STAT 1222 Common Final Exam

SPRING 2016 May 5, 2016

PLEASE PRINT THE FOLLOWING INFORMATION:

Name: ______________________ Instructor: ______________________

Student ID #: ______________ Section/Time: ______________

THIS EXAM HAS TWO PARTS.

PART I.

Part I consists of 30 multiple choice questions. Each correct answer is scored 2 points; each incorrect (or blank) answer is scored 0, so there is no penalty for guessing. You may do calculations on the test paper, but your answers must be marked on the OPSCAN sheet with a soft lead pencil (HB or No. 2 lead). Any question with more than one choice marked will be counted as incorrect. If more than one choice seems correct, choose the one that is most complete or most accurate. Make sure that your name and ID number are written and correctly bubbled on the OPSCAN sheet.

PART II.

Part II consists of 3 free response questions with values as indicated. You must show all work in the space provided or elsewhere on the exam paper in a place that you clearly indicate. Work on loose sheets will not be graded.

FOR DEPARTMENT USE ONLY:

Part II.

Question	1	2	3
Score			

Part I	Part II	TOTAL

PART - I

For questions 1, 2, 3 and 4: The following data is a random sample of motor vehicle thefts of different models that took place in Charlotte area in 2015 :

6, 3, 7, 5, 1, 2, 5, 6, 9

1. The sample mean is

(a) 4.30 (b) 4.11 (c) 4.89 (d) 5.11 (e) 3.89

2. The sample median is

(a) 4 (b) 5 (c) 5.5 (d) 6 (e) 6.5

3. The sample inter-quartile range is

(a) 3 (b) 4 (c) 4.5 (d) 5 (e) 5.5

4. The sample standard deviation is about

(a) 6.36 (b) 2.52 (c) 3.52 (d) 5 (e) 8

For questions 5 and 6: A certain strain of bacteria occurs in all raw milk. The health department has found that if the milk is not contaminated, the distribution of the bacteria count per milliliter of milk has bell-shaped symmetric distribution with mean 2500 and standard deviation 300.

5. The percentage of bacteria count per milliliter of uncontaminated milk between 2200 and 3100 is approximately

(a) 95% (b) 81.5% (c) 68% (d) 99.7% (e) 50%

6. The percentage of bacteria count per milliliter of uncontaminated milk more than 3100 is approximately

(a) 2.5% (b) 5% (c) 95% (d) 68% (e) 45%

7. The serum cholesterol levels in men aged 18 to 24 have a positively skewed distribution with mean 178.1 and a standard deviation 40.7. All units are in mg/100 ml and the data re based on the National Health Survey. If a man aged 18 to 24 is randomly selected, the probability that his serum cholesterol level is between 96.7 and 259.8 is at least

(a) 0.68 (b) 0.75 (c) 0.95 (d) .50 (e) .89

For questions 8, 9 and 10: The ELISA test is used to screen blood for the presence of HIV. Like most diagnostic tests, the tests is not foolproof. A positive results means that the test says that the person has the HIV infection. A negative result means that the tests says that the person does not have the virus. The following table gives the result for a sample of 100,000 people. A person is chosen at random from these 100,000 people.

ELISA Test Results	Person has HIV	Person does not have HIV	Total
Positive	498	1,990	2,488
Negative	2	97,510	97,512
Total	500	99,500	100,000

8. The probability that the person does not have HIV is about

(a) 0.05 (b) 0.5 (c) 0.005 (d) 0.995 (e) 0.95

9. The probability that the person is positive *and* does not have HIV is about

(a) 0.05 (b) 0.9801 (c) 0.0199 (d) 0.50 (e) 0.996

10. The probability that the person is positive *or* does not have HIV is about

(a) 0.38215 (b) .99998 (c) 0.00002 (d) 0.91237 (e) 0.92134

For questions 11, 12 and 13: In the following table, x represents the number of long-distance telephone calls made during a one-hour period in a telemarketing department. The probability distribution of x is shown in the following table

x	1	2	3	4	5	6
$P(x)$	0.03	0.14	0.31	0.33	0.15	0.04

11. $P(2 \leq x < 5)$ is about

(a) 0.22 (b) 0.78 (c) 0.17 (d) 0.50 (e) 0.52

12. The mean of the random variable x is about

(a) 3.55 (b) 0.59 (c) 3.00 (d) 4.12 (e) 3.96

13. The standard deviation of the random variable x is about

(a) 1.25 (b) 1.12 (c) 13.85 (d) 3.55 (e) 12.60

14. Forced vital capacity (FVC), a standard measure of pulmonary function, is the volume of air a person can expel in 6 second. The standardized FVC follows approximately a standard normal distribution.A child is considered to have a normal long growth if his or her standardized FVC is within 1.5 standard deviation of the mean. The probability that a child is within the normal range of long growth is

