PGDM (IBM), Batch 2015-17

STATISTICS FOR BUSINESS ANALYSIS

INS-105

Trimester-I, End-Term Examination, September, 2015

Time Allowed: 2Hrs. & 30Mins.

SECTION-A **(Marks: 3X5)**

Q.1 Fifty percent of American think we are in a recession, even though technically we have not had two straight quarters of negative growth. For a sample of 20 Americans, make the following calculations.

(a) Compute the probability that exactly 12 people think we are in recession.

(b) How many people would you expect to say we are in a recession?

(c) Compute the variance and standard deviation of the number of people who think we are in a recession.

Q.2 At the US mint in Philadelphia, 10 machines stamp out pennies in lots of 50. These lots are arranged sequentially on a single conveyor belt, which passes an inspection station. An inspector decides to use systematic sampling in inspecting the pennies and is trying to decide whether to inspect every fifth or every seventh lot of pennies. Which is better? Why?

Q.3 Concert pianist Donna Prima has become quite upset at the number of coughs occurring in the audience just before she begins to play. On her latest tour, Donna estimates that on average eight coughs occurs just before the start of her performance. Ms Prima has sworn to her conductor that if she hears more than five coughs at tonight's performance, she will refuse to play. What is the probability that she will play tonight?

Q.4 On the basis of past experience, automobile inspectors in Pennsylvania have noticed that 5 percent of all cars coming in for their annual inspection fail to pass. Using the normal approximation to the binomial, find the probability that between 7 and 18 of the next 200 cars to enter the Lancaster inspection station will fail the inspection.

Q.5 The US custom agency routinely checks all passengers arriving from foreign countries as they enter the US. The department reports that the number of people per day found to be carrying contraband material as they enter the US through John F. Kennedy airport in New York averages 42 and has a standard deviation of 11. What is the probability that in five days at the airport, the average number of passengers found carrying contraband will exceed 50?

SECTION-B **(Marks: 2X10)**

Q.6 The physician care group operates a number of walk-in clinics. Patient charts indicate the time that a patient arrived at the clinic and the time that the patient was actually seen by a physician .Administrator Val Likmer has just received a stinging phone call from a patient complaining of an excessive wait at the Rockridge clinic. Val pulls 49 charts at random from last week's workload and calculates an average wait time of 15.2 minutes. A previous large –scale study of waiting time over several clinics had a standard deviation of 2.5 minutes. Construct a confidence interval for the average wait time with confidence level :

(a) 90 percent

(b) 99 percent

Q.7 A research analyst dispute a trade group's prediction that back-to-school spending will average $606.40 per family this year. She believe that average back-to-school spending will significantly differ from this amount. She decides to conduct a test on the basis of a random sample of 30 households with school-age children. She calculates the sample mean as $622.85.She also believes that back-to-school spending is normally distributed with a population standard deviation of $65.

(a) Specify the competing hypothesis in order to test the research analyst's claim.

(b) Calculate the value of the test statistics.

(c) Calculate the ***p*-value** and the state the decision rule.

(d) At the 5% significance level, does average back-to-school spending differ from $606.40?

Q.8 A professor is trying to show his students the importance of quizzes even though 90 percent of the final grade is determined by exams. He believes that the higher the quiz grade, the higher the final grade. A random sample of 15 students in his class was selected with the data given below:

Quiz Average	Final average
59	65
92	84
72	77
90	80
95	77
87	81
89	80
77	84
76	80
65	69
97	83
42	40
94	78
62	65
91	90

(a) State the dependent(Y) variable and the independent(X) variable.
(b) Draw a scatter diagram of these data.
(c) Does the relationship between the variables appear to be linear or curvilinear?
(d) Does the Professor's belief appear to be justified? Explain your reasoning.

SECTION-C (15 Marks)
Case Study

The significant decline of savings in the US from the 1970s and 1980s to the 1990s and 2000s has been widely discussed by economist. According to the bureau of Economic analysis, the savings rate of American households, defined as a percentage of the disposable personal income, was 4.20% in 2009. The reported savings rate is not uniform across the country. A public policy institute conducts two of its own surveys to compute the savings rate in the Midwest. In the first survey, a sample of 160 households is taken and the average savings rate is found to be 4.48%.Another sample of 40 households finds an average saving rate of 4.60%.Assume that the population standard deviation is 1.4%.
In a report, use the above information to:

(1) Compute the probability of obtaining a sample mean that is at least as high as the one computed in each of the two surveys.
(2) Use these probabilities to decide which of the two samples is likely to be more representative of the US as whole.

Formulae:

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

$$\bar{x} \pm z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$\bar{x} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} \le \mu \le \bar{x} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}$$

$$P\left[\bar{x} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} \le \mu \le \bar{x} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}\right] = (1-\alpha)$$

$$\bar{x} - z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}} \le \mu \le \bar{x} + z_{\frac{\alpha}{2}} \frac{s}{\sqrt{n}}$$

$$\text{Probability of } x \text{ success in } n \text{ trials} = P(x) = \frac{!n}{!(n-x)!(x)} p^x q^{n-x}$$

Mean and variance of a binomial probability distribution

$$\text{Mean} = \mu = E(x) = np$$

$$\text{Var}(x) = \sigma^2 = np(1-p) = npq$$

$$\text{Standard deviation} = \sigma = \sqrt{npq}$$

Poisson formula

$$P(x) = \frac{\lambda^x \times e^{-\lambda}}{!x}$$

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

$$r = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{[\sum (x-\bar{x})^2][\sum (y-\bar{y})^2]}}$$

$$z \equiv \frac{x = \mu}{\sigma}$$

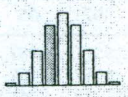
$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

$$b_1 = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sum (x-\bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

APPENDIX A

EXACT BINOMIAL PROBABILITIES



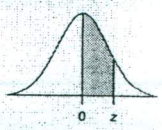
		π																
n	X	.01	.02	.05	.10	.15	.20	.30	.40	.50	.60	.70	.80	.85	.90	.95	.98	.99
2	0	.9801	.9604	.9025	.8100	.7225	.6400	.4900	.3600	.2500	.1600	.0900	.0400	.0225	.0100	.0025	.0004	.0001
	1	.0198	.0392	.0950	.1800	.2550	.3200	.4200	.4800	.5000	.4800	.4200	.3200	.2550	.1800	.0950	.0392	.0198
	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 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

APPENDIX B

EXACT POISSON PROBABILITIES

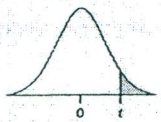
	λ														
X	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
0	.9048	.8187	.7408	.6703	.6065	.5488	.4966	.4493	.4066	.3679	.3329	.3012	.2725	.2466	.2231
1	.0905	.1637	.2222	.2681	.3033	.3293	.3476	.3595	.3659	.3679	.3662	.3614	.3543	.3452	.3347
2	.0045	.0164	.0333	.0536	.0758	.0988	.1217	.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

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.