VERSION A

Choose the best answer. Do not write letters in the margin or communicate with other students in any way; if you do you will receive a 0. If you have a question note it on your exam and ask for clarification when your exam is returned. In the meantime choose the best answer. Neither the proctors nor Dr. Cox will answer statistics questions during the exam.

Please check each question and possible answers thoroughly as questions at the bottom of a page sometimes run onto the next page. Please verify that your test version and scantron version are the same.

This exam has 25 questions. Cost for turning in exam late: 1st minute is 10 points; 2nd minute is 20 additional points (30 total); 3rd minute is 30 points (60 total) ; 4th minute is 40 points (100 total); 5th minute is 50 points (150 total); 6th minute is 80 points (230 total) and no exams are graded past that point.

As noted in the syllabus entering your student ID incorrectly on your scantron results in a 10 point deduction.

1. Suppose X follows the standard normal distribution. If $z < 0$ then $P(X < z) < .5$.

   (a) True.

   (b) False.

   (c) True if X is drawn from a sample of at least 30 observations but otherwise it is not necessarily true.

2. In the October 1, 2017 referendum on Catalan independence 42% of registered voters went to the polls and voted. Of those, 90% voted for independence. Choose the correct statement below that is consistent with descriptive statistics.

   (a) Most registered voters in Catalan favor independence.

   (b) At least 37% of Catalan's registered voters favor independence.

   (c) Catalan should be independent.

3. In an assigned reading for the class you read about a survey of wedding costs in the US. The survery sponsored by TheKnot found an average cost of over $35,000. In that survey

   (a) the sample was a random sample.

   (b) the sample was a convenience sample.

   (c) the sample was a stratified sample.

   (d) the sample was was taken from a cluster.

   (e) the sample was a systematic sample.

4. Suppose you were trying to find the average cost of a wedding in the US (you own a wedding planning business). You obtain 18,000 responses to a questionaire about wedding expenses. You want to show the distribution of total wedding expenses. Choose the best way to do this.

   (a) a histogram.

   (b) a pie chart.

   (c) a scatter plot.

   (d) a frequency table.

   (e) a z table.

5. Zack Greinke pitched in the Diamondbacks' wild card game October 4, 2017 and retired 11 batters (he got 11 batters out). Assume that the number of batters a pitcher gets out follows roughly the Poisson distribution (this is actually a pretty good assumption). Greinke's average for the season was 19, as in on average he would get 19 batters out. What is the probability that he would get out exactly 11 batters?

   (a) .03467.
   (b) .02371.
   (c) .03207.
   (d) .00498.
   (e) .01635.

6. Kazuo Ishiguro won the 2017 Nobel Prize for Literature. The table below shows his books. What is the average price for one of his novels?

Ishiguro's Novels

Novel	Year	Pages	Price (Amazon)
A Pale View of the Hills	1982	192	$9.99
An Artist of the Floating World	1986	206	$11.16
The Remains of the Day	1989	245	$10.77
The Unconsoled	1995	535	$15.86
When We Were Orphans	2000	313	$10.74
Never Let Me Go	2005	288	$10.87
The Buried Giant	2015	352	$9.52

   (a) $11.07
   (b) $10.92
   (c) $11.38
   (d) $11.82
   (e) $11.27

7. Use the information about Ishiguro's novels. What is the standard deviation for page lengths for his books?

   (a) 124.55
   (b) 102.43
   (c) 96.05

(d) 116.64
(e) 144.33

8. Use the information about Ishiguro's novels. Which novel has the largest z score for its price?

   (a) The Unconsoled
   (b) Never Let Me Go
   (c) A Pale View of the Hills
   (d) The Remains of the Day
   (e) An Artist of the Floating World

9. Use the information about Ishiguro's novels. Suppose you think that the time between Ishiguro's novels follows an exponentail distribution. In what year do you expect his next novel to appear?

   (a) 2018
   (b) 2025
   (c) 2020
   (d) 2026
   (e) 2017

10. Use the information about Ishiguro's novels. Suppose you think that the time between Ishiguro's novels follows an exponentail distribution. Suppose you are in the year 2015 and *The Buried Giant* was just released, what is the probability that his next novel would come in 2019 or sooner?