(a) 0.1336 (b) 0.8664 (c) 0.4332 (d) 0.9332 (e) 0.0668

For questions 15 and 16: Systolic blood pressure readings (in mm Hg) are normally distributed with mean 80 and standard deviation 8.

15. The probability that the systolic blood pressure is more than 86 hours is about

(a) 0.7704 (b) 0.7734 (c) 0.2266 (d) 0.7764 (e) 0.95

16. The minimum systolic blood pressure required for a person to be in the top 10% of systolic blood pressure is about

(a) 90.24 (b) 93.16 (c) 85 (d) 85 (e) 100

For questions 17 and 18: The weights (in pounds) of paper discarded each week by households in Tuscon are normally distributed with a mean of 9.43 pounds and standard deviation of 4.17 pounds (based on Garbage project at the University of Arizona).

17. The mean and standard deviation of the sampling distribution of the mean of a random sample of 12 households are respectively

(a) 9.43, 4.17 (b) 9.43, 1.20 (c) 2.72, 1.20 (d) 2.72, 4.17 (e) 0.78, 1.20

18. The probability that a randomly selected 12 households have a mean between 10.1 pound and 12.2 pounds is about

(a) 0.1588 (b) .7227 (c) .2773 (d) 0.8412 (e) 0.5900

19. The tobacco industry closely monitors all surveys that involve smoking. One survey showed that among 785 randomly selected subjects who completed 4 years of college, 18.3% smoke (based on data from American Medical Association). The 99% confidence interval for the true percentage of smokers of all people who completed 4 years of college is closest to

(a) (0.160, 0.206) (b) (0.165, 0.201) (c) (0.156, 0.210) (d) (0.147, 0.219)
(e) (0.138, 0.228)

20. In a study of amounts of time required for room service delivery at a newly opened Radisson Hotel, 45 deliveries had a mean time of 24.2 min and a standard deviation of 8.7 min. The 90% confidence interval for the mean of all deliveries is closest to

(a) (22.06, 26.34) (b) (21.65, 26.75) (c) (20.86, 27.54) (d) (22.54, 25.86)
(e) (20.56, 27.84)

21. In a study of the use of hypnosis to relieve pain, sensory ratings were measured for 16 subjects and the mean sensory ratings was found to be 7.5 and standard deviation to be 2.3. The sensory ratings are normally distributed. The 95% confidence interval for the mean sensory ratings of the population is

(a) (6.48, 8.52) (b) (6.36, 8.64) (c) (5.20, 9.80) (d) (6.55, 8.50) (e) (6.27, 8.73)

22. We want to estimate the mean weight of plastic discarded by households in one week. Assume that a previous study has shown that the population standard deviation is 1.1 lb. The number of households must we randomly select if we want to be 99% certain that the sample mean is within 0.25 lb of the population mean is

(a) 105 (b) 75 (c) 129 (d) 53 (e) 153

23. Nielsen wants to estimate the percentage that are tuned to the Tonight Show. Assume that they want 95% confidence that their sample percentage has a margin of error 2 percentage points. A prior study found that 19% tune to the Tonight Show. The number of households must Nielsen survey is

(a) 1479 (b) 2555 (c) 1042 (d) 633 (e) 3034

For questions 24, 25, and 26: A random sample of 125 registered voters in Phoenix is asked if they favor the use of oxygenated fuels year-round to reduce air pollution and 86 voters responded positively. The city office claims that more than 65% of voters in Phoenix use oxygenated fuels.

