PGDM, Batch-2018-20

Statistics for Business Analysis

DM-108

Trimester - I, End-Term Examination: September 2018

Time allowed: 2.5 Hours Max Marks: 50

Roll No: _____

Instruction: Students are required to write Roll No on every page of the question paper, writing anything except the Roll No will be treated as **Unfair Means**. In case of rough work please use answer sheet.

Section-A

Attempt any 3 out of 5 Short Questions, each question carries equal marks. (3*5 = 15 Marks)

Question A1:

The National Centre for Health Statistics reports that 25% of all Americans between the ages of 65 and 74 have a chronic heart condition. Suppose you live in a state where the environment is conducive to good health and low stress and you believe that the conditions in this state promote healthy heart. To investigate this theory, you conduct a random telephone survey of 20 persons aged 65 to 74 years of age in your state.

Suppose only one person in the survey has a chronic heart condition. What is the probability of getting at most one person with a chronic heart condition in a sample of 20? What do you conclude about your state from the sample data?

Question A2:

The hypothesized 95% confidence interval for the sampling proportion of persons who under-report tax filings are .23 to .27. What is the probability under assumptions of the null hypothesis, that one observes that the proportion of under-reporters is .29?

Question A3:

What is a sampling distribution of means? How does the sampling distribution help in the testing of hypothesis?

Question A4:

Suppose that in the book keeping operation of a large corporation the probability of a recording error on any one billing is .01. Suppose the probability of a recording error from one billing to the next is constant, and 1000 billings are randomly sampled by an auditor.

a) What is the probability that fewer than four billings contain a recording error?

b) What is the probability that more than 10 billings contain a billing error?

Question A5:

What is the difference between Type I and Type II error? How do these error probabilities influence the risk(s) in testing of hypothesis?

Section B:

Attempt any 2 out of 3 Short Questions, each question carries equal marks. (2*10 = 30 Marks)

Question B1:

The Consumer Reports Restaurant Customer Satisfaction Survey is based upon 148,600 visits to full-service restaurant chains. One of the variables in the study is meal price, the average amount paid per person for dinner and drinks, minus the tip. Suppose a reporter for the Times thought that it would be of interest to her readers to conduct a similar study for such restaurants. The reporter selected a sample of eight seafood restaurants, eight Italian restaurants, and eight steakhouses. The following data show the meal price obtained for the 24 restaurants sampled. Use $\alpha = .05$ to test whether there is a significant difference among the mean meal price for the three types of restaurants.

	Cuisine Type		
	Italian	**Seafood**	**Steakhouse**
	12	16	24
	13	18	19
	15	17	23
	17	26	25
	18	23	21
	20	15	22
	17	19	27
	24	18	31
Mean	**17**	**19**	**24**
SD	**3.85**	**3.70**	**3.74**
Grand Mean	**20**		
Grand SD	**4.69**		

Question B2:

Assume that the test scores from a college admissions test are normally distributed, with a mean of 450 and a standard deviation of 100.

a. Suppose someone receives a score of 630. What percentage of the people taking the test score better? What percentage score worse?

b. If a particular university will not admit anyone scoring below 480, what percentage of the persons taking the test would be acceptable to the university?

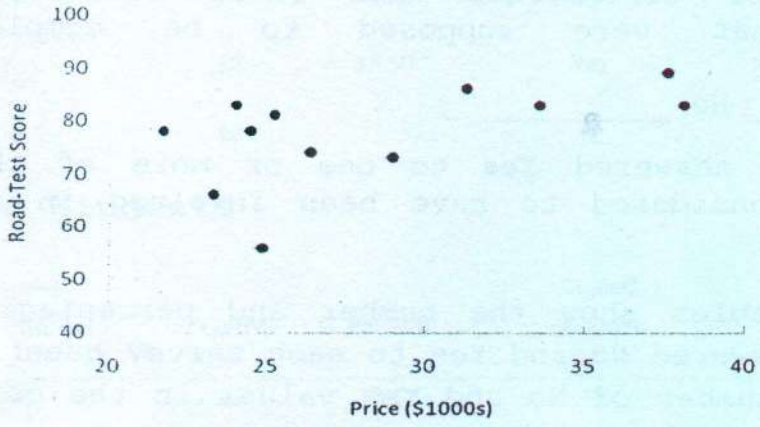
Question B3:

Sporty Cars are designed to provide better handling, acceleration, and a more responsive driving experience than a typical sedan. But, even

within this select group of cars, performance as well as price can vary. Consumer Reports provided road-test scores and prices for the following 12 sporty cars. Prices are in thousands of rupees and road-test scores are based on a 0-100 rating scale, with higher values indicating better performance.

Car	Price (Rs.1000s)	Road-Test Score
Chevrolet Cobalt SS	24.5	78
Dodge Caliber SRT4	24.9	56
Ford Mustang GT (V8)	29	73
Honda Civic Si	21.7	78
Mazda RX-8	31.3	86
Mini Cooper S	26.4	74
Mitsubishi Lancer Evolution GSR	38.1	83
Nissan Sentra SE-R Spec V	23.3	66
Suburu Impreza WRX	25.2	81
Suburu Impreza WRX Sti	37.6	89
Volkswagen GTI	24	83
Volkswagen R32	33.6	83

a. What does the scatter diagram depicted below indicate about the relationship between the two variables?
b. Calculate the correlation coefficient
c. Use the least squares method to develop the estimated regression equation.



Section-C

Compulsory Case Study (15 Marks)

Ethical Behavior of Business Students at XYZ University

During the global recession of 2008 and 2009, there were many accusations of unethical behavior by executives, financial managers, and other corporate officers. At that time, an article appeared that suggested that part of the reason for such unethical business behavior may stem from the fact that cheating has become more prevalent among business students. The article reported that 56% of

business students admitted to cheating at some time during their academic career as compared to 47% of non-business students.

Cheating has been a concern of the Dean of the College of Business at XYZ University for several years. Some faculty members in the college believe that cheating is more widespread at XYZ than at other universities, while other faculty members think that cheating is not a major problem in the college. To resolve some of these issues, the dean commissioned a study to assess the current ethical behavior of business students at XYZ. As part of this study, an anonymous exit survey was administered to a sample of 90 business students from this year's graduating class. Responses to the following questions were used to obtain data regarding three types of cheating.

During your time at the college,

1. did you ever present work copied off the Internet as your own?
   Yes _____ No _____
2. did you ever copy answers off another student's exam?
   Yes _____ No _____
3. did you ever collaborate with other students on projects that were supposed to be completed individually?
   Yes _____ No _____

Any student who answered ***Yes*** to one or more of these questions was considered to have been involved in some type of cheating.

The following tables show the number and percentage of students that answered No and Yes to each survey question, as well as the number of No and Yes values in the column named Cheated.