    (a) 0.343644444452916
    (b) 0.766493520909087
    (c) 0.166247081924819
    (d) 0.516774918810175
    (e) 0.80531329166849

11. Using the Poisson PMF, when the mean is 10, what is $P(X = 8)$?

    (a) 0.31889854822353
    (b) 0.0375594192894118
    (c) 0.11259903214902

(d) 0.88740096785098

12. Suppose that the average number of online purchases a customer makes in a week is 2 and that for each customer this random variable follows the Poisson distribution. What is the probability that a customer will make exactly 1 online purchases in a week?

    (a) 0.506005849709838
    (b) 0.132402339883935
    (c) 0.270670566473225
    (d) 0.729329433526775

13. Suppose at ASU 54% of students take out some form of student loan to pay for school. In a class of 365 what is the expected number of students with a loan?

    (a) 171.477
    (b) 197.1
    (c) 207.1
    (d) 167.1

14. Suppose that a random variable X follows the exponential distribution. Suppose then that researchers at hundreds of different universities across the world independently collect samples of this random variable and find its sample mean; each of their samples has approximately 90 observations. You decide to take these hundreds of reported sample means and put them into a histgram.

    (a) Since this is a random variable we don't know what the histogram will look like.
    (b) Your histogram will appear like the unifrom distribution.
    (c) Your histogram will look like an exponential distribution and be right skewed.
    (d) Your histogram will be roughly bell shaped.
    (e) None of the above.

15. Suppose you have a random variable that is uniformly distributed with a maximum of 261 and a minimum of 74. What is the expected value of this random variable?

    (a) 187.5
    (b) 152.5
    (c) 217.75

(d) 167.5
(e) 158.12

16. What is the critical t value when there are 19 degrees of freedom and the confidence coefficient is .90?

    (a) 2.093
    (b) 1.3277
    (c) 1.7291
    (d) 1.7341
    (e) 1.3304

17. Suppose that the known standard deviation for the numbers of hours that students work in a week is 15.6. If I draw a sample of 24 what is the standard error?

    (a) 2.54746933249451
    (b) 0.65
    (c) 4.13963766530357
    (d) 4.39438459855302
    (e) 3.18433666561813

18. Zack Greinke averaged 6.3 innings per game in 2017 with a standard deviation of 1.26. Find the z score for a game in which he had 3.67 innings.

    (a) -2.04138095238095
    (b) -2.08730158730159
    (c) -1.87857142857143
    (d) 1.99546031746032
    (e) -2.13739682539682

19. Suppose that in a recent sample of 38 recent graduates with business degrees the mean starting salary is 54082 and the standard deviation is 1604. Construct a 99% confidence interval for the mean starting salary for business majors.

    (a) [53775, 54388]
    (b) [52775, 55388]
    (c) [53375, 54788]
    (d) [48037, 49309]

20. You are given the following, $s = 6.7$, $\bar{x} = 54$ and $n = 26$. Construct a 90% confidence interval. The resulting interval is

(a) [49.7555404387296, 60.2444595612704]
(b) [45.7555404387296, 62.2444595612704]
(c) [51.7555404387296, 56.2444595612704]
(d) [46.5799863948566, 59.0566825393339]
(e) none of the above.

21. Suppose that you have a sample with 26 observations. You are going to use this sample to construct a confidence interval for the population mean. How many degrees of freedom are there?

(a) 13
(b) 25
(c) 5.09901951359278
(d) 26

22. What is the probability of observing a random variable with a value greater than 1.33 when the random variable follows the standard normal distribution?

(a) .0918
(b) .9082
(c) .9541
(d) .0464

23. What is the probability of observing a z value less than -0.51?

(a) 0.695
(b) 0.305
(c) 0.425
(d) 0.235

24. In the context of constructing a confidence interval, as α increases the probability of the interval containing the true parameter value increases.

(a) True
(b) False

25. The true standard deviation for a given random variable is 7.7. If you draw a sample of 44 observations of this random variable the standard error is

    (a) 0.418330013267038
    (b) 1.3475
    (c) 1.16081867662439
    (d) 51.0760217714732
    (e) 1.10277774279317

26. (bonus question) Before Ishiguro won the Nobel Prize I had already read all of his novels. I did not read them in the order in which he wrote them. The novel that I read third has a price that is more than two standard deviations away from the average price. Which novel did I read third?

