.1230 | 0.1210 | 0.1190 | 0.1170 |
| -1.0 | 0.1587 | 0.1562 | 0.1539 | 0.1515 | 0.1492 | 0.1469 | 0.1446 | 0.1423 | 0.1401 | 0.1379 |
| -0.9 | 0.1841 | 0.1814 | 0.1788 | 0.1762 | 0.1736 | 0.1711 | 0.1685 | 0.1660 | 0.1635 | 0.1611 |
| -0.8 | 0.2119 | 0.2090 | 0.2061 | 0.2033 | 0.2005 | 0.1977 | 0.1949 | 0.1922 | 0.1894 | 0.1867 |
| -0.7 | 0.2420 | 0.2389 | 0.2358 | 0.2327 | 0.2296 | 0.2266 | 0.2236 | 0.2206 | 0.2177 | 0.2148 |
| -0.6 | 0.2743 | 0.2709 | 0.2676 | 0.2643 | 0.2611 | 0.2578 | 0.2546 | 0.2514 | 0.2483 | 0.2451 |
| -0.5 | 0.3085 | 0.3050 | 0.3015 | 0.2981 | 0.2946 | 0.2912 | 0.2877 | 0.2843 | 0.2810 | 0.2776 |
| -0.4 | 0.3446 | 0.3409 | 0.3372 | 0.3336 | 0.3300 | 0.3264 | 0.3228 | 0.3192 | 0.3156 | 0.3121 |
| -0.3 | 0.3821 | 0.3783 | 0.3745 | 0.3707 | 0.3669 | 0.3632 | 0.3594 | 0.3557 | 0.3520 | 0.3483 |
| -0.2 | 0.4207 | 0.4168 | 0.4129 | 0.4090 | 0.4052 | 0.4013 | 0.3974 | 0.3936 | 0.3897 | 0.3859 |
| -0.1 | 0.4602 | 0.4562 | 0.4522 | 0.4483 | 0.4443 | 0.4404 | 0.4364 | 0.4325 | 0.4286 | 0.4247 |
| 0.0 | 0.5000 | 0.4960 | 0.4920 | 0.4880 | 0.4840 | 0.4801 | 0.4761 | 0.4721 | 0.4681 | 0.4641 |