All Business Students

Copied from Internet	Count	Percent	Copied on Exam	Count	Percent
No	74	82.22	No	72	80.00
Yes	16	17.78	Yes	18	20.00
N	90		N	90	

Collaborated on Individual Project	Count	Percent	Cheated	Count	Percent
No	61	67.78	No	53	58.89
Yes	29	32.22	Yes	37	41.11
N	90		N	90	

Male Students

Copied from Internet	Count	Percent	Copied on Exam	Count	Percent
No	41	85.42	No	39	81.25
Yes	7	14.58	Yes	9	18.75
N	48		N	48	

Collaborated on Individual Project	Count	Percent	Cheated	Count	Percent
No	30	62.50	No	27	56.25
Yes	18	37.50	Yes	21	43.75
N	48		N	48	

Female Students

Copied from Internet	Count	Percent	Copied on Exam	Count	Percent
No	33	78.57	No	33	78.57
Yes	9	21.43	Yes	9	21.43
N	42		N	42	

Collaborated on Individual Project	Count	Percent	Cheated	Count	Percent
No	31	73.81	No	26	61.90
Yes	11	26.19	Yes	16	38.10
N	42		N	42	

Prepare a report for the dean of the college that summarizes your assessment of the nature of cheating by business students at XYZ University. Be sure to include the following items in your report.

1) Develop 95% confidence intervals for the proportion of all students, the proportion of male students, and the proportion of female students who were involved in some type of cheating.
2) Conduct a hypothesis test to determine if the proportion of business students at XYZ University who were involved in some type of cheating is less than that of business students at other institutions.
3) Conduct a hypothesis test to determine if the proportion of business students at XYZ University who were involved in some form of cheating is less than that of non-business students at other institutions.
4) What advice would you give to the dean based upon your analysis of the data?

Some Useful Formulae

$$S_e = \sqrt{\frac{(y-\hat{y})^2}{n-2}}$$

$$Z = \frac{\bar{X} - \mu_{\bar{X}}}{\sigma_{\bar{X}}} = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

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

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

$$r^2 = 1 - \frac{\sum(y-\hat{y})^2}{\sum(y-\bar{y})^2}$$

$$\mu = n \cdot p$$
$$\sigma = \sqrt{n \cdot p \cdot q}$$

$$Z = \frac{X - \mu}{\sigma}$$

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

$$t = \frac{\bar{X} - \mu}{\frac{S}{\sqrt{n}}}$$

$$\bar{x} \pm z\frac{\sigma}{\sqrt{n}}$$

or

$$\bar{x} - z\frac{\sigma}{\sqrt{n}} \le \mu \le \bar{x} + z\frac{\sigma}{\sqrt{n}}$$

$$\bar{X} - Z\frac{\sigma}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}} \le \mu \le \bar{X} + Z\frac{\sigma}{\sqrt{n}}\sqrt{\frac{N-n}{N-1}}$$

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

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$\mu_{\bar{x}_1 - \bar{x}_2} = \mu_1 - \mu_2$$

$$t = \frac{\bar{d} - D}{\frac{s_d}{\sqrt{n}}}$$

$$df = n - 1$$

n = number of pairs

d = sample difference in pairs

D = mean population difference

s_d = standard deviation of sample difference

$\bar{d}$ = mean sample difference

$$\hat{p} - Z\sqrt{\frac{\hat{p}\hat{q}}{n}} \le P \le \hat{p} + Z\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$\bar{d} = \frac{\sum d}{n}$$

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

Mean Square Due to Treatments

$$\text{MSTR} = \frac{\text{SSTR}}{k-1}$$

Sum of Squares Due to Treatments

$$\text{SSTR} = \sum_{j=1}^{k} n_j(\bar{x}_j - \bar{\bar{x}})^2$$

Mean Square Due to Error

$$\text{MSE} = \frac{\text{SSE}}{n_T - k}$$

Sum of Squares Due to Error

$$\text{SSE} = \sum_{j=1}^{k}(n_j - 1)s_j^2$$

Test Statistic for the Equality of *k* Population Means

$$F = \frac{\text{MSTR}}{\text{MSE}}$$

Total Sum of Squares

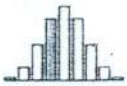
$$\text{SST} = \sum_{j=1}^{k}\sum_{i=1}^{n_j}(x_{ij} - \bar{\bar{x}})^2$$

