

FORMULAE & TABLES FOR STAT 1123 FINAL EXAM

μ : population mean, \bar{x} : sample mean; $\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$, where n: sample size

σ : population standard deviation, s: sample standard deviation; $s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

Confidence interval for μ when σ is known: $\bar{x} - Z \frac{\sigma}{\sqrt{n}} < \mu < \bar{x} + Z \frac{\sigma}{\sqrt{n}}$

$$\text{LCL} = \bar{x} - Z \frac{\sigma}{\sqrt{n}}, \quad \text{UCL} = \bar{x} + Z \frac{\sigma}{\sqrt{n}}$$

$$\text{Sample size: } n = \left(\frac{Z \times \sigma}{E} \right)^2$$

Confidence interval for μ when σ is unknown: $\bar{x} - t \frac{s}{\sqrt{n}} < \mu < \bar{x} + t \frac{s}{\sqrt{n}}$, df = n - 1

$$\text{LCL} = \bar{x} - t \frac{s}{\sqrt{n}}, \quad \text{UCL} = \bar{x} + t \frac{s}{\sqrt{n}}$$

Testing Hypothesis about μ :

Test statistics: $Z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$, if σ is known.

Or, $t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$, if σ is unknown, degree of freedom = n - 1.

Test Statistics for Two Independent Samples:

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}, \text{ if } \sigma_1 \text{ and } \sigma_2 \text{ are available.} \quad (\text{Note: } (\mu_1 - \mu_2) = 0).$$

Test Statistics for Two Independent Samples: degrees of freedom = $n_1 + n_2 - 2$

$$\text{Standard error} = S_e = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

$$\text{Test statistics: } t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{(S_e) \times \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}, \text{ where } (\mu_1 - \mu_2) = 0$$

Test Statistics for Two Dependent Samples (matched pairs): degrees of freedom = $n - 1$

$$\bar{D} = \bar{d} = \frac{\sum_{i=1}^n d_i}{n} = \frac{d_1 + d_2 + \dots + d_n}{n}, \text{ and } d_1 = x_1 - y_1, d_2 = x_2 - y_2, \dots, d_n = x_n - y_n,$$

$$S_d = \sqrt{\frac{\sum (d - \bar{d})^2}{n - 1}}, \text{ df} = n - 1$$

$$\text{Test statistic: } t = \frac{\bar{d} - \mu_d}{\frac{S_d}{\sqrt{n}}}, \text{ where } \mu_d = 0$$

Test Statistics for Goodness-of-Fit Test:

$$\chi^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}, \text{ degree of freedom } v = k - 1$$

Where, O_i : Observed frequency, ($O_1 + O_2 + \dots + O_k = n$).

E_i : Expected frequency.

k : number of categories.

ANOVA:

- Reject the null hypothesis if $F > F_{\text{crit}}$
- Fail to reject the null hypothesis if $F < F_{\text{crit}}$.

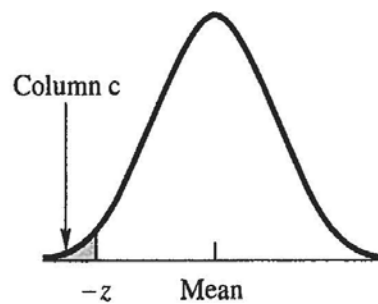
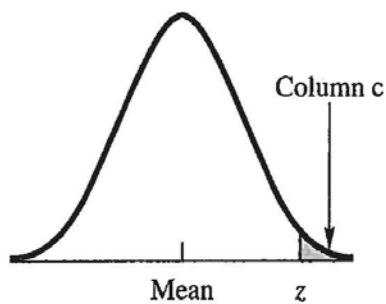
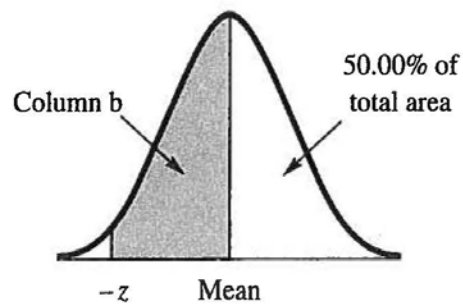
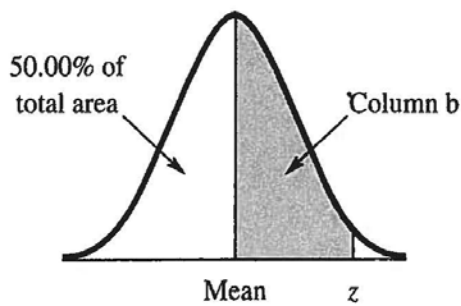
Hypothesis Testing with Excel/SPSS (p-value approach):

- Reject the null hypothesis if the P -value is less or equal to the significance level α .
- Fail to reject the null hypothesis if the P -value is greater than the significance level α .