# Standard Normal Cumulative Probability Table




**Cumulative probabilities for POSITIVE z-values are shown in the following table:**

| z | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **0.0** | 0.5000 | 0.5040 | 0.5080 | 0.5120 | 0.5160 | 0.5199 | 0.5239 | 0.5279 | 0.5319 | 0.5359 |
| **0.1** | 0.5398 | 0.5438 | 0.5478 | 0.5517 | 0.5557 | 0.5596 | 0.5636 | 0.5675 | 0.5714 | 0.5753 |
| **0.2** | 0.5793 | 0.5832 | 0.5871 | 0.5910 | 0.5948 | 0.5987 | 0.6026 | 0.6064 | 0.6103 | 0.6141 |
| **0.3** | 0.6179 | 0.6217 | 0.6255 | 0.6293 | 0.6331 | 0.6368 | 0.6406 | 0.6443 | 0.6480 | 0.6517 |
| **0.4** | 0.6554 | 0.6591 | 0.6628 | 0.6664 | 0.6700 | 0.6736 | 0.6772 | 0.6808 | 0.6844 | 0.6879 |
| **0.5** | 0.6915 | 0.6950 | 0.6985 | 0.7019 | 0.7054 | 0.7088 | 0.7123 | 0.7157 | 0.7190 | 0.7224 |
| **0.6** | 0.7257 | 0.7291 | 0.7324 | 0.7357 | 0.7389 | 0.7422 | 0.7454 | 0.7486 | 0.7517 | 0.7549 |
| **0.7** | 0.7580 | 0.7611 | 0.7642 | 0.7673 | 0.7704 | 0.7734 | 0.7764 | 0.7794 | 0.7823 | 0.7852 |
| **0.8** | 0.7881 | 0.7910 | 0.7939 | 0.7967 | 0.7995 | 0.8023 | 0.8051 | 0.8078 | 0.8106 | 0.8133 |
| **0.9** | 0.8159 | 0.8186 | 0.8212 | 0.8238 | 0.8264 | 0.8289 | 0.8315 | 0.8340 | 0.8365 | 0.8389 |
| **1.0** | 0.8413 | 0.8438 | 0.8461 | 0.8485 | 0.8508 | 0.8531 | 0.8554 | 0.8577 | 0.8599 | 0.8621 |
| **1.1** | 0.8643 | 0.8665 | 0.8686 | 0.8708 | 0.8729 | 0.8749 | 0.8770 | 0.8790 | 0.8810 | 0.8830 |
| **1.2** | 0.8849 | 0.8869 | 0.8888 | 0.8907 | 0.8925 | 0.8944 | 0.8962 | 0.8980 | 0.8997 | 0.9015 |
| **1.3** | 0.9032 | 0.9049 | 0.9066 | 0.9082 | 0.9099 | 0.9115 | 0.9131 | 0.9147 | 0.9162 | 0.9177 |
| **1.4** | 0.9192 | 0.9207 | 0.9222 | 0.9236 | 0.9251 | 0.9265 | 0.9279 | 0.9292 | 0.9306 | 0.9319 |
| **1.5** | 0.9332 | 0.9345 | 0.9357 | 0.9370 | 0.9382 | 0.9394 | 0.9406 | 0.9418 | 0.9429 | 0.9441 |
| **1.6** | 0.9452 | 0.9463 | 0.9474 | 0.9484 | 0.9495 | 0.9505 | 0.9515 | 0.9525 | 0.9535 | 0.9545 |
| **1.7** | 0.9554 | 0.9564 | 0.9573 | 0.9582 | 0.9591 | 0.9599 | 0.9608 | 0.9616 | 0.9625 | 0.9633 |
| **1.8** | 0.9641 | 0.9649 | 0.9656 | 0.9664 | 0.9671 | 0.9678 | 0.9686 | 0.9693 | 0.9699 | 0.9706 |
| **1.9** | 0.9713 | 0.9719 | 0.9726 | 0.9732 | 0.9738 | 0.9744 | 0.9750 | 0.9756 | 0.9761 | 0.9767 |
| **2.0** | 0.9772 | 0.9778 | 0.9783 | 0.9788 | 0.9793 | 0.9798 | 0.9803 | 0.9808 | 0.9812 | 0.9817 |
| **2.1** | 0.9821 | 0.9826 | 0.9830 | 0.9834 | 0.9838 | 0.9842 | 0.9846 | 0.9850 | 0.9854 | 0.9857 |
| **2.2** | 0.9861 | 0.9864 | 0.9868 | 0.9871 | 0.9875 | 0.9878 | 0.9881 | 0.9884 | 0.9887 | 0.9890 |
| **2.3** | 0.9893 | 0.9896 | 0.9898 | 0.9901 | 0.9904 | 0.9906 | 0.9909 | 0.9911 | 0.9913 | 0.9916 |
| **2.4** | 0.9918 | 0.9920 | 0.9922 | 0.9925 | 0.9927 | 0.9929 | 0.9931 | 0.9932 | 0.9934 | 0.9936 |
| **2.5** | 0.9938 | 0.9940 | 0.9941 | 0.9943 | 0.9945 | 0.9946 | 0.9948 | 0.9949 | 0.9951 | 0.9952 |
| **2.6** | 0.9953 | 0.9955 | 0.9956 | 0.9957 | 0.9959 | 0.9960 | 0.9961 | 0.9962 | 0.9963 | 0.9964 |
| **2.7** | 0.9965 | 0.9966 | 0.9967 | 0.9968 | 0.9969 | 0.9970 | 0.9971 | 0.9972 | 0.9973 | 0.9974 |
| **2.8** | 0.9974 | 0.9975 | 0.9976 | 0.9977 | 0.9977 | 0.9978 | 0.9979 | 0.9979 | 0.9980 | 0.9981 |
| **2.9** | 0.9981 | 0.9982 | 0.9982 | 0.9983 | 0.9984 | 0.9984 | 0.9985 | 0.9985 | 0.9986 | 0.9986 |
| **3.0** | 0.9987 | 0.9987 | 0.9987 | 0.9988 | 0.9988 | 0.9989 | 0.9989 | 0.9989 | 0.9990 | 0.9990 |
| **3.1** | 0.9990 | 0.9991 | 0.9991 | 0.9991 | 0.9992 | 0.9992 | 0.9992 | 0.9992 | 0.9993 | 0.9993 |
| **3.2** | 0.9993 | 0.9993 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9994 | 0.9995 | 0.9995 | 0.9995 |
| **3.3** | 0.9995 | 0.9995 | 0.9995 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9996 | 0.9997 |
| **3.4** | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9997 | 0.9998 |