    (a) *Never Let Me Go*
    (b) *When We Were Orphans*
    (c) *The Unconsoled*
    (d) *An Artist of the Floating World*
    (e) none of the above.

Key

1. a
2. b, find $.9 \times 42\%$.
3. b
4. a
5. e, $19^{11}e^{-19}/11!$
6. e
7. d
8. a
9. c, average time betwen is 5.5, 2015+5.5=June 2020.
10. d, 2019-2015=4, $\mu = 5.5$ (see previous question), $1 - exp(-4/5.5)$ =0.516774918810175
11. c, use Poisson pmf
12. c
13. b
14. d, this is a result of the central limit theorem.
15. d, $(a + b)/2$.
16. c
17. e, use $\sigma/\sqrt{n}$.
18. b, $z = (3.67 - 6.3)/1.26$.
19. c
20. c
21. b
22. a, consult the z table.
23. b
24. b
25. c, use $\sigma/\sqrt{n}$.
26. c.

Chapter 3:

sample mean: $\bar{x} = \sum_{i=1}^{n} x_i/n$

sample variance: $s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$.

sample standard deviation: $s = \sqrt{s^2}$.

Coefficient of Variation: $CV = \frac{s}{\bar{x}}\left(100\%\right)$

sample z-Score: $z = \frac{x_i - \bar{x}}{s}$

Interquartile Range: IQR $= Q_3 - Q_1$.

Sample Covariance: $s_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{n-1}$

Sample Correlation Coefficient: $r_{xy} = s_{xy}/(s_x s_y)$

Chapter 4:

The complement rule: $P(A) + P(A') = 1$

addition rule: $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

conditional probability: $P(A|B) = \frac{P(A \text{ and } B)}{P(B)}$

Bayes' Theorem

$$P(A_i|B) = \frac{P(A_i)P(B|A_i)}{P(A_1)P(B|A_1) + P(A_2)P(B|A_2) + \cdots + P(A_n)P(B|A_n)}$$

Combinations: ${}_nC_x = \frac{n!}{(n-x)!x!}$

Chapter 5:

Expected Value and mean of a Discrete Probability Distribution:

$$E(x) = \mu = \sum_{i=1}^{n} x_i P(x_i)$$

Variance of a Discrete Probability Distribution:

$$\sigma^2 = \sum_{i=1}^{n}(x_i - \mu)^2 P(x_i)$$

Chapter 5 continued:

Binomial Probability Dist.: $P(x, n) = \frac{n!}{(n-x)!x!} p^x (q)^{(n-x)}$

Mean of a Binomial Distribution: $\mu = np$

Standard Dev. of a Binomial Distribution: $\sigma = \sqrt{npq}$

Poisson Probability Distribution: $P(x) = \frac{\lambda^x e^{-\lambda}}{x!}$

Chapter 6:

Normal PDF: $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(1/2)[(x-\mu)/\sigma]^2}$

the z-score: $z = \frac{x-\mu}{\sigma}$

Exponential PDF: $f(x) = \lambda e^{-\lambda x}$

Exponential CDF: $P(x \le a) = 1 - e^{-a\lambda}$

Standard Dev. of Exponential Dist.: $\sigma = \mu = \frac{1}{\lambda}$

Continuous Uniform PDF

$$f(x) = \begin{cases} \frac{1}{b-a} & \text{if } a \le x \le b \\ 0 & \text{otherwise} \end{cases}$$

Uniform CDF: $P(x_1 \le x \le x_2) = \frac{x_2 - x_1}{b-a}$

mean of the continuous uniform dist.: $\mu = \frac{a+b}{2}$

standard dev. of the continuous uniform dist.: $\sigma = \frac{b-a}{\sqrt{12}}$

Chapter 7:

standard error of the mean: $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$.

z-score for the mean: $z_{\bar{x}} = \frac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}}$

Chapter 7 continued:

sample proportion: $\bar{p} = \frac{x}{n}$

standard error of the proportion: $\sigma_{\bar{p}} = \sqrt{\frac{p(1-p)}{n}}$

Chapter 8:

Confidence Interval for the mean (σ known):

$$\bar{x} \pm z_{\alpha/2}\sigma_{\bar{x}}$$

margin of error for a CI for the mean: $ME_{\bar{x}} = z_{\alpha/2}\sigma_{\bar{x}}$

approximate standard error of the mean: $\hat{\sigma}_{\bar{x}} = \frac{s}{\sqrt{n}}$.