Tables:

TABLE A Percentage of Area under the Normal Curve

Column a gives the distance in standard deviation units from the mean (z). Column b represents the percentage of area between the mean and a given z . Column c represents the percentage at or beyond a given z .



(continued)

TABLE A (continued)

(a)	(b)	(c)	(a)	(b)	(c)
<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>	<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>
.00	.00	50.00	.44	17.00	33.00
.01	.40	49.60	.45	17.36	32.64
.02	.80	49.20	.46	17.72	32.28
.03	1.20	48.80	.47	18.08	31.92
.04	1.60	48.40	.48	18.44	31.56
.05	1.99	48.01	.49	18.79	31.21
.06	2.39	47.61	.50	19.15	30.85
.07	2.79	47.21	.51	19.50	30.50
.08	3.19	46.81	.52	19.85	30.15
.09	3.59	46.41	.53	20.19	29.81
.10	3.98	46.02	.54	20.54	29.46
.11	4.38	45.62	.55	20.88	29.12
.12	4.78	45.22	.56	21.23	28.77
.13	5.17	44.83	.57	21.57	28.43
.14	5.57	44.43	.58	21.90	28.10
.15	5.96	44.04	.59	22.24	27.76
.16	6.36	43.64	.60	22.57	27.43
.17	6.75	43.25	.61	22.91	27.09
.18	7.14	42.86	.62	23.24	26.76
.19	7.53	42.47	.63	23.57	26.43
.20	7.93	42.07	.64	23.89	26.11
.21	8.32	41.68	.65	24.22	25.78
.22	8.71	41.29	.66	24.54	25.46
.23	9.10	40.90	.67	24.86	25.14
.24	9.48	40.52	.68	25.17	24.83
.25	9.87	40.13	.69	25.49	24.51
.26	10.26	39.74	.70	25.80	24.20
.27	10.64	39.36	.71	26.11	23.89
.28	11.03	38.97	.72	26.42	23.58
.29	11.41	38.59	.73	26.73	23.27
.30	11.79	38.21	.74	27.04	22.96
.31	12.17	37.83	.75	27.34	22.66
.32	12.55	37.45	.76	27.64	22.36
.33	12.93	37.07	.77	27.94	22.06
.34	13.31	36.69	.78	28.23	21.77
.35	13.68	36.32	.79	28.52	21.48
.36	14.06	35.94	.80	28.81	21.19
.37	14.43	35.57	.81	29.10	20.90
.38	14.80	35.20	.82	29.39	20.61
.39	15.17	34.83	.83	29.67	20.33
.40	15.54	34.46	.84	29.95	20.05
.41	15.91	34.09	.85	30.23	19.77
.42	16.28	33.72	.86	30.51	19.49
.43	16.64	33.36	.87	30.78	19.22

TABLE A (continued)

(a)	(b)	(c)	(a)	(b)	(c)
<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>	<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>
.88	31.06	18.94	1.32	40.66	9.34
.89	31.33	18.67	1.33	40.82	9.18
.90	31.59	18.41	1.34	40.99	9.01
.91	31.86	18.14	1.35	41.15	8.85
.92	32.12	17.88	1.36	41.31	8.69
.93	32.38	17.62	1.37	41.47	8.53
.94	32.64	17.36	1.38	41.62	8.38
.95	32.89	17.11	1.39	41.77	8.23
.96	33.15	16.85	1.40	41.92	8.08
.97	33.40	16.60	1.41	42.07	7.93
.98	33.65	16.35	1.42	42.22	7.78
.99	33.89	16.11	1.43	42.36	7.64
1.00	34.13	15.87	1.44	42.51	7.49
1.01	34.38	15.62	1.45	42.65	7.35
1.02	34.61	15.39	1.46	42.79	7.21
1.03	34.85	15.15	1.47	42.92	7.08
1.04	35.08	14.92	1.48	43.06	6.94
1.05	35.31	14.69	1.49	43.19	6.81
1.06	35.54	14.46	1.50	43.32	6.68
1.07	35.77	14.23	1.51	43.45	6.55
1.08	35.99	14.01	1.52	43.57	6.43
1.09	36.21	13.79	1.53	43.70	6.30
1.10	36.43	13.57	1.54	43.82	6.18
1.11	36.65	13.35	1.55	43.94	6.06
1.12	36.86	13.14	1.56	44.06	5.94
1.13	37.08	12.92	1.57	44.18	5.82
1.14	37.29	12.71	1.58	44.29	5.71
1.15	37.49	12.51	1.59	44.41	5.59
1.16	37.70	12.30	1.60	44.52	5.48
1.17	37.90	12.10	1.61	44.63	5.37
1.18	38.10	11.90	1.62	44.74	5.26
1.19	38.30	11.70	1.63	44.84	5.16
1.20	38.49	11.51	1.64	44.95	5.05
1.21	38.69	11.31	1.65	45.05	4.95
1.22	38.88	11.12	1.66	45.15	4.85
1.23	39.07	10.93	1.67	45.25	4.75
1.24	39.25	10.75	1.68	45.35	4.65
1.25	39.44	10.56	1.69	45.45	4.55
1.26	39.62	10.38	1.70	45.54	4.46
1.27	39.80	10.20	1.71	45.64	4.36
1.28	39.97	10.03	1.72	45.73	4.27
1.29	40.15	9.85	1.73	45.82	4.18
1.30	40.32	9.68	1.74	45.91	4.09
1.31	40.49	9.51	1.75	45.99	4.01

