PGDM –IB (14-16)

Statistics for Business Analysis

IB-101

Trimester-I, End Term Examination: September 2014

Time allowed :2 hrs 30 min **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.

A1. Military radar and missile detection system are designed to warn a country of an enemy attack. A reliability question is whether a detection system will be able to identify an attack and issue a warning. Assume that a particular detection system has a .90 probability of detecting a missile attack. Use the binomial probability distribution to answer the following questions.

a) If two detection systems are installed in the same area and operate independently, what is the probability that at least one of the systems will detect the attack?
b) If three systems are installed, what is the probability that at least one of the systems will detect the attack?
c) Would you recommend that multiple detection system be used? Explain.

A2. A hospital finds that 25% of its bills are at least one month in arrears. A random sample of forty-five bills was taken.

a) What is the probability that less than ten bills in the sample were at least one month in arrears?
b) What is the probability that the number of bills in the sample at least one month in arrears was between twelve and fifteen (inclusive)?

A3. A home furnishings stores that sells bedroom furniture is conducting an end-of–month inventory of the beds (mattress, bed spring, and frame) in stock. An auditor for the store wants to estimate the mean values of the beds in the stock at that time. She wants to have 99% confidence that her estimate of the mean value is correct to within $\pm$\$100. On the basis of past experience, she estimates that the standard deviation of the value of a bed is \$200.

a) What sample size should she select?

b) Using the sample size selected in (a), an audit was conducted, with the following results:

$\bar{X}$ (sample mean) = \$ 1,654.27 S = \$184.62

Construct a 99% confidence interval estimate of the total value of the beds in the stock at the end of the month if there were 258 beds in the stock.

A4. Carpetland salespersons average \$8000 per week in sales. Steve Contois, the firm's vice president, proposes a compensation plan with new selling incentives. Steve hopes that the results of a trial selling period will enable him to conclude that the compensation plan increases the average sales per salesperson.

a) Develop the appropriate null and alternative hypotheses.

b) What is the Type I error in this situation? What are the consequences of making this error?

c) What is the Type II error in this situation? What are the consequences of making this error?

A5. In a completely randomised design, 12 experimental units were used for the first treatment, 15 for the second treatment and 20 for the third treatment. State the hypothesis for the problem, complete the following ANOVA table.

At 0.05 level of significance, is there a significant difference between the treatments?

Source	SS	df	MS	F(cal)	F(tab)
Between (group)	1200				
Within/Error					
Total	1800				

SECTION B

Attempt ANY two questions in this section. Each question carries 10 marks. (2 X 10)

B1. A manager wishes to determine whether the mean times required to complete a certain task differ for the three levels of employee training. He randomly selected 10 employees with each of the three levels of training (Beginner, Intermediate and Advanced). Do the data provide sufficient evidence to indicate that the mean times required to complete a certain task differ for at least two of the three levels of training? Test the hypothesis with 95% confidence. The data is summarized in the table.

Level of Training	n	$\bar{x}$	s^2
Advanced	10	24.2	21.54
Intermediate	10	27.1	18.64
Beginner	10	30.2	17.76

B2. A company believes that the number of salespersons employed is a good predictor of sales. The following table exhibits sales (in thousand rupees) and number of salespersons employed for different years.

Sales (in thousand rupees)	120	122	118	115	100	130	140	135	130	120
Number of Salespersons employed	10	15	12	16	20	21	22	20	15	19

a) Develop a regression model to predict the impact of number of salesperson employed on sales.
b) Plot appropriate graphs for observed sales and estimated sales.
c) Interpret the slope of the regression line

B3. A survey of CPAs across the United State found that the average net income for sole proprietor CPAs is $74,914. Because this survey is now more than ten years old, an accounting researchers wants to test this figure by taking a random sample of 112 sole proprietor accountants in United State to determine whether the net income figure changed. Suppose the 112 CPAs who respond produce a sample mean of $79,268. Assume the population standard deviation of net incomes for sole proprietor CPAs is $14,530.

a) Test the researcher claim at $\alpha = 0.05$ level of significance.
b) How would the above test have changed, if accounting researcher was interested in testing whether the net income has increased?

c) Explain what is the role of the sample size (n=112)in the validity of the results of this problem.

d) Construct a 95% confidence interval for the present average net income for sole proprietor CPAs

SECTION C

Compulsory Case Study (15 marks)

Case : FRITO-LAY TARGETS THE HISPANIC Market

Founded in 1932 in San Antonio, Texas, Frito-Lay produced, distributed, and marketed snack foods with particular emphasis on various types of chips. Today, Frito-Lay brands account for 59% of the U.S. snack chip industry, and there are more than 45,000 Frito-Lay employees in the United States and Canada.