Confidence Interval for the mean (σ unknown):

$$\bar{x} \pm t_{\alpha/2}\hat{\sigma}_{\bar{x}}$$

Sample Size needed to Estimate a population mean

$$n = \frac{(z_{\alpha/2})^2\sigma^2}{(ME_{\bar{x}})^2}$$

Sample Size needed to Estimate the population proportion

$$n = \frac{(z_{\alpha/2})^2\bar{p}(1-\bar{p})}{(ME_p)^2}$$

Chapter 9:

the z-test statistic for a hypothesis test for the population mean (when σ is known)

$$z_{\bar{x}} = \frac{\bar{x} - \mu_{H_0}}{\sigma/\sqrt{n}}$$

the t-test statistic for a hypothesis test for the population mean (when σ is unknown)

$$t_{\bar{x}} = \frac{\bar{x} - \mu_{H_0}}{s/\sqrt{n}}$$

Chapter 10:
the mean of the sampling distribution for the difference in means:

$$\mu_{\bar{x}_1-\bar{x}_2} = \mu_{\bar{x}_1} - \mu_{\bar{x}_2}$$

the standard error of the difference between two means:

$$\sigma_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

the z-test statistic for a hypothesis test for the difference between two means (σ_1 and σ_2 known)

$$z_{\bar{x}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_{H_0}}{\sigma_{\bar{x}_1-\bar{x}_2}}$$

the t-test statistic for a hypothesis test for the difference between two means (σ_1 and σ_2 unknown but equal)

$$t_{\bar{x}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_{H_0}}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

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

the t-test statistic for a hypothesis test for the difference between two means (σ_1 and σ_2 unknown and unequal)

$$t_{\bar{x}} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)_{H_0}}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

Confidence Interval for the difference between the means of two independent populations (σ_1 and σ_2 unknown but equal)

$$(\bar{x}_1 - \bar{x}_2) \pm t_{\alpha/2}\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$$

the matched-pair difference: $d = x_1 - x_2$

the mean of matched-pair difference: $\bar{d} = \frac{\sum_{i=1}^n d_i}{n}$

the standard deviation of the matched-pair differences

$$s_d = \sqrt{\frac{\sum_{i=1}^n (d_i - \bar{d})^2}{n-1}}$$

the t-Test Statistic for a Matched-Pair hypothesis test for the mean

$$t_{\bar{x}} = \frac{\bar{d} - (\mu_d)_{H_0}}{s_d/\sqrt{n}}$$

Chapter 11:

the total sum of squares (SST): $SST = \sum_{j=1}^{k}\sum_{i=1}^{n_j}(x_{ij} - \bar{\bar{x}})^2$

the mean square total (MST): $MST = \frac{SST}{n_T - 1}$

the partitioning of the Total Sum of Squares (SST) for a One-Way ANOVA: SST=SSB+SSW.

sum of squares between (SSB): $SSB = \sum_{j=1}^{k} n - j(\bar{x}_j - \bar{\bar{x}})^2$

the mean square between (MSB): $MSB = \frac{SSB}{k-1}$

sum of squares within (SSW): $SSW = \sum_{j=1}^{k}\sum_{i=1}^{n_j}(x_{ij} - \bar{x}_j)^2$

the mean square within (MSW): $MSW = \frac{SSW}{n_T - k}$

the F-test statistic for One-Way ANOVA: $F_{\bar{x}} = \frac{MSB}{MSW}$

Tukey-Kramer critical range:

$$CR_{ij} = Q_\alpha\sqrt{\frac{MSW}{2}\left(\frac{1}{n_i} + \frac{1}{n_j}\right)}$$

Chapter 14: simple linear regression model for a population $y_i = \beta_0 + \beta_1 x_i + \epsilon_i$

$$\hat{y} = b_0 + b_1 x \qquad e_i = y_i - \hat{y}_i$$

sum of squares error: $SSE = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2$

total sum of squares (SST): $SST = \sum(y - \bar{y})^2$

$$SST = SSR + SSE$$

sum of squares regression (SSR): $SSR = \sum(\hat{y} - \bar{y})^2$

Chapter 14 continued:

$$R^2 = \frac{SSR}{SST}$$

F-statistic for the coef. of determination: $F = \frac{SSR}{SSE/(n-2)}$

Standard Error of the Estimate, $s_e = \sqrt{SSE/(n-2)}$.
Confidence Interval (CI) for an average value of Y:

$$CI = \hat{y}^* \pm t_{\alpha/2}s_e\sqrt{\frac{1}{n} + \frac{(x-\bar{x})^2}{\sum x^2 - ((\sum x)^2/n)}}$$