## TABLE A.2

### *t* Distribution: Critical Values of *t*

| *Degrees of freedom* | *Two-tailed test:* / *One-tailed test:* | *Significance level* 10% / 5% | 5% / 2.5% | 2% / 1% | 1% / 0.5% | 0.2% / 0.1% | 0.1% / 0.05% |
|---|---|---|---|---|---|---|---|
| 1 | | 6.314 | 12.706 | 31.821 | 63.657 | 318.309 | 636.619 |
| 2 | | 2.920 | 4.303 | 6.965 | 9.925 | 22.327 | 31.599 |
| 3 | | 2.353 | 3.182 | 4.541 | 5.841 | 10.215 | 12.924 |
| 4 | | 2.132 | 2.776 | 3.747 | 4.604 | 7.173 | 8.610 |
| 5 | | 2.015 | 2.571 | 3.365 | 4.032 | 5.893 | 6.869 |
| 6 | | 1.943 | 2.447 | 3.143 | 3.707 | 5.208 | 5.959 |
| 7 | | 1.894 | 2.365 | 2.998 | 3.499 | 4.785 | 5.408 |
| 8 | | 1.860 | 2.306 | 2.896 | 3.355 | 4.501 | 5.041 |
| 9 | | 1.833 | 2.262 | 2.821 | 3.250 | 4.297 | 4.781 |
| 10 | | 1.812 | 2.228 | 2.764 | 3.169 | 4.144 | 4.587 |
| 11 | | 1.796 | 2.201 | 2.718 | 3.106 | 4.025 | 4.437 |
| 12 | | 1.782 | 2.179 | 2.681 | 3.055 | 3.930 | 4.318 |
| 13 | | 1.771 | 2.160 | 2.650 | 3.012 | 3.852 | 4.221 |
| 14 | | 1.761 | 2.145 | 2.624 | 2.977 | 3.787 | 4.140 |
| 15 | | 1.753 | 2.131 | 2.602 | 2.947 | 3.733 | 4.073 |
| 16 | | 1.746 | 2.120 | 2.583 | 2.921 | 3.686 | 4.015 |
| 17 | | 1.740 | 2.110 | 2.567 | 2.898 | 3.646 | 3.965 |
| 18 | | 1.734 | 2.101 | 2.552 | 2.878 | 3.610 | 3.922 |
| 19 | | 1.729 | 2.093 | 2.539 | 2.861 | 3.579 | 3.883 |
| 20 | | 1.725 | 2.086 | 2.528 | 2.845 | 3.552 | 3.850 |
| 21 | | 1.721 | 2.080 | 2.518 | 2.831 | 3.527 | 3.819 |
| 22 | | 1.717 | 2.074 | 2.508 | 2.819 | 3.505 | 3.792 |
| 23 | | 1.714 | 2.069 | 2.500 | 2.807 | 3.485 | 3.768 |
| 24 | | 1.711 | 2.064 | 2.492 | 2.797 | 3.467 | 3.745 |
| 25 | | 1.708 | 2.060 | 2.485 | 2.787 | 3.450 | 3.725 |
| 26 | | 1.706 | 2.056 | 2.479 | 2.779 | 3.435 | 3.707 |
| 27 | | 1.703 | 2.052 | 2.473 | 2.771 | 3.421 | 3.690 |
| 28 | | 1.701 | 2.048 | 2.467 | 2.763 | 3.408 | 3.674 |
| 29 | | 1.699 | 2.045 | 2.462 | 2.756 | 3.396 | 3.659 |
| 30 | | 1.697 | 2.042 | 2.457 | 2.750 | 3.385 | 3.646 |
| 32 | | 1.694 | 2.037 | 2.449 | 2.738 | 3.365 | 3.622 |
| 34 | | 1.691 | 2.032 | 2.441 | 2.728 | 3.348 | 3.601 |
| 36 | | 1.688 | 2.028 | 2.434 | 2.719 | 3.333 | 3.582 |
| 38 | | 1.686 | 2.024 | 2.429 | 2.712 | 3.319 | 3.566 |
| 40 | | 1.684 | 2.021 | 2.423 | 2.704 | 3.307 | 3.551 |
| 42 | | 1.682 | 2.018 | 2.418 | 2.698 | 3.296 | 3.538 |
| 44 | | 1.680 | 2.015 | 2.414 | 2.692 | 3.286 | 3.526 |
| 46 | | 1.679 | 2.013 | 2.410 | 2.687 | 3.277 | 3.515 |
| 48 | | 1.677 | 2.011 | 2.407 | 2.682 | 3.269 | 3.505 |
| 50 | | 1.676 | 2.009 | 2.403 | 2.678 | 3.261 | 3.496 |
| 60 | | 1.671 | 2.000 | 2.390 | 2.660 | 3.232 | 3.460 |
| 70 | | 1.667 | 1.994 | 2.381 | 2.648 | 3.211 | 3.435 |
| 80 | | 1.664 | 1.990 | 2.374 | 2.639 | 3.195 | 3.416 |
| 90 | | 1.662 | 1.987 | 2.368 | 2.632 | 3.183 | 3.402 |
| 100 | | 1.660 | 1.984 | 2.364 | 2.626 | 3.174 | 3.390 |
| 120 | | 1.658 | 1.980 | 2.358 | 2.617 | 3.160 | 3.373 |
| 150 | | 1.655 | 1.976 | 2.351 | 2.609 | 3.145 | 3.357 |
| 200 | | 1.653 | 1.972 | 2.345 | 2.601 | 3.131 | 3.340 |
| 300 | | 1.650 | 1.968 | 2.339 | 2.592 | 3.118 | 3.323 |
| 400 | | 1.649 | 1.966 | 2.336 | 2.588 | 3.111 | 3.315 |
| 500 | | 1.648 | 1.965 | 2.334 | 2.586 | 3.107 | 3.310 |
| 600 | | 1.647 | 1.964 | 2.333 | 2.584 | 3.104 | 3.307 |
| ∞ | | 1.645 | 1.960 | 2.326 | 2.576 | 3.090 | 3.291 |