Partitioning of Sum of Squares

$$\text{SST} = \text{SSTR} + \text{SSE}$$

APPENDIX A

EXACT BINOMIAL PROBABILITIES

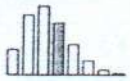


		π																
n	X	.01	.02	.05	.10	.15	.20	.30	.40	.50	.60	.70	.80	.85	.90	.95	.98	.99
2	0	.9801	.9604	.9025	.8100	.7225	.6400	.4900	.3600	.2500	.1600	.0900	.0400	.0225	.0100	.0025	.0004	.0001
	1	.0198	.0392	.0950	.1800	.2550	.3200	.4200	.4800	.5000	.4800	.4200	.3200	.2550	.1800	.0950	.0392	.0198
	2	.0001	.0004	.0025	.0100	.0225	.0400	.0900	.1600	.2500	.3600	.4900	.6400	.7225	.8100	.9025	.9604	.9801
3	0	.9703	.9412	.8574	.7290	.6141	.5120	.3430	.2160	.1250	.0640	.0270	.0080	.0034	.0010	.0001	—	—
	1	.0294	.0576	.1354	.2430	.3251	.3840	.4410	.4320	.3750	.2880	.1890	.0960	.0574	.0270	.0071	.0012	.0003
	2	.0003	.0012	.0071	.0270	.0574	.0960	.1890	.2880	.3750	.4320	.4410	.3840	.3251	.2430	.1354	.0576	.0294
	3	—	—	.0001	.0010	.0034	.0080	.0270	.0640	.1250	.2160	.3430	.5120	.6141	.7290	.8574	.9412	.9703
4	0	.9606	.9224	.8145	.6561	.5220	.4096	.2401	.1296	.0625	.0256	.0081	.0016	.0005	.0001	—	—	—
	1	.0388	.0753	.1715	.2916	.3685	.4096	.4116	.3456	.2500	.1536	.0756	.0256	.0115	.0036	.0005	—	—
	2	.0006	.0023	.0135	.0486	.0975	.1536	.2646	.3456	.3750	.3456	.2646	.1536	.0975	.0486	.0135	.0023	.0006
	3	—	—	.0005	.0036	.0115	.0256	.0756	.1536	.2500	.3456	.4116	.4096	.3685	.2916	.1715	.0753	.0388
	4	—	—	—	.0001	.0005	.0016	.0081	.0256	.0625	.1296	.2401	.4096	.5220	.6561	.8145	.9224	.9606
5	0	.9510	.9039	.7738	.5905	.4437	.3277	.1681	.0778	.0313	.0102	.0024	.0003	.0001	—	—	—	—
	1	.0480	.0922	.2036	.3281	.3915	.4096	.3602	.2592	.1563	.0768	.0284	.0064	.0022	.0005	—	—	—
	2	.0010	.0038	.0214	.0729	.1382	.2048	.3087	.3456	.3125	.2304	.1323	.0512	.0244	.0081	.0011	.0001	—
	3	—	.0001	.0011	.0081	.0244	.0512	.1323	.2304	.3125	.3456	.3087	.2048	.1382	.0729	.0214	.0038	.0010
	4	—	—	—	.0005	.0022	.0064	.0284	.0768	.1563	.2592	.3602	.4096	.3915	.3281	.2036	.0922	.0480
	5	—	—	—	—	.0001	.0003	.0024	.0102	.0313	.0778	.1681	.3277	.4437	.5905	.7738	.9039	.9510
6	0	.9415	.8858	.7351	.5314	.3771	.2621	.1176	.0467	.0156	.0041	.0007	.0001	—	—	—	—	—
	1	.0571	.1085	.2321	.3543	.3993	.3932	.3025	.1866	.0938	.0369	.0102	.0015	.0004	.0001	—	—	—
	2	.0014	.0055	.0305	.0984	.1762	.2458	.3241	.3110	.2344	.1382	.0595	.0154	.0055	.0012	.0001	—	—
	3	—	.0002	.0021	.0146	.0415	.0819	.1852	.2765	.3125	.2765	.1852	.0819	.0415	.0146	.0021	.0002	—
	4	—	—	.0001	.0012	.0055	.0154	.0595	.1382	.2344	.3110	.3241	.2458	.1762	.0984	.0305	.0055	.0014
	5	—	—	—	.0001	.0004	.0015	.0102	.0369	.0938	.1866	.3025	.3932	.3993	.3543	.2321	.1085	.0571
	6	—	—	—	—	—	.0001	.0007	.0041	.0156	.0467	.1176	.2621	.3771	.5314	.7351	.8858	.9415
7	0	.9321	.8681	.6983	.4783	.3206	.2097	.0824	.0280	.0078	.0016	.0002	—	—	—	—	—	—
	1	.0659	.1240	.2573	.3720	.3960	.3670	.2471	.1306	.0547	.0172	.0036	.0004	.0001	—	—	—	—
	2	.0020	.0076	.0406	.1240	.2097	.2753	.3177	.2613	.1641	.0774	.0250	.0043	.0012	.0002	—	—	—
	3	—	.0003	.0036	.0230	.0617	.1147	.2269	.2903	.2734	.1935	.0972	.0287	.0109	.0026	.0002	—	—
	4	—	—	.0002	.0026	.0109	.0287	.0972	.1935	.2734	.2903	.2269	.1147	.0617	.0230	.0036	.0003	—
	5	—	—	—	.0002	.0012	.0043	.0250	.0774	.1641	.2613	.3177	.2753	.2097	.1240	.0406	.0076	.0020
	6	—	—	—	—	.0001	.0004	.0036	.0172	.0547	.1306	.2471	.3670	.3960	.3720	.2573	.1240	.0659
	7	—	—	—	—	—	—	.0002	.0016	.0078	.0280	.0824	.2097	.3206	.4783	.6983	.8681	.9321
8	0	.9227	.8508	.6634	.4305	.2725	.1678	.0576	.0168	.0039	.0007	.0001	—	—	—	—	—	—
	1	.0746	.1389	.2793	.3826	.3847	.3355	.1977	.0896	.0313	.0079	.0012	.0001	—	—	—	—	—
	2	.0026	.0099	.0515	.1488	.2376	.2936	.2965	.2090	.1094	.0413	.0100	.0011	.0002	—	—	—	—
	3	.0001	.0004	.0054	.0331	.0839	.1468	.2541	.2787	.2188	.1239	.0467	.0092	.0026	.0004	—	—	—
	4	—	—	.0004	.0046	.0185	.0459	.1361	.2322	.2734	.2322	.1361	.0459	.0185	.0046	.0004	—	—
	5	—	—	—	.0004	.0026	.0092	.0467	.1239	.2188	.2787	.2541	.1468	.0839	.0331	.0054	.0004	.0001
	6	—	—	—	—	.0002	.0011	.0100	.0413	.1094	.2090	.2965	.2936	.2376	.1488	.0515	.0099	.0026
	7	—	—	—	—	—	.0001	.0012	.0079	.0313	.0896	.1977	.3355	.3847	.3826	.2793	.1389	.0746
	8	—	—	—	—	—	—	.0001	.0007	.0039	.0168	.0576	.1678	.2725	.4305	.6634	.8508	.9227
9	0	.9135	.8337	.6302	.3874	.2316	.1342	.0404	.0101	.0020	.0003	—	—	—	—	—	—	—
	1	.0830	.1531	.2985	.3874	.3679	.3020	.1556	.0605	.0176	.0035	.0004	—	—	—	—	—	—
	2	.0034	.0125	.0629	.1722	.2597	.3020	.2668	.1612	.0703	.0212	.0039	.0003	—	—	—	—	—
	3	.0001	.0006	.0077	.0446	.1069	.1762	.2668	.2508	.1641	.0743	.0210	.0028	.0006	.0001	—	—	—
	4	—	—	.0006	.0074	.0283	.0661	.1715	.2508	.2461	.1672	.0735	.0165	.0050	.0008	—	—	—
	5	—	—	—	.0008	.0050	.0165	.0735	.1672	.2461	.2508	.1715	.0661	.0283	.0074	.0006	—	—
	6	—	—	—	.0001	.0006	.0028	.0210	.0743	.1641	.2508	.2668	.1762	.1069	.0446	.0077	.0006	.0001
	7	—	—	—	—	—	.0003	.0039	.0212	.0703	.1612	.2668	.3020	.2597	.1722	.0629	.0125	.0034
	8	—	—	—	—	—	—	.0004	.0035	.0176	.0605	.1556	.3020	.3679	.3874	.2985	.1531	.0830
	9	—	—	—	—	—	—	—	.0003	.0020	.0101	.0404	.1342	.2316	.3874	.6302	.8337	.9135