24. At 5% level of significance, to test that more than 65% of voters in Phoenix have used oxygenated fuels, the suitable null and alternative hypotheses are

(a) $H_0 : p = 0.69$ versus $H_a : p < 0.69$
(b) $H_0 : p = 0.65$ versus $H_a : p \geq 0.65$
(c) $H_0 : p = 0.65$ versus $H_a : p > 0.65$
(d) $H_0 : p = 0.65$ versus $H_a : p \neq 0.65$
(e) $H_0 : p \geq 65$ versus $H_a : p \leq 65$

25. The value of the test statistics z is about

(a) 0.04 (b) −0.89 (c) 0.65 (d) 0.89 (e) 0.69

26. The $p-$value of the test is about

(a) 0.8133 (b) 0.688 (c) 0.65 (d) 0.05 (e) 0.1867

27. A Type-I error in a test of hypothesis occurs if

(a) we do not reject H_0 when in fact H_0 is true
(b) we do not reject H_a when in fact H_a is true
(c) we reject H_0 when in fact H_a is true
(d) we reject H_0 when in fact H_0 is true
(e) we do not reject H_0 when in fact H_0 is false

28. The Wisconsin Bottling Company employs two shifts of workers to fill bottles with iced tea. A random sample of 12 bottles from day shift yields a mean and standard deviation of 12.2 oz and 0.14 oz respectively. A random sample of 13 bottles from night shift yields a mean and standard deviation of 11.85 oz and 0.22 oz respectively. At 5% level of significance, to test that the mean amount of iced tea filed in the day shift and the night shift are different, the null and alternative hypothesis are

(a) $H_0 : \mu_1 - \mu_2 > 0$ versus $H_a : \mu_1 - \mu_2 \leq 0$
(b) $H_0 : \mu_1 - \mu_2 = 0$ versus $H_a : \mu_1 - \mu_2 \geq 0$
(c) $H_0 : \mu_1 - \mu_2 = 0$ versus $H_a : \mu_1 - \mu_2 > 0$
(d) $H_0 : \mu_1 - \mu_2 \geq 0$ versus $H_a : \mu_1 - \mu_2 < 0$
(e) $H_0 : \mu_1 - \mu_2 = 0$ versus $H_a : \mu_1 - \mu_2 \neq 0$

29. Two competing headache remedies claim to give fast-acting relief. An experiment was performed to compare the mean length of time required for bodily absorption of brand A and brand B headache remedies. The length of the time in minutes for the drugs to reach a specified level in the blood were recorded. Twelve people were randomly selected and given an oral dosage of brand A which gave a mean and standard deviation of 21.8 min and 8.7 min respectively. Another 12 were randomly selected and given an equal dosage of brand B which gave a mean and standard deviation of 18.9 min and 7.5 min respectively. Past experience with the drug composition of the two remedies permits researchers to assume that both distributions are approximately normal. To test at 1% level of significance, that there is no difference in the mean time required for bodily absorption, the formula of the test statistics is

(a) $Z = \frac{\hat{p}-p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$ (b) $T = \frac{\hat{\beta}_1 - B_0}{s_\epsilon/\sqrt{SS_{xx}}}$ (c) $T = \frac{(\bar{x}_1-\bar{x}_2)-D_0}{\sqrt{s_p^2(\frac{1}{n_1}+\frac{1}{n_2})}}$ (d) $T = \frac{\bar{d}-D_0}{s_d/\sqrt{n}}$ (e) $T = \frac{\bar{X}-\mu_0}{s/\sqrt{n}}$

30. The equation of a regression line relating to $x=$ distance (in miles) from the closest fire station and $y=$ fire damage (in thousands of dollars) is $\hat{y} = 10.28 + 4.92x$. If x increases by one unit, then

(a) y decreases by about 4.92 units
(b) y increases by about 4.92 units
(c) y decreases by about 10.28 units
(d) y increases by about 10.28 units
(e) the response of y cannot be predicted.

End of Multiple Choice Section

PART - II

1. Total blood volume (in ml) per body weight (in kg)is important in medical research. For healthy adults , the red blood cell volume mean is about 28 ml/kg. Red blood cell that is too low or too high can indicate a medical problem. Suppose that Roger has seven blood tests and and the mean is 32.7 ml/kg. Suppose that red blood cell volume follows normal distribution with standard deviation 4.75 ml/kg. With 5% level of significance, test that the mean blood cell volume is different from 28 ml/kg?

a) (3 pts) State the null and the alternative hypotheses.