Prediction Interval (PI) fpr a specific value of y:

$$PI = \hat{y}^* \pm t_{\alpha/2}s_e\sqrt{1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{\sum x^2 - ((\sum x)^2/n)}}$$

t-test statistic for the regression slope: $t = \frac{b_1 - \beta_1}{s_b}$

the standard error of a slope: $s_b = \frac{s_e}{\sqrt{\sum x^2 - n(\bar{x})^2}}$

confid. interval for the pop. slope: $CI = b_1 \pm t_{\alpha/2}s_b$

Chapter 15:
mean square regression (MSR): $MSR = SSR/k$

mean square error (MSE): $MSE = SSE/(n-k-1)$

F-test stat. for the overall regression model: $F = \frac{MSR}{MSE}$

adjusted multiple coef. of det.: $R_A^2 = 1 - (1 - R^2)\frac{n-1}{n-k-1}$

variance inflation factor: $VIF_j = \frac{1}{1 - R_j^2}$

Other Math Rule Reminders:

$$e^x = \exp(x) \quad \text{and} \quad \ln 1 = 0 \quad \text{and} \quad \ln e = 1$$

$$x! = (x)(x-1)(x-2)\cdots(2)(1) \quad \text{and} \quad 0! = 1 \quad \text{and} \quad x^0 = 1$$

t Distribution

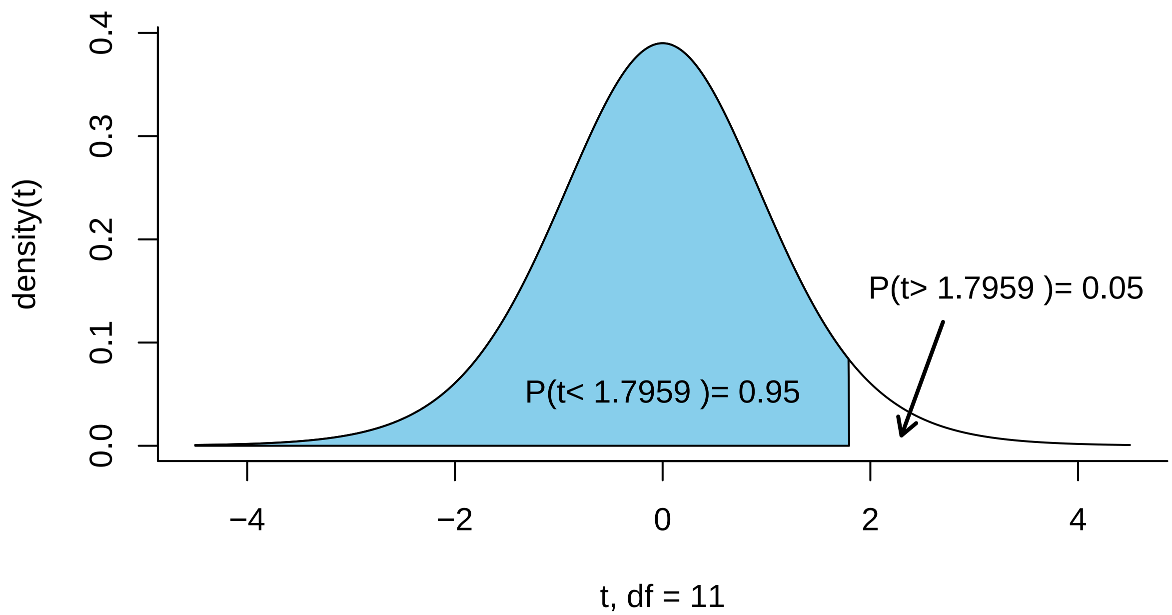

Table of t values. Degrees of Freedom are in the "df" column and *right tail* probabilities are in the top row. Example: for df=11 and $P(t > 2.7181) = .01$.