		π															
n	X	.01	.02	.05	.10	.15	.20	.30	.40	.50	.60	.70	.80	.85	.90	.95	.98	.99
10	0	.9044	.8171	.5987	.3487	.1969	.1074	.0282	.0060	.0010	.0001	—	—	—	—	—	—	—
	1	.0914	.1667	.3151	.3874	.3474	.2684	.1211	.0403	.0098	.0016	.0001	—	—	—	—	—	—
	2	.0042	.0153	.0746	.1937	.2759	.3020	.2335	.1209	.0439	.0106	.0014	.0001	—	—	—	—	—
	3	.0001	.0008	.0105	.0574	.1298	.2013	.2668	.2150	.1172	.0425	.0090	.0008	.0001	—	—	—	—
	4	—	—	.0010	.0112	.0401	.0881	.2001	.2508	.2051	.1115	.0368	.0055	.0012	.0001	—	—	—
	5	—	—	.0001	.0015	.0085	.0264	.1029	.2007	.2461	.2007	.1029	.0264	.0085	.0015	.0001	—	—
	6	—	—	—	.0001	.0012	.0055	.0368	.1115	.2051	.2508	.2001	.0881	.0401	.0112	.0010	—	—
	7	—	—	—	—	.0001	.0008	.0090	.0425	.1172	.2150	.2668	.2013	.1298	.0574	.0105	.0008	.0001
	8	—	—	—	—	—	.0001	.0014	.0106	.0439	.1209	.2335	.3020	.2759	.1937	.0746	.0153	.0042
	9	—	—	—	—	—	—	.0001	.0016	.0098	.0403	.1211	.2684	.3474	.3874	.3151	.1667	.0914
	10	—	—	—	—	—	—	—	.0001	.0010	.0060	.0282	.1074	.1969	.3487	.5987	.8171	.9044
12	0	.8864	.7847	.5404	.2824	.1422	.0687	.0138	.0022	.0002	—	—	—	—	—	—	—	—
	1	.1074	.1922	.3413	.3766	.3012	.2062	.0712	.0174	.0029	.0003	—	—	—	—	—	—	—
	2	.0060	.0216	.0988	.2301	.2924	.2835	.1678	.0639	.0161	.0025	.0002	—	—	—	—	—	—
	3	.0002	.0015	.0173	.0852	.1720	.2362	.2397	.1419	.0537	.0125	.0015	.0001	—	—	—	—	—
	4	—	.0001	.0021	.0213	.0683	.1329	.2311	.2128	.1208	.0420	.0078	.0005	.0001	—	—	—	—
	5	—	—	.0002	.0038	.0193	.0532	.1585	.2270	.1934	.1009	.0291	.0033	.0006	—	—	—	—
	6	—	—	—	.0005	.0040	.0155	.0792	.1766	.2256	.1766	.0792	.0155	.0040	.0005	—	—	—
	7	—	—	—	—	.0006	.0033	.0291	.1009	.1934	.2270	.1585	.0532	.0193	.0038	.0002	—	—
	8	—	—	—	—	.0001	.0005	.0078	.0420	.1208	.2128	.2311	.1329	.0683	.0213	.0021	.0001	—
	9	—	—	—	—	—	.0001	.0015	.0125	.0537	.1419	.2397	.2362	.1720	.0852	.0173	.0015	.0002
	10	—	—	—	—	—	—	.0002	.0025	.0161	.0639	.1678	.2835	.2924	.2301	.0988	.0216	.0060
	11	—	—	—	—	—	—	—	.0003	.0029	.0174	.0712	.2062	.3012	.3766	.3413	.1922	.1074
	12	—	—	—	—	—	—	—	—	.0002	.0022	.0138	.0687	.1422	.2824	.5404	.7847	.8864
14	0	.8687	.7536	.4877	.2288	.1028	.0440	.0068	.0008	.0001	—	—	—	—	—	—	—	—
	1	.1229	.2153	.3593	.3559	.2539	.1539	.0407	.0073	.0009	.0001	—	—	—	—	—	—	—
	2	.0081	.0286	.1229	.2570	.2912	.2501	.1134	.0317	.0056	.0005	—	—	—	—	—	—	—
	3	.0003	.0023	.0259	.1142	.2056	.2501	.1943	.0845	.0222	.0033	.0002	—	—	—	—	—	—
	4	—	.0001	.0037	.0349	.0998	.1720	.2290	.1549	.0611	.0136	.0014	—	—	—	—	—	—
	5	—	—	.0004	.0078	.0352	.0860	.1963	.2066	.1222	.0408	.0066	.0003	—	—	—	—	—
	6	—	—	—	.0013	.0093	.0322	.1262	.2066	.1833	.0918	.0232	.0020	.0003	—	—	—	—
	7	—	—	—	.0002	.0019	.0092	.0618	.1574	.2095	.1574	.0618	.0092	.0019	.0002	—	—	—
	8	—	—	—	—	.0003	.0020	.0232	.0918	.1833	.2066	.1262	.0322	.0093	.0013	—	—	—
	9	—	—	—	—	—	.0003	.0066	.0408	.1222	.2066	.1963	.0860	.0352	.0078	.0004	—	—
	10	—	—	—	—	—	—	.0014	.0136	.0611	.1549	.2290	.1720	.0998	.0349	.0037	.0001	—
	11	—	—	—	—	—	—	.0002	.0033	.0222	.0845	.1943	.2501	.2056	.1142	.0259	.0023	.0003
	12	—	—	—	—	—	—	—	.0005	.0056	.0317	.1134	.2501	.2912	.2570	.1229	.0286	.0081
	13	—	—	—	—	—	—	—	.0001	.0009	.0073	.0407	.1539	.2539	.3559	.3593	.2153	.1229
	14	—	—	—	—	—	—	—	—	.0001	.0008	.0068	.0440	.1028	.2288	.4877	.7536	.8687
16	0	.8515	.7238	.4401	.1853	.0743	.0281	.0033	.0003	—	—	—	—	—	—	—	—	—
	1	.1376	.2363	.3706	.3294	.2097	.1126	.0228	.0030	.0002	—	—	—	—	—	—	—	—
	2	.0104	.0362	.1463	.2745	.2775	.2111	.0732	.0150	.0018	.0001	—	—	—	—	—	—	—
	3	.0005	.0034	.0359	.1423	.2285	.2463	.1465	.0468	.0085	.0008	—	—	—	—	—	—	—
	4	—	.0002	.0061	.0514	.1311	.2001	.2040	.1014	.0278	.0040	.0002	—	—	—	—	—	—
	5	—	—	.0008	.0137	.0555	.1201	.2099	.1623	.0667	.0142	.0013	—	—	—	—	—	—
	6	—	—	.0001	.0028	.0180	.0550	.1649	.1983	.1222	.0392	.0056	.0002	—	—	—	—	—
	7	—	—	—	.0004	.0045	.0197	.1010	.1889	.1746	.0840	.0185	.0012	.0001	—	—	—	—
	8	—	—	—	.0001	.0009	.0055	.0487	.1417	.1964	.1417	.0487	.0055	.0009	.0001	—	—	—
	9	—	—	—	—	.0001	.0012	.0185	.0840	.1746	.1889	.1010	.0197	.0045	.0004	—	—	—
	10	—	—	—	—	—	.0002	.0056	.0392	.1222	.1983	.1649	.0550	.0180	.0028	.0001	—	—
	11	—	—	—	—	—	—	.0013	.0142	.0667	.1623	.2099	.1201	.0555	.0137	.0008	—	—
	12	—	—	—	—	—	—	.0002	.0040	.0278	.1014	.2040	.2001	.1311	.0514	.0061	.0002	—
	13	—	—	—	—	—	—	—	.0008	.0085	.0468	.1465	.2463	.2285	.1423	.0359	.0034	.0005
	14	—	—	—	—	—	—	—	.0001	.0018	.0150	.0732	.2111	.2775	.2745	.1463	.0362	.0104
	15	—	—	—	—	—	—	—	—	.0002	.0030	.0228	.1126	.2097	.3294	.3706	.2363	.1376
	16	—	—	—	—	—	—	—	—	—	.0003	.0033	.0281	.0743	.1853	.4401	.7238	.8515