H_0 :

H_a :

b) (4 pts) Write down the formula of the test statistics and find its value.

c) (3 pts) Determine the rejection region and make a decision.

d) (2 pts) State your conclusion in the context of the problem.

2. Do professional golfers play better in their first round? Let row B represent the score in the fourth (and final) round and let row A represent the score in the first round of a professional golf tournament. A random sample of finalists gave the following data:

B: Last	73	68	73	71	71	72	68	68	74
A: First	66	70	64	71	65	71	71	71	71

Let d = score in the last round − score in the first round and μ_d= mean in the last round − mean in the first round. The population of paired difference of golf scores has normal distribution with unknown standard deviation. At 10% level of significance, test the claim that the professional golfers do better in the first round.

a) (3 pts) State the null and the alternative hypotheses.

H_0 :

H_a :

c) (4 pts) Write down the formula of the test statistics and find its value.

d) (3 pts) Determine the rejection region and make a decision.

e) (2 pts) Make a conclusion in the context of the problem.

3. In one of the Boston city parks, there has been a problem with muggings in the summer months. A police cadre took a random sample of 10 days (out of a 90-day summer) and compiled the following data. For each day, x represents the number of police officers on duty and y represents the number of reported muggings on that day.

x	10	15	16	1	4	6	18	12	14	7
y	5	2	1	9	7	8	1	5	3	6

$\sum x = 103,\ \sum y = 47,\ \sum x^2 = 1347,\ \sum y^2 = 295,\ \sum xy = 343.$

a) (4 pts) Calculate the sample correlation coefficient.

b) (4 pts) Find the equation of the regression line relating y to x.

c) (2 pts) Predict the number of muggings for 20 police officers on duty.

d) (6 pts) Test at 1% significance level, the claim that the slope of the regression line between the number of police officers and number of muggings is positive. Interpret the result in the context of the problem.

STAT 122x Formula sheet

Descriptive

$$\bar{x} = \frac{\sum x}{n} \qquad s = \sqrt{\frac{\sum x^2 - \frac{1}{n}(\sum x)^2}{n-1}} \qquad z = \frac{x - \bar{x}}{s} \text{ or } z = \frac{x-\mu}{\sigma}$$

Probability

Complements: $P(A^c) = 1 - P(A)$

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

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

Independence: $P(A \cap B) = P(A) \cdot P(B)$ if and only if A and B are independent events

Discrete Random Variables

$$\mu = E(X) = \sum x P(x) \qquad \sigma = \sqrt{\sum (x-\mu)^2 \, P(x)} = \sqrt{\left[\sum x^2 \, P(x)\right] - \mu^2}$$

Binomial Random Variable

$$P(x) = \frac{n!}{x!(n-x)!} p^x q^{n-x} \qquad \mu = E(X) = np \qquad \sigma = \sqrt{npq}$$

Sampling Distributions

$$\mu_{\bar{X}} = \mu \qquad \sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}} \qquad \mu_{\hat{p}} = p \qquad \sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$$

Sample Sizes for Confidence Intervals

$$n = \frac{(z_{\alpha/2})^2 \sigma^2}{E^2} \quad \text{and} \quad n = \frac{(z_{\alpha/2})^2 \hat{p}(1-\hat{p})}{E^2}$$