	Right tail probability				
df	0.1	0.05	0.025	0.01	0.005
1	3.0777	6.3138	12.7062	31.8205	63.6567
2	1.8856	2.92	4.3027	6.9646	9.9248
3	1.6377	2.3534	3.1824	4.5407	5.8409
4	1.5332	2.1318	2.7764	3.7469	4.6041
5	1.4759	2.015	2.5706	3.3649	4.0321
6	1.4398	1.9432	2.4469	3.1427	3.7074
7	1.4149	1.8946	2.3646	2.998	3.4995
8	1.3968	1.8595	2.306	2.8965	3.3554
9	1.383	1.8331	2.2622	2.8214	3.2498
10	1.3722	1.8125	2.2281	2.7638	3.1693
11	1.3634	1.7959	2.201	**2.7181**	3.1058
12	1.3562	1.7823	2.1788	2.681	3.0545
13	1.3502	1.7709	2.1604	2.6503	3.0123
14	1.345	1.7613	2.1448	2.6245	2.9768
15	1.3406	1.7531	2.1314	2.6025	2.9467
16	1.3368	1.7459	2.1199	2.5835	2.9208
17	1.3334	1.7396	2.1098	2.5669	2.8982
18	1.3304	1.7341	2.1009	2.5524	2.8784
19	1.3277	1.7291	2.093	2.5395	2.8609
20	1.3253	1.7247	2.086	2.528	2.8453

Table of t values **continued**. For values not on table approximate based on available values.					
	Right tail probability				
df	0.1	0.05	0.025	0.01	0.005
21	1.3232	1.7207	2.0796	2.5176	2.8314
22	1.3212	1.7171	2.0739	2.5083	2.8188
23	1.3195	1.7139	2.0687	2.4999	2.8073
24	1.3178	1.7109	2.0639	2.4922	2.7969
25	1.3163	1.7081	2.0595	2.4851	2.7874
26	1.315	1.7056	2.0555	2.4786	2.7787
27	1.3137	1.7033	2.0518	2.4727	2.7707
28	1.3125	1.7011	2.0484	2.4671	2.7633
29	1.3114	1.6991	2.0452	2.462	2.7564
30	1.3104	1.6973	2.0423	2.4573	2.75
31	1.3095	1.6955	2.0395	2.4528	2.744
32	1.3086	1.6939	2.0369	2.4487	2.7385
33	1.3077	1.6924	2.0345	2.4448	2.7333
34	1.307	1.6909	2.0322	2.4411	2.7284
35	1.3062	1.6896	2.0301	2.4377	2.7238
36	1.3055	1.6883	2.0281	2.4345	2.7195
37	1.3049	1.6871	2.0262	2.4314	2.7154
38	1.3042	1.686	2.0244	2.4286	2.7116
39	1.3036	1.6849	2.0227	2.4258	2.7079
40	1.3031	1.6839	2.0211	2.4233	2.7045
41	1.3025	1.6829	2.0195	2.4208	2.7012
42	1.302	1.682	2.0181	2.4185	2.6981
43	1.3016	1.6811	2.0167	2.4163	2.6951
44	1.3011	1.6802	2.0154	2.4141	2.6923
45	1.3006	1.6794	2.0141	2.4121	2.6896
46	1.3002	1.6787	2.0129	2.4102	2.687
47	1.2998	1.6779	2.0117	2.4083	2.6846
48	1.2994	1.6772	2.0106	2.4066	2.6822
49	1.2991	1.6766	2.0096	2.4049	2.68
50	1.2987	1.6759	2.0086	2.4033	2.6778
51	1.2984	1.6753	2.0076	2.4017	2.6757
52	1.298	1.6747	2.0066	2.4002	2.6737
53	1.2977	1.6741	2.0057	2.3988	2.6718
54	1.2974	1.6736	2.0049	2.3974	2.67
55	1.2971	1.673	2.004	2.3961	2.6682
56	1.2969	1.6725	2.0032	2.3948	2.6665
57	1.2966	1.672	2.0025	2.3936	2.6649
58	1.2963	1.6716	2.0017	2.3924	2.6633
59	1.2961	1.6711	2.001	2.3912	2.6618
60	1.2958	1.6706	2.0003	2.3901	2.6603
61	1.2956	1.6702	1.9996	2.389	2.6589
62	1.2954	1.6698	1.999	2.388	2.6575
63	1.2951	1.6694	1.9983	2.387	2.6561
64	1.2949	1.669	1.9977	2.386	2.6549
65	1.2947	1.6686	1.9971	2.3851	2.6536
66	1.2945	1.6683	1.9966	2.3842	2.6524
67	1.2943	1.6679	1.996	2.3833	2.6512
68	1.2941	1.6676	1.9955	2.3824	2.6501
69	1.2939	1.6672	1.9949	2.3816	2.649
70	1.2938	1.6669	1.9944	2.3808	2.6479