APPENDIX B

EXACT POISSON PROBABILITIES



	λ														
X	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
0	.9048	.8187	.7408	.6703	.6065	.5488	.4966	.4493	.4066	.3679	.3329	.3012	.2725	.2466	.2231
1	.0905	.1637	.2222	.2681	.3033	.3293	.3476	.3595	.3659	.3679	.3662	.3614	.3543	.3452	.3347
2	.0045	.0164	.0333	.0536	.0758	.0988	.1217	.1438	.1647	.1839	.2014	.2169	.2303	.2417	.2510
3	.0002	.0011	.0033	.0072	.0126	.0198	.0284	.0383	.0494	.0613	.0738	.0867	.0998	.1128	.1255
4	—	.0001	.0003	.0007	.0016	.0030	.0050	.0077	.0111	.0153	.0203	.0260	.0324	.0395	.0471
5	—	—	—	.0001	.0002	.0004	.0007	.0012	.0020	.0031	.0045	.0062	.0084	.0111	.0141
6	—	—	—	—	—	—	.0001	.0002	.0003	.0005	.0008	.0012	.0018	.0026	.0035
7	—	—	—	—	—	—	—	—	—	.0001	.0001	.0002	.0003	.0005	.0008
8	—	—	—	—	—	—	—	—	—	—	—	—	.0001	.0001	.0001

	λ														
X	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
0	.2019	.1827	.1653	.1496	.1353	.1225	.1108	.1003	.0907	.0821	.0743	.0672	.0608	.0550	.0498
1	.3230	.3106	.2975	.2842	.2707	.2572	.2438	.2306	.2177	.2052	.1931	.1815	.1703	.1596	.1494
2	.2584	.2640	.2678	.2700	.2707	.2700	.2681	.2652	.2613	.2565	.2510	.2450	.2384	.2314	.2240
3	.1378	.1496	.1607	.1710	.1804	.1890	.1966	.2033	.2090	.2138	.2176	.2205	.2225	.2237	.2240
4	.0551	.0636	.0723	.0812	.0902	.0992	.1082	.1169	.1254	.1336	.1414	.1488	.1557	.1622	.1680
5	.0176	.0216	.0260	.0309	.0361	.0417	.0476	.0538	.0602	.0668	.0735	.0804	.0872	.0940	.1008
6	.0047	.0061	.0078	.0098	.0120	.0146	.0174	.0206	.0241	.0278	.0319	.0362	.0407	.0455	.0504
7	.0011	.0015	.0020	.0027	.0034	.0044	.0055	.0068	.0083	.0099	.0118	.0139	.0163	.0188	.0216
8	.0002	.0003	.0005	.0006	.0009	.0011	.0015	.0019	.0025	.0031	.0038	.0047	.0057	.0068	.0081
9	—	.0001	.0001	.0001	.0002	.0003	.0004	.0005	.0007	.0009	.0011	.0014	.0018	.0022	.0027
10	—	—	—	—	—	.0001	.0001	.0001	.0002	.0002	.0003	.0004	.0005	.0006	.0008
11	—	—	—	—	—	—	—	—	—	—	.0001	.0001	.0001	.0002	.0002
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.0001

	λ														
X	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
0	.0450	.0408	.0369	.0334	.0302	.0273	.0247	.0224	.0202	.0183	.0166	.0150	.0136	.0123	.0111
1	.1397	.1304	.1217	.1135	.1057	.0984	.0915	.0850	.0789	.0733	.0679	.0630	.0583	.0540	.0500
2	.2165	.2087	.2008	.1929	.1850	.1771	.1692	.1615	.1539	.1465	.1393	.1323	.1254	.1188	.1125
3	.2237	.2226	.2209	.2186	.2158	.2125	.2087	.2046	.2001	.1954	.1904	.1852	.1798	.1743	.1687
4	.1733	.1781	.1823	.1858	.1888	.1912	.1931	.1944	.1951	.1954	.1951	.1944	.1933	.1917	.1898
5	.1075	.1140	.1203	.1264	.1322	.1377	.1429	.1477	.1522	.1563	.1600	.1633	.1662	.1687	.1708
6	.0555	.0608	.0662	.0716	.0771	.0826	.0881	.0936	.0989	.1042	.1093	.1143	.1191	.1237	.1281
7	.0246	.0278	.0312	.0348	.0385	.0425	.0466	.0508	.0551	.0595	.0640	.0686	.0732	.0778	.0824
8	.0095	.0111	.0129	.0148	.0169	.0191	.0215	.0241	.0269	.0298	.0328	.0360	.0393	.0428	.0463
9	.0033	.0040	.0047	.0056	.0066	.0076	.0089	.0102	.0116	.0132	.0150	.0168	.0188	.0209	.0232
10	.0010	.0013	.0016	.0019	.0023	.0028	.0033	.0039	.0045	.0053	.0061	.0071	.0081	.0092	.0104
11	.0003	.0004	.0005	.0006	.0007	.0009	.0011	.0013	.0016	.0019	.0023	.0027	.0032	.0037	.0043
12	.0001	.0001	.0001	.0002	.0002	.0003	.0003	.0004	.0005	.0006	.0008	.0009	.0011	.0013	.0016
13	—	—	—	—	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0003	.0004	.0005	.0006
14	—	—	—	—	—	—	—	—	—	.0001	.0001	.0001	.0001	.0001	.0002
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.0001