Inference conditions		Confidence Interval	Test Statistic	df
Inference About a Single Population Mean				
$n \geq 30$	σ known	$\bar{x} \pm z_{\alpha/2}(\frac{\sigma}{\sqrt{n}})$	$Z = \frac{\bar{X}-\mu_0}{\sigma/\sqrt{n}}$	-
	σ unknown	$\bar{x} \pm z_{\alpha/2}(\frac{s}{\sqrt{n}})$	$Z = \frac{\bar{X}-\mu_0}{s/\sqrt{n}}$	-
$n < 30$ and normal population	σ known	$\bar{x} \pm z_{\alpha/2}(\frac{\sigma}{\sqrt{n}})$	$Z = \frac{\bar{X}-\mu_0}{\sigma/\sqrt{n}}$	-
	σ unknown	$\bar{x} \pm t_{\alpha/2}(\frac{s}{\sqrt{n}})$	$T = \frac{\bar{X}-\mu_0}{s/\sqrt{n}}$	$n-1$
Inference About a Single Population Proportion				
$\widehat{p} \pm 3\sqrt{\frac{\widehat{p}(1-\widehat{p})}{n}} \in [0,1]$		$\widehat{p} \pm z_{\alpha/2}\sqrt{\frac{\widehat{p}(1-\widehat{p})}{n}}$	$Z = \frac{\widehat{p}-p_0}{\sqrt{\frac{p_0(10\ p_0)}{n}}}$	-
Inference About Two Population Means				
independent samples	$n_1 \geq 30$ and $n_2 \geq 30$	$(\bar{x}_1 - \bar{x}_2) \pm z_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$	$Z = \frac{(\bar{x}_1-\bar{x}_2)-D_0}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}$	-
	$n_1 < 30$ or $n_2 < 30$, σ_1 and σ_2 unknown but assumed equal, normal populations	$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\sqrt{s_p^2(\frac{1}{n_1} + \frac{1}{n_2})}$; $s_p^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$	$T = \frac{(\bar{x}_1-\bar{x}_2)-D_0}{\sqrt{s_p^2(\frac{1}{n_1}+\frac{1}{n_2})}}$	$n_1 + n_2 - 2$
paired samples, normal population of differences		$\bar{d} \pm t_{\alpha/2}\frac{s_d}{\sqrt{n}}$	$T = \frac{\bar{d}-D_0}{s_d/\sqrt{n}}$	$n-1$
Inference About Two Population Proportions				
$\widehat{p}_j \pm 3\sqrt{\frac{\widehat{p}_j(1-\widehat{p}_j)}{n_j}} \in [0,1]$, $j = 1,2$		$(\widehat{p}_1 - \widehat{p}_2) \pm z_{\alpha/2}\sqrt{\frac{\widehat{p}_1\widehat{q}_1}{n_1} + \frac{\widehat{p}_2\widehat{q}_2}{n_2}}$	$Z = \frac{(\widehat{p}_1-\widehat{p}_2)-D_0}{\sqrt{\frac{p_1q_1}{n_1}+\frac{p_2q_2}{n_2}}}$	-

Correlation and Regression

$$SS_{xx} = \sum x^2 - \frac{1}{n}\left(\sum x\right)^2 \qquad SS_{xy} = \sum xy - \frac{1}{n}\left(\sum x\right)\left(\sum y\right) \qquad SS_{yy} = \sum y^2 - \frac{1}{n}\left(\sum y\right)^2$$

$$r = \frac{SS_{xy}}{\sqrt{SS_{xx} \cdot SS_{yy}}} \qquad \widehat{y} = \widehat{\beta}_1 x + \widehat{\beta}_0 \quad \text{where } \widehat{\beta}_1 = \frac{SS_{xy}}{SS_{xx}} \text{ and } \widehat{\beta}_0 = \bar{y} - \widehat{\beta}_1\bar{x}$$

$$SSE = SS_{yy} - \widehat{\beta}_1 SS_{xy} \qquad s_\varepsilon = \sqrt{\frac{SSE}{n-2}} \qquad r^2 = \frac{SS_{yy}-SSE}{SS_{yy}} = \frac{SS_{xy}^2}{SS_{xx}SS_{yy}} = \widehat{\beta}_1\frac{SS_{xy}}{SS_{yy}}.$$

$100(1-\alpha)\%$ confidence interval for β_1:

$\widehat{\beta}_1 \pm t_{\alpha/2}\frac{s_\varepsilon}{\sqrt{SS_{xx}}}$ $\quad (df = n-2)$

Test statistic for β_1:

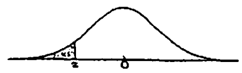
$T = \frac{\widehat{\beta}_1 - B_0}{s_\varepsilon/\sqrt{SS_{xx}}}$ $\quad (df = n-2)$

$100(1-\alpha)\%$ confidence interval for the mean value of y at $x = x_p$:

$\widehat{y}_p \pm t_{\alpha/2}\, s_\varepsilon \sqrt{\frac{1}{n} + \frac{(x_p-\bar{x})^2}{SS_{xx}}}$ $\quad (df = n-2)$