In the late 1990s, despite its overall popularity, Frito-Lay faced a general lack of appeal to Hispanics, a fast-growing U.S. market. In an effort to better penetrate that market, Frito-Lay hired various market researchers to determine why Hispanics were not purchasing their products as often as company officials had hoped and what could be done about the problem. In the studies, market researchers discovered that Hispanics thought Frito-Lay products were too bland, Frito-Lay advertisements were not being widely viewed by Hispanics, and Hispanics tended to purchase snacks in small bags at local grocery stores rather than in the large family-style bags sold at large supermarkets.

From the research, it was concluded that Spanish advertisements would be needed to reach Hispanics. It was also found that using a "Happy Face" logo, which is an icon of Frito-Lay's sister company in Mexico, was effective. Because it reminded the 63% of all Hispanics in the United States who are Mexican American of snack foods from home, the logo increased product familiarity.

In the research process many different numerical questions were raised regarding Frito-Lay products, advertising techniques, and purchase patterns among Hispanics. Using the case information and the concepts of statistical hypothesis testing, discuss the following:

a) The case information stated that 63% of all U.S. Hispanics are Mexican American. How might we test that figure? Suppose 850 U.S. Hispanics are randomly selected using U.S Census Bureau information. Suppose 575 states that they are Mexican – Americans. Test the 63 percentage using alpha of 0.05.

b) Suppose that in the past, 94% of all Hispanic grocery shoppers were women. Perhaps due to changing cultural values, we believe that more Hispanic men are now grocery shopping. We randomly sample 689 Hispanic grocery shoppers from around the United States and 606 are women. Does this result provide enough evidence to conclude that a lower proportion of Hispanic grocery shoppers now are women?

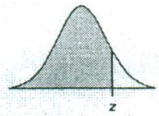
c) What is the average age of a purchaser of Frito- Lay? Suppose initial tests indicate that the mean age is 31. Is this figure really correct? To test whether it is, a researcher randomly contacts 24 purchasers of Frito- Lay for this the sample mean is 28.81 and sample standard variation is 7.09. Discuss the output in terms of a hypothesis test to determine whether the mean age is actually 31. Let α be 0.05.

Assume that ages of purchasers are normally distributed in the population.

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

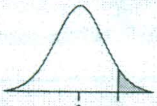


This table shows the normal area less than z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992

APPENDIX D

STUDENT'S *t* CRITICAL VALUES

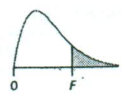


This table shows the *t*-value that defines the area for the stated degrees of freedom (ν).

	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

Some important Formulae

$$P(x) = \binom{n}{x} p^{x} q^{(n-x)} = \frac{n!}{x!(n-x)!} p^{x} q^{(n-x)} \quad ;\mu = np \quad ;\sigma^2 = npq$$

$$P(x) = \frac{\mu^{x} e^{-\mu}}{x!} \text{ for } x = 1,2,3,\ldots \quad ; \quad z = \frac{x-\mu}{\sigma}$$

$$\frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \qquad \frac{\bar{X}-\mu}{s/\sqrt{n}} \qquad \frac{\hat{p}-p}{\sqrt{\frac{p(1-p)}{n}}}$$

$$\frac{\bar{X}-\mu_0}{\sigma/\sqrt{n}} \qquad \frac{\bar{X}-\mu_0}{s/\sqrt{n}} \qquad \frac{(\hat{p}-p_0)}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

$$\bar{x} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}} \qquad \bar{X} \pm t_{(\frac{\alpha}{2},n-1)}\frac{s}{\sqrt{n}} \qquad n = \frac{(z_{\alpha/2})^2\sigma^2}{E^2}$$

Finite Correction Factor : $\sqrt{\frac{N-n}{N-1}}$ $\qquad N\bar{X} \pm N\left(t_{\alpha/2,n-1}\right)\frac{S}{\sqrt{n}}\sqrt{\frac{(N-n)}{(N-1)}}$

$SS(B) = \sum_{i=1}^{k} n_i(\bar{x}_i - \bar{\bar{x}})^2$ d.f. = k-1

$SS(W) = \sum_{i=1}^{k} df_i s_i^2$ d.f = n-k

SST = SSB + SSW d.f = n-1

$$F_{(k-1,n-k \text{ at } \alpha)} = \frac{MSB}{MSW}$$

$Y_i = b_0 + b_1 X$ $\qquad b_0 = \bar{y} - b_1\bar{x}$

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