	λ														
X	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
0	.0101	.0091	.0082	.0074	.0067	.0061	.0055	.0050	.0045	.0041	.0037	.0033	.0030	.0027	.0025
1	.0462	.0427	.0395	.0365	.0337	.0311	.0287	.0265	.0244	.0225	.0207	.0191	.0176	.0162	.0149
2	.1063	.1005	.0948	.0894	.0842	.0793	.0746	.0701	.0659	.0618	.0580	.0544	.0509	.0477	.0446
3	.1631	.1574	.1517	.1460	.1404	.1348	.1293	.1239	.1185	.1133	.1082	.1033	.0985	.0938	.0892
4	.1875	.1849	.1820	.1789	.1755	.1719	.1681	.1641	.1600	.1558	.1515	.1472	.1428	.1383	.1339
5	.1725	.1738	.1747	.1753	.1755	.1753	.1748	.1740	.1728	.1714	.1697	.1678	.1656	.1632	.1606
6	.1323	.1362	.1398	.1432	.1462	.1490	.1515	.1537	.1555	.1571	.1584	.1594	.1601	.1605	.1606
7	.0869	.0914	.0959	.1002	.1044	.1086	.1125	.1163	.1200	.1234	.1267	.1298	.1326	.1353	.1377
8	.0500	.0537	.0575	.0614	.0653	.0692	.0731	.0771	.0810	.0849	.0887	.0925	.0962	.0998	.1033
9	.0255	.0281	.0307	.0334	.0363	.0392	.0423	.0454	.0486	.0519	.0552	.0586	.0620	.0654	.0688
10	.0118	.0132	.0147	.0164	.0181	.0200	.0220	.0241	.0262	.0285	.0309	.0334	.0359	.0386	.0413
11	.0049	.0056	.0064	.0073	.0082	.0093	.0104	.0116	.0129	.0143	.0157	.0173	.0190	.0207	.0225
12	.0019	.0022	.0026	.0030	.0034	.0039	.0045	.0051	.0058	.0065	.0073	.0082	.0092	.0102	.0113
13	.0007	.0008	.0009	.0011	.0013	.0015	.0018	.0021	.0024	.0028	.0032	.0036	.0041	.0046	.0052
14	.0002	.0003	.0003	.0004	.0005	.0006	.0007	.0008	.0009	.0011	.0013	.0015	.0017	.0019	.0022
15	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0003	.0003	.0004	.0005	.0006	.0007	.0008	.0009
16	—	—	—	—	—	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0003	.0003
17	—	—	—	—	—	—	—	—	—	—	.0001	.0001	.0001	.0001	.0001

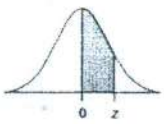
	λ														
X	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5
0	.0022	.0020	.0018	.0017	.0015	.0014	.0012	.0011	.0010	.0009	.0008	.0007	.0007	.0006	.0006
1	.0137	.0126	.0116	.0106	.0098	.0090	.0082	.0076	.0070	.0064	.0059	.0054	.0049	.0045	.0041
2	.0417	.0390	.0364	.0340	.0318	.0296	.0276	.0258	.0240	.0223	.0208	.0194	.0180	.0167	.0156
3	.0848	.0806	.0765	.0726	.0688	.0652	.0617	.0584	.0552	.0521	.0492	.0464	.0438	.0413	.0389
4	.1294	.1249	.1205	.1162	.1118	.1076	.1034	.0992	.0952	.0912	.0874	.0836	.0799	.0764	.0729
5	.1579	.1549	.1519	.1487	.1454	.1420	.1385	.1349	.1314	.1277	.1241	.1204	.1167	.1130	.1094
6	.1605	.1601	.1595	.1586	.1575	.1562	.1546	.1529	.1511	.1490	.1468	.1445	.1420	.1394	.1367
7	.1399	.1418	.1435	.1450	.1462	.1472	.1480	.1486	.1489	.1490	.1489	.1486	.1481	.1474	.1465
8	.1066	.1099	.1130	.1160	.1188	.1215	.1240	.1263	.1284	.1304	.1321	.1337	.1351	.1363	.1373
9	.0723	.0757	.0791	.0825	.0858	.0891	.0923	.0954	.0985	.1014	.1042	.1070	.1096	.1121	.1144
10	.0441	.0469	.0498	.0528	.0558	.0588	.0618	.0649	.0679	.0710	.0740	.0770	.0800	.0829	.0858
11	.0244	.0265	.0285	.0307	.0330	.0353	.0377	.0401	.0426	.0452	.0478	.0504	.0531	.0558	.0585
12	.0124	.0137	.0150	.0164	.0179	.0194	.0210	.0227	.0245	.0263	.0283	.0303	.0323	.0344	.0366
13	.0058	.0065	.0073	.0081	.0089	.0099	.0108	.0119	.0130	.0142	.0154	.0168	.0181	.0196	.0211
14	.0025	.0029	.0033	.0037	.0041	.0046	.0052	.0058	.0064	.0071	.0078	.0086	.0095	.0104	.0113
15	.0010	.0012	.0014	.0016	.0018	.0020	.0023	.0026	.0029	.0033	.0037	.0041	.0046	.0051	.0057
16	.0004	.0005	.0005	.0006	.0007	.0008	.0010	.0011	.0013	.0014	.0016	.0019	.0021	.0024	.0026
17	.0001	.0002	.0002	.0002	.0003	.0003	.0004	.0004	.0005	.0006	.0007	.0008	.0009	.0010	.0012
18	—	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0003	.0003	.0004	.0004	.0005
19	—	—	—	—	—	—	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002
20	—	—	—	—	—	—	—	—	—	—	—	—	.0001	.0001	.0001