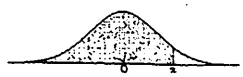
$100(1-\alpha)\%$ prediction interval for an individual new value of y at $x = x_p$:

$\widehat{y}_p \pm t_{\alpha/2}\, s_\varepsilon \sqrt{1 + \frac{1}{n} + \frac{(x_p-\bar{x})^2}{SS_{xx}}}$ $\quad (df = n-2)$



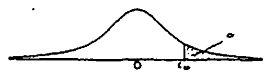
Cumulative Normal Probability $P(Z \leq z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
−3.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−3.8	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.7	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.6	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.5	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
−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



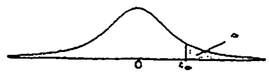
Cumulative Normal Probability $P(Z \leq z)$

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	0.8304	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
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000



Critical Values of t

df	$t_{0.200}$	$t_{0.100}$	$t_{0.050}$	$t_{0.025}$	$t_{0.010}$	$t_{0.005}$	$t_{0.0025}$	$t_{0.001}$	$t_{0.0005}$
1	1.376	3.078	6.314	12.706	31.821	63.657	127.321	318.309	636.619
2	1.061	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.599
3	0.978	1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4	0.941	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.920	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.906	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.896	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.889	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.883	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.879	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.876	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.873	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.870	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.868	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.866	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.865	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.863	1.333	1.740	2.110	2.576	2.898	3.222	3.646	3.965
18	0.862	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	0.861	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.860	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	0.859	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	0.858	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	0.858	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.768
24	0.857	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.856	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	0.856	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	0.855	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	0.855	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	0.854	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	0.854	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
31	0.853	1.309	1.696	2.040	2.453	2.744	3.022	3.375	3.633
32	0.853	1.309	1.694	2.037	2.449	2.738	3.015	3.365	3.622
33	0.853	1.308	1.692	2.035	2.445	2.733	3.008	3.356	3.611
34	0.852	1.307	1.691	2.032	2.441	2.728	3.002	3.348	3.601
35	0.852	1.306	1.690	2.030	2.438	2.724	2.996	3.340	3.591
36	0.852	1.306	1.688	2.028	2.434	2.719	2.990	3.333	3.582
37	0.851	1.305	1.687	2.026	2.431	2.715	2.985	3.326	3.574
38	0.851	1.304	1.686	2.024	2.429	2.712	2.980	3.319	3.566
39	0.851	1.304	1.685	2.023	2.426	2.708	2.976	3.313	3.558
40	0.851	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
41	0.851	1.303	1.683	2.020	2.421	2.701	2.967	3.301	3.544
42	0.851	1.302	1.682	2.018	2.418	2.698	2.963	3.296	3.538
43	0.851	1.302	1.681	2.017	2.416	2.695	2.959	3.291	3.532
44	8.850	1.301	1.680	2.015	2.414	2.692	2.956	3.286	3.526
45	0.850	1.301	1.679	2.014	2.412	2.690	2.952	3.281	3.520
46	0.850	1.300	1.679	2.013	2.410	2.687	2.949	3.277	3.515
47	0.849	1.300	1.678	2.012	2.408	2.685	2.946	3.273	3.510
48	0.849	1.299	1.677	2.011	2.407	2.682	2.943	3.269	3.505
49	0.849	1.299	1.677	2.010	2.405	2.680	2.940	3.265	3.500
50	0.849	1.299	1.676	2.009	2.403	2.678	2.937	3.261	3.496