Table of t values **continued**. For values not on table approximate based on available values.					
	Right tail probability				
df	0.1	0.05	0.025	0.01	0.005
71	1.2936	1.6666	1.9939	2.38	2.6469
72	1.2934	1.6663	1.9935	2.3793	2.6459
73	1.2933	1.666	1.993	2.3785	2.6449
74	1.2931	1.6657	1.9925	2.3778	2.6439
75	1.2929	1.6654	1.9921	2.3771	2.643
76	1.2928	1.6652	1.9917	2.3764	2.6421
77	1.2926	1.6649	1.9913	2.3758	2.6412
78	1.2925	1.6646	1.9908	2.3751	2.6403
79	1.2924	1.6644	1.9905	2.3745	2.6395
80	1.2922	1.6641	1.9901	2.3739	2.6387
81	1.2921	1.6639	1.9897	2.3733	2.6379
82	1.292	1.6636	1.9893	2.3727	2.6371
83	1.2918	1.6634	1.989	2.3721	2.6364
84	1.2917	1.6632	1.9886	2.3716	2.6356
85	1.2916	1.663	1.9883	2.371	2.6349
86	1.2915	1.6628	1.9879	2.3705	2.6342
87	1.2914	1.6626	1.9876	2.37	2.6335
88	1.2912	1.6624	1.9873	2.3695	2.6329
89	1.2911	1.6622	1.987	2.369	2.6322
90	1.291	1.662	1.9867	2.3685	2.6316
91	1.2909	1.6618	1.9864	2.368	2.6309
92	1.2908	1.6616	1.9861	2.3676	2.6303
93	1.2907	1.6614	1.9858	2.3671	2.6297
94	1.2906	1.6612	1.9855	2.3667	2.6291
95	1.2905	1.6611	1.9853	2.3662	2.6286
96	1.2904	1.6609	1.985	2.3658	2.628
97	1.2903	1.6607	1.9847	2.3654	2.6275
98	1.2902	1.6606	1.9845	2.365	2.6269
99	1.2902	1.6604	1.9842	2.3646	2.6264
100	1.2901	1.6602	1.984	2.3642	2.6259
120	1.2886	1.6577	1.9799	2.3578	2.6174
150	1.2872	1.6551	1.9759	2.3515	2.609
200	1.2858	1.6525	1.9719	2.3451	2.6006
300	1.2844	1.6499	1.9679	2.3388	2.5923
500	1.2832	1.6479	1.9647	2.3338	2.5857
1000	1.2824	1.6464	1.9623	2.3301	2.5808
10000+	1.2816	1.645	1.9602	2.3267	2.5763

Notes: for values not on the table, e.g. where df are 101 you can either approximate or for homework and test taking in ECN221 you can simply use the previous available value on the table. For example, you have a problem where df=125 and you are looking for a right tail probability of .05 then you can simply go to the row where df=120 and find a value of 1.6577 and use that value. For *left tail* probabilities the t values are the negative of the values in the table since the t distribution is symmetric around 0. For example, for 50 df and a left tail probability of .1 the t value is -1.2987.

Standard Normal, aka z Distribution

Table of z values and probabilities for the standard normal distribution. z is in the first column plus the top row. Each cell shows $P(X \leq z)$. For example $P(Z \leq 1.04) = .8508$. For $z < 0$ subtract the value from 1, e.g., $P(X \leq -1.04) = 1 - .8508 = .1492$.