	λ														
x	8.0	8.5	9.0	9.5	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
0	.0003	.0002	.0001	.0001	—	—	—	—	—	—	—	—	—	—	—
1	.0027	.0017	.0011	.0007	.0005	.0002	.0001	—	—	—	—	—	—	—	—
2	.0107	.0074	.0050	.0034	.0023	.0010	.0004	.0002	.0001	—	—	—	—	—	—
3	.0286	.0208	.0150	.0107	.0076	.0037	.0018	.0008	.0004	.0002	.0001	—	—	—	—
4	.0573	.0443	.0337	.0254	.0189	.0102	.0053	.0027	.0013	.0006	.0003	.0001	.0001	—	—
5	.0916	.0752	.0607	.0483	.0378	.0224	.0127	.0070	.0037	.0019	.0010	.0005	.0002	.0001	.0001
6	.1221	.1066	.0911	.0764	.0631	.0411	.0255	.0152	.0087	.0048	.0026	.0014	.0007	.0004	.0002
7	.1396	.1294	.1171	.1037	.0901	.0646	.0437	.0281	.0174	.0104	.0060	.0034	.0019	.0010	.0005
8	.1396	.1375	.1318	.1232	.1126	.0888	.0655	.0457	.0304	.0194	.0120	.0072	.0042	.0024	.0013
9	.1241	.1299	.1318	.1300	.1251	.1085	.0874	.0661	.0473	.0324	.0213	.0135	.0083	.0050	.0029
10	.0993	.1104	.1186	.1235	.1251	.1194	.1048	.0859	.0663	.0486	.0341	.0230	.0150	.0095	.0058
11	.0722	.0853	.0970	.1067	.1137	.1194	.1144	.1015	.0844	.0663	.0496	.0355	.0245	.0164	.0106
12	.0481	.0604	.0728	.0844	.0948	.1094	.1144	.1099	.0984	.0829	.0661	.0504	.0368	.0259	.0176
13	.0296	.0395	.0504	.0617	.0729	.0926	.1056	.1099	.1060	.0956	.0814	.0658	.0509	.0378	.0271
14	.0169	.0240	.0324	.0419	.0521	.0728	.0905	.1021	.1060	.1024	.0930	.0800	.0655	.0514	.0387
15	.0090	.0136	.0194	.0265	.0347	.0534	.0724	.0885	.0989	.1024	.0992	.0906	.0786	.0650	.0516
16	.0045	.0072	.0109	.0157	.0217	.0367	.0543	.0719	.0866	.0960	.0992	.0963	.0884	.0772	.0646
17	.0021	.0036	.0058	.0088	.0128	.0237	.0383	.0550	.0713	.0847	.0934	.0963	.0936	.0863	.0760
18	.0009	.0017	.0029	.0046	.0071	.0145	.0255	.0397	.0554	.0706	.0830	.0909	.0936	.0911	.0844
19	.0004	.0008	.0014	.0023	.0037	.0084	.0161	.0272	.0409	.0557	.0699	.0814	.0887	.0911	.0888
20	.0002	.0003	.0006	.0011	.0019	.0046	.0097	.0177	.0286	.0418	.0559	.0692	.0798	.0866	.0888
21	.0001	.0001	.0003	.0005	.0009	.0024	.0055	.0109	.0191	.0299	.0426	.0560	.0684	.0783	.0846
22	—	.0001	.0001	.0002	.0004	.0012	.0030	.0065	.0121	.0204	.0310	.0433	.0560	.0676	.0769
23	—	—	—	.0001	.0002	.0006	.0016	.0037	.0074	.0133	.0216	.0320	.0438	.0559	.0669
24	—	—	—	—	.0001	.0003	.0008	.0020	.0043	.0083	.0144	.0226	.0328	.0442	.0557
25	—	—	—	—	—	.0001	.0004	.0010	.0024	.0050	.0092	.0154	.0237	.0336	.0446
26	—	—	—	—	—	—	.0002	.0005	.0013	.0029	.0057	.0101	.0164	.0246	.0343
27	—	—	—	—	—	—	.0001	.0002	.0007	.0016	.0034	.0063	.0109	.0173	.0254
28	—	—	—	—	—	—	—	.0001	.0003	.0009	.0019	.0038	.0070	.0117	.0181
29	—	—	—	—	—	—	—	.0001	.0002	.0004	.0011	.0023	.0044	.0077	.0125
30	—	—	—	—	—	—	—	—	.0001	.0002	.0006	.0013	.0026	.0049	.0083
31	—	—	—	—	—	—	—	—	—	.0001	.0003	.0007	.0015	.0030	.0054
32	—	—	—	—	—	—	—	—	—	.0001	.0001	.0004	.0009	.0018	.0034
33	—	—	—	—	—	—	—	—	—	—	.0001	.0002	.0005	.0010	.0020
34	—	—	—	—	—	—	—	—	—	—	—	.0001	.0002	.0006	.0012
35	—	—	—	—	—	—	—	—	—	—	—	—	.0001	.0003	.0007
36	—	—	—	—	—	—	—	—	—	—	—	—	.0001	.0002	.0004
37	—	—	—	—	—	—	—	—	—	—	—	—	—	.0001	.0002
38	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.0001
39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	.0001

APPENDIX C-1

STANDARD NORMAL AREAS

Example: $P(0 < z < 1.96) = .4750$



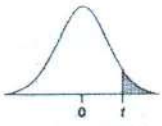
This table shows the normal area between 0 and z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.49865	.49869	.49874	.49878	.49882	.49886	.49889	.49893	.49896	.49900
3.1	.49903	.49906	.49910	.49913	.49916	.49918	.49921	.49924	.49926	.49929
3.2	.49931	.49934	.49936	.49938	.49940	.49942	.49944	.49946	.49948	.49950
3.3	.49952	.49953	.49955	.49957	.49958	.49960	.49961	.49962	.49964	.49965
3.4	.49966	.49968	.49969	.49970	.49971	.49972	.49973	.49974	.49975	.49976
3.5	.49977	.49978	.49978	.49979	.49980	.49981	.49981	.49982	.49983	.49983
3.6	.49984	.49985	.49985	.49986	.49986	.49987	.49987	.49988	.49988	.49989
3.7	.49989	.49990	.49990	.49990	.49991	.49991	.49992	.49992	.49992	.49992

45-

APPENDIX D

STUDENT'S *t* CRITICAL VALUES

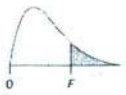


This table shows the t-value that defines the area for the stated degrees of freedom (ν).

	Confidence Level						Confidence Level				
	.80	.90	.95	.98	.99		.80	.90	.95	.98	.99
	Significance Level for Two-Tailed Test						Significance Level for Two-Tailed Test				
	.20	.10	.05	.02	.01		.20	.10	.05	.02	.01
	Significance Level for One-Tailed Test						Significance Level for One-Tailed Test				
ν	.10	.05	.025	.01	.005	ν	.10	.05	.025	.01	.005
1	3.078	6.314	12.706	31.821	63.656	36	1.306	1.688	2.028	2.434	2.719
2	1.886	2.920	4.303	6.965	9.925	37	1.305	1.687	2.026	2.431	2.715
3	1.638	2.353	3.182	4.541	5.841	38	1.304	1.686	2.024	2.429	2.712
4	1.533	2.132	2.776	3.747	4.604	39	1.304	1.685	2.023	2.426	2.708
5	1.476	2.015	2.571	3.365	4.032	40	1.303	1.684	2.021	2.423	2.704
6	1.440	1.943	2.447	3.143	3.707	41	1.303	1.683	2.020	2.421	2.701
7	1.415	1.895	2.365	2.998	3.499	42	1.302	1.682	2.018	2.418	2.698
8	1.397	1.860	2.306	2.896	3.355	43	1.302	1.681	2.017	2.416	2.695
9	1.383	1.833	2.262	2.821	3.250	44	1.301	1.680	2.015	2.414	2.692
10	1.372	1.812	2.228	2.764	3.169	45	1.301	1.679	2.014	2.412	2.690
11	1.363	1.796	2.201	2.718	3.106	46	1.300	1.679	2.013	2.410	2.687
12	1.356	1.782	2.179	2.681	3.055	47	1.300	1.678	2.012	2.408	2.685
13	1.350	1.771	2.160	2.650	3.012	48	1.299	1.677	2.011	2.407	2.682
14	1.345	1.761	2.145	2.624	2.977	49	1.299	1.677	2.010	2.405	2.680
15	1.341	1.753	2.131	2.602	2.947	50	1.299	1.676	2.009	2.403	2.678
16	1.337	1.746	2.120	2.583	2.921	55	1.297	1.673	2.004	2.396	2.668
17	1.333	1.740	2.110	2.567	2.898	60	1.296	1.671	2.000	2.390	2.660
18	1.330	1.734	2.101	2.552	2.878	65	1.295	1.669	1.997	2.385	2.654
19	1.328	1.729	2.093	2.539	2.861	70	1.294	1.667	1.994	2.381	2.648
20	1.325	1.725	2.086	2.528	2.845	75	1.293	1.665	1.992	2.377	2.643
21	1.323	1.721	2.080	2.518	2.831	80	1.292	1.664	1.990	2.374	2.639
22	1.321	1.717	2.074	2.508	2.819	85	1.292	1.663	1.988	2.371	2.635
23	1.319	1.714	2.069	2.500	2.807	90	1.291	1.662	1.987	2.368	2.632
24	1.318	1.711	2.064	2.492	2.797	95	1.291	1.661	1.985	2.366	2.629
25	1.316	1.708	2.060	2.485	2.787	100	1.290	1.660	1.984	2.364	2.626
26	1.315	1.706	2.056	2.479	2.779	110	1.289	1.659	1.982	2.361	2.621
27	1.314	1.703	2.052	2.473	2.771	120	1.289	1.658	1.980	2.358	2.617
28	1.313	1.701	2.048	2.467	2.763	130	1.288	1.657	1.978	2.355	2.614
29	1.311	1.699	2.045	2.462	2.756	140	1.288	1.656	1.977	2.353	2.611
30	1.310	1.697	2.042	2.457	2.750	150	1.287	1.655	1.976	2.351	2.609
31	1.309	1.696	2.040	2.453	2.744	∞	1.282	1.645	1.960	2.326	2.576
32	1.309	1.694	2.037	2.449	2.738						
33	1.308	1.692	2.035	2.445	2.733						
34	1.307	1.691	2.032	2.441	2.728						
35	1.306	1.690	2.030	2.438	2.724						