Critical Values of t

df	$t_{0.200}$	$t_{0.100}$	$t_{0.050}$	$t_{0.025}$	$t_{0.010}$	$t_{0.005}$	$t_{0.0025}$	$t_{0.001}$	$t_{0.0005}$
51	0.849	1.298	1.675	2.008	2.402	2.676	2.934	3.258	3.492
52	0.849	1.298	1.675	2.007	2.400	2.674	2.932	3.255	3.488
53	0.849	1.298	1.674	2.006	2.399	2.672	2.929	3.251	3.484
54	0.848	1.297	1.674	2.005	2.397	2.670	2.927	3.248	3.480
55	0.848	1.297	1.673	2.004	2.396	2.668	2.925	3.245	3.476
56	0.848	1.297	1.673	2.003	2.395	2.667	2.923	3.242	3.473
57	0.848	1.297	1.672	2.002	2.394	2.665	2.920	3.239	3.470
58	0.848	1.296	1.672	2.002	2.392	2.663	2.918	3.237	3.466
59	0.848	1.296	1.671	2.001	2.391	2.662	2.916	3.234	3.463
60	0.848	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
61	0.848	1.296	1.670	2.000	2.389	2.659	2.913	3.229	3.457
62	0.848	1.295	1.670	1.999	2.388	2.657	2.911	3.227	3.454
63	0.847	1.295	1.669	1.998	2.387	2.656	2.909	3.225	3.452
64	0.847	1.295	1.669	1.998	2.386	2.655	2.908	3.223	3.449
65	0.847	1.295	1.669	1.997	2.385	2.654	2.906	3.220	3.447
66	0.847	1.295	1.668	1.997	2.384	2.652	2.904	3.218	3.444
67	0.847	1.294	1.668	1.996	2.383	2.651	2.903	3.216	3.442
68	0.847	1.294	1.668	1.995	2.382	2.650	2.902	3.214	3.439
69	0.847	1.294	1.667	1.995	2.382	2.649	2.900	3.213	3.437
70	0.847	1.294	1.667	1.994	2.381	2.648	2.899	3.211	3.435
71	0.847	1.294	1.667	1.994	2.380	2.647	2.897	3.209	3.433
72	0.847	1.293	1.666	1.993	2.379	2.646	2.896	3.207	3.431
73	0.847	1.293	1.666	1.993	2.379	2.645	2.895	3.206	3.429
74	0.847	1.293	1.666	1.993	2.378	2.644	2.894	3.204	3.427
75	0.846	1.293	1.665	1.992	2.377	2.643	2.892	3.202	3.425
76	0.846	1.293	1.665	1.992	2.376	2.642	2.891	3.201	3.423
77	0.846	1.293	1.665	1.991	2.376	2.641	2.890	3.199	3.421
78	0.846	1.292	1.665	1.991	2.375	2.640	2.889	3.198	3.420
79	0.846	1.292	1.664	1.990	2.374	2.640	2.888	3.197	3.418
80	0.846	1.292	1.664	1.990	2.374	2.639	2.887	3.195	3.416
81	0.846	1.292	1.664	1.990	2.373	2.638	2.886	3.194	3.415
82	0.846	1.292	1.664	1.989	2.373	2.637	2.885	3.193	3.413
83	0.846	1.292	1.663	1.989	2.372	2.636	2.884	3.191	3.412
84	0.846	1.292	1.663	1.989	2.372	2.636	2.883	3.190	3.410
85	0.846	1.292	1.663	1.988	2.371	2.635	2.882	3.189	3.409
86	0.846	1.291	1.663	1.988	2.370	2.634	2.881	3.188	3.407
87	0.846	1.291	1.663	1.988	2.370	2.634	2.880	3.187	3.406
88	0.846	1.291	1.662	1.987	2.369	2.633	2.880	3.185	3.405
89	0.846	1.291	1.662	1.987	2.369	2.632	2.879	3.184	3.403
90	0.846	1.291	1.662	1.987	2.368	2.632	2.878	3.183	3.402
91	0.846	1.291	1.662	1.986	2.368	2.631	2.877	3.182	3.401
92	0.846	1.291	1.662	1.986	2.368	2.630	2.876	3.181	3.399
93	0.846	1.291	1.661	1.986	2.367	2.630	2.876	3.180	3.398
94	0.846	1.291	1.661	1.986	2.367	2.629	2.875	3.179	3.397
95	0.845	1.291	1.661	1.985	2.366	2.629	2.874	3.178	3.396
96	0.845	1.290	1.661	1.985	2.366	2.628	2.873	3.177	3.395
97	0.845	1.290	1.661	1.985	2.365	2.627	2.873	3.176	3.394
98	0.845	1.290	1.661	1.984	2.365	2.627	2.872	3.175	3.393
99	0.845	1.290	1.660	1.984	2.365	2.626	2.871	3.175	3.392
100	0.845	1.290	1.660	1.984	2.364	2.626	2.871	3.174	3.390
∞ [z]	0.842	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291