## Data description

Mean for individual data, $\bar{x} = \frac{\sum x}{n}$

Mean for grouped data, $\bar{x} = \frac{\sum f \cdot x_m}{n}$

Standard deviation for a sample, $s = \sqrt{\frac{n\left(\sum x^2\right) - \left(\sum x\right)^2}{n(n-1)}}$

Standard deviation for grouped data,

$$s = \sqrt{\frac{n\left(\sum f \cdot x_m^2\right) - \left(\sum f \cdot x_m\right)^2}{n(n-1)}}$$

## Probability and Counting Rules

Addition rule 1 (mutually exclusive)

$$P(A \cup B) = P(A) + P(B)$$

Addition rule 2 (not mutually exclusive)

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Multiplication rule 1 (independent events)

$$P(A \cap B) = P(A) \cdot P(B)$$

Multiplication rule 2 (dependent events)

$$P(A \cap B) = P(A) \cdot P(B|A)$$

Conditional probability $P(B|A) = \frac{P(A \cap B)}{P(A)}$

Conditional events $P(\bar{E}) = 1 - P(E)$

## Normal Distribution

Standard score $z = \frac{X - \mu}{\sigma}$ or $z = \frac{X - \bar{X}}{s}$

Central limit theorem $z = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$

## Hypothesis Testing

z test, $z = \frac{\bar{X} - \mu}{\sigma/\sqrt{n}}$

t test, $t = \frac{\bar{X} - \mu}{s/\sqrt{n}}$, $(d.f = n - 1)$

Chi-square test, $\chi^2 = \frac{(n-1)s^2}{\sigma^2}$, $(d.f = n - 1)$

## Testing the Difference Between Two Means, Two Proportions and Two Variances

z test for comparing two means $z = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$

t test for comparing two means $t = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

z test for comparing two proportions

$$z = \frac{\left(\hat{p}_1 - \hat{p}_2\right) - \left(p_1 - p_2\right)}{\sqrt{\overline{pq}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

F test for comparing two variance $F = \frac{s_1^2}{s_2^2}$,

$$(d.f.N = n_1 - 1, d.f.D = n_2 - 1)$$

## Correlation and Regression

Correlation coefficient,

$$r = \frac{n\left(\sum xy\right) - \sum x \sum y}{\sqrt{\left[n\left(\sum x^2\right) - \left(\sum x\right)^2\right]\left[n\left(\sum y^2\right) - \left(\sum y\right)^2\right]}}$$

$$a = \frac{\left(\sum y\right)\left(\sum x^2\right) - \left(\sum x\right)\left(\sum xy\right)}{n\left(\sum x^2\right) - \left(\sum x\right)^2}$$

$$b = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{n\left(\sum x^2\right) - \left(\sum x\right)^2}$$

Chi Square and ANOVA

Chi-square for goodness-of-fit

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Anova test $F = \frac{s_B^2}{s_W^2}$

$$s_B^2 = \frac{\sum n_i (\bar{X} - \bar{X}_{GM})^2}{k - 1}$$

$$s_w^2 = \frac{\sum (n_i - 1) s_i^2}{\sum (n_i - 1)}$$