Note: As n increases, critical values of Student's t approach the z-values in the last line of this table. A common rule of thumb is to use z when $n > 30$, but that is *not* conservative.

CRITICAL VALUES OF $F_{.05}$



This table shows the 5 percent right-tail critical values of F for the stated degrees of freedom (ν).

Denominator Degrees of Freedom (ν_2)	Numerator Degrees of Freedom (ν_1)										
	1	2	3	4	5	6	7	8	9	10	12
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00
50	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.03	1.95
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83
200	3.89	3.04	2.65	2.42	2.26	2.14	2.06	1.98	1.93	1.88	1.80
∞	2.71	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83

Denominator Degrees of Freedom (ν_2)	Numerator Degrees of Freedom (ν_1)										
	15	20	25	30	35	40	50	60	120	200	∞
1	245.9	248.0	249.3	250.1	250.7	251.1	251.8	252.2	253.3	253.7	254.3
2	19.43	19.45	19.46	19.46	19.47	19.47	19.48	19.48	19.49	19.49	19.50
3	8.70	8.66	8.63	8.62	8.60	8.59	8.58	8.57	8.55	8.54	8.53
4	5.86	5.80	5.77	5.75	5.73	5.72	5.70	5.69	5.66	5.65	5.63
5	4.62	4.56	4.52	4.50	4.48	4.46	4.44	4.43	4.40	4.39	4.37
6	3.94	3.87	3.83	3.81	3.79	3.77	3.75	3.74	3.70	3.69	3.67
7	3.51	3.44	3.40	3.38	3.36	3.34	3.32	3.30	3.27	3.25	3.23
8	3.22	3.15	3.11	3.08	3.06	3.04	3.02	3.01	2.97	2.95	2.93
9	3.01	2.94	2.89	2.86	2.84	2.83	2.80	2.79	2.75	2.73	2.71
10	2.85	2.77	2.73	2.70	2.68	2.66	2.64	2.62	2.58	2.56	2.54
11	2.72	2.65	2.60	2.57	2.55	2.53	2.51	2.49	2.45	2.43	2.41
12	2.62	2.54	2.50	2.47	2.44	2.43	2.40	2.38	2.34	2.32	2.30
13	2.53	2.46	2.41	2.38	2.36	2.34	2.31	2.30	2.25	2.23	2.21
14	2.46	2.39	2.34	2.31	2.28	2.27	2.24	2.22	2.18	2.16	2.13
15	2.40	2.33	2.28	2.25	2.22	2.20	2.18	2.16	2.11	2.10	2.07
16	2.35	2.28	2.23	2.19	2.17	2.15	2.12	2.11	2.06	2.04	2.01
17	2.31	2.23	2.18	2.15	2.12	2.10	2.08	2.06	2.01	1.99	1.96
18	2.27	2.19	2.14	2.11	2.08	2.06	2.04	2.02	1.97	1.95	1.92
19	2.23	2.16	2.11	2.07	2.05	2.03	2.00	1.98	1.93	1.91	1.88
20	2.20	2.12	2.07	2.04	2.01	1.99	1.97	1.95	1.90	1.88	1.84
21	2.18	2.10	2.05	2.01	1.98	1.96	1.94	1.92	1.87	1.84	1.81
22	2.15	2.07	2.02	1.98	1.96	1.94	1.91	1.89	1.84	1.82	1.78
23	2.13	2.05	2.00	1.96	1.93	1.91	1.88	1.86	1.81	1.79	1.76
24	2.11	2.03	1.97	1.94	1.91	1.89	1.86	1.84	1.79	1.77	1.73
25	2.09	2.01	1.96	1.92	1.89	1.87	1.84	1.82	1.77	1.75	1.71
26	2.07	1.99	1.94	1.90	1.87	1.85	1.82	1.80	1.75	1.73	1.69
27	2.06	1.97	1.92	1.88	1.86	1.84	1.81	1.79	1.73	1.71	1.67
28	2.04	1.96	1.91	1.87	1.84	1.82	1.79	1.77	1.71	1.69	1.66
29	2.03	1.94	1.89	1.85	1.83	1.81	1.77	1.75	1.70	1.67	1.64
30	2.01	1.93	1.88	1.84	1.81	1.79	1.76	1.74	1.68	1.66	1.62
40	1.92	1.84	1.78	1.74	1.72	1.69	1.66	1.64	1.58	1.55	1.51
50	1.87	1.78	1.73	1.69	1.66	1.63	1.60	1.58	1.51	1.48	1.44
60	1.84	1.75	1.69	1.65	1.62	1.59	1.56	1.53	1.47	1.44	1.39
120	1.75	1.66	1.60	1.55	1.52	1.50	1.46	1.43	1.35	1.32	1.26
200	1.72	1.62	1.56	1.52	1.48	1.46	1.41	1.39	1.30	1.26	1.19
∞	2.71	1.67	1.57	1.51	1.46	1.42	1.39	1.35	1.32	1.22	1.17