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5	0.504	0.508	0.512	0.516	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	0.591	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	0.648	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.67	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.695	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.719	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	0.758	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.791	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	0.834	0.8365	0.8389
1	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	0.877	0.879	0.881	0.883
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.898	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	0.937	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	0.975	0.9756	0.9761	0.9767
2	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	0.983	0.9834	0.9838	0.9842	0.9846	0.985	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
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	0.992	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.994	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	0.996	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.997	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	0.998	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	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.999	0.999
3.1	0.999	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

Table of F values for right tail probabilities of .05. Degrees of freedom for the denominator are in the first column and degrees of freedom for the numerator are in the top row.										
denom. df	numerator df									
	1	2	3	4	5	7	10	15	50	100
1	161.448	199.5	215.707	224.583	230.162	236.768	241.882	245.95	251.774	253.041
2	18.513	19	19.164	19.247	19.296	19.353	19.396	19.429	19.476	19.486
3	10.128	9.552	9.277	9.117	9.013	8.887	8.786	8.703	8.581	8.554
4	7.709	6.944	6.591	6.388	6.256	6.094	5.964	5.858	5.699	5.664
5	6.608	5.786	5.409	5.192	5.05	4.876	4.735	4.619	4.444	4.405
6	5.987	5.143	4.757	4.534	4.387	4.207	4.06	3.938	3.754	3.712
7	5.591	4.737	4.347	4.12	3.972	3.787	3.637	3.511	3.319	3.275
8	5.318	4.459	4.066	3.838	3.687	3.5	3.347	3.218	3.02	2.975
9	5.117	4.256	3.863	3.633	3.482	3.293	3.137	3.006	2.803	2.756
10	4.965	4.103	3.708	3.478	3.326	3.135	2.978	2.845	2.637	2.588
11	4.844	3.982	3.587	3.357	3.204	3.012	2.854	2.719	2.507	2.457
12	4.747	3.885	3.49	3.259	3.106	2.913	2.753	2.617	2.401	2.35
13	4.667	3.806	3.411	3.179	3.025	2.832	2.671	2.533	2.314	2.261
14	4.6	3.739	3.344	3.112	2.958	2.764	2.602	2.463	2.241	2.187
15	4.543	3.682	3.287	3.056	2.901	2.707	2.544	2.403	2.178	2.123
16	4.494	3.634	3.239	3.007	2.852	2.657	2.494	2.352	2.124	2.068
17	4.451	3.592	3.197	2.965	2.81	2.614	2.45	2.308	2.077	2.02
18	4.414	3.555	3.16	2.928	2.773	2.577	2.412	2.269	2.035	1.978
19	4.381	3.522	3.127	2.895	2.74	2.544	2.378	2.234	1.999	1.94
20	4.351	3.493	3.098	2.866	2.711	2.514	2.348	2.203	1.966	1.907
21	4.325	3.467	3.072	2.84	2.685	2.488	2.321	2.176	1.936	1.876
22	4.301	3.443	3.049	2.817	2.661	2.464	2.297	2.151	1.909	1.849
23	4.279	3.422	3.028	2.796	2.64	2.442	2.275	2.128	1.885	1.823
24	4.26	3.403	3.009	2.776	2.621	2.423	2.255	2.108	1.863	1.8
25	4.242	3.385	2.991	2.759	2.603	2.405	2.236	2.089	1.842	1.779
26	4.225	3.369	2.975	2.743	2.587	2.388	2.22	2.072	1.823	1.76
27	4.21	3.354	2.96	2.728	2.572	2.373	2.204	2.056	1.806	1.742
28	4.196	3.34	2.947	2.714	2.558	2.359	2.19	2.041	1.79	1.725
29	4.183	3.328	2.934	2.701	2.545	2.346	2.177	2.027	1.775	1.71
30	4.171	3.316	2.922	2.69	2.534	2.334	2.165	2.015	1.761	1.695
35	4.121	3.267	2.874	2.641	2.485	2.285	2.114	1.963	1.703	1.635
40	4.085	3.232	2.839	2.606	2.449	2.249	2.077	1.924	1.66	1.589
50	4.034	3.183	2.79	2.557	2.4	2.199	2.026	1.871	1.599	1.525
60	4.001	3.15	2.758	2.525	2.368	2.167	1.993	1.836	1.559	1.481
80	3.96	3.111	2.719	2.486	2.329	2.126	1.951	1.793	1.508	1.426
100	3.936	3.087	2.696	2.463	2.305	2.103	1.927	1.768	1.477	1.392
1000	3.851	3.005	2.614	2.381	2.223	2.019	1.84	1.676	1.363	1.26