(continued)

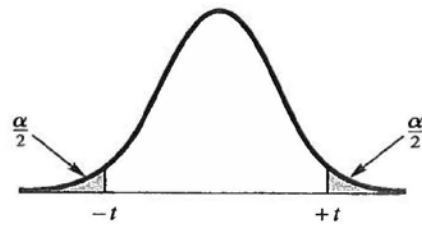
TABLE A (continued)

(a)	(b)	(c)	(a)	(b)	(c)
<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>	<i>z</i>	Area between Mean and <i>z</i>	Area beyond <i>z</i>
1.76	46.08	3.92	2.20	48.61	1.39
1.77	46.16	3.84	2.21	48.64	1.36
1.78	46.25	3.75	2.22	48.68	1.32
1.79	46.33	3.67	2.23	48.71	1.29
1.80	46.41	3.59	2.24	48.75	1.25
1.81	46.49	3.51	2.25	48.78	1.22
1.82	46.56	3.44	2.26	48.81	1.19
1.83	46.64	3.36	2.27	48.84	1.16
1.84	46.71	3.29	2.28	48.87	1.13
1.85	46.78	3.22	2.29	48.90	1.10
1.86	46.86	3.14	2.30	48.93	1.07
1.87	46.93	3.07	2.31	48.96	1.04
1.88	46.99	3.01	2.32	48.98	1.02
1.89	47.06	2.94	2.33	49.01	.99
1.90	47.13	2.87	2.34	49.04	.96
1.91	47.19	2.81	2.35	49.06	.94
1.92	47.26	2.74	2.36	49.09	.91
1.93	47.32	2.68	2.37	49.11	.89
1.94	47.38	2.62	2.38	49.13	.87
1.95	47.44	2.56	2.39	49.16	.84
1.96	47.50	2.50	2.40	49.18	.82
1.97	47.56	2.44	2.41	49.20	.80
1.98	47.61	2.39	2.42	49.22	.78
1.99	47.67	2.33	2.43	49.25	.75
2.00	47.72	2.28	2.44	49.27	.73
2.01	47.78	2.22	2.45	49.29	.71
2.02	47.83	2.17	2.46	49.31	.69
2.03	47.88	2.12	2.47	49.32	.68
2.04	47.93	2.07	2.48	49.34	.66
2.05	47.98	2.02	2.49	49.36	.64
2.06	48.03	1.97	2.50	49.38	.62
2.07	48.08	1.92	2.51	49.40	.60
2.08	48.12	1.88	2.52	49.41	.59
2.09	48.17	1.83	2.53	49.43	.57
2.10	48.21	1.79	2.54	49.45	.55
2.11	48.26	1.74	2.55	49.46	.54
2.12	48.30	1.70	2.56	49.48	.52
2.13	48.34	1.66	2.57	49.49	.51
2.14	48.38	1.62	2.58	49.51	.49
2.15	48.42	1.58	2.59	49.52	.48
2.16	48.46	1.54	2.60	49.53	.47
2.17	48.50	1.50	2.61	49.55	.45
2.18	48.54	1.46	2.62	49.56	.44
2.19	48.57	1.43	2.63	49.57	.43

TABLE A (continued)

(a) z	(b) Area between Mean and z	(c) Area beyond z	(a) z	(b) Area between Mean and z	(c) Area beyond z
2.64	49.59	.41	3.00	49.87	.13
2.65	49.60	.40	3.01	49.87	.13
2.66	49.61	.39	3.02	49.87	.13
2.67	49.62	.38	3.03	49.88	.12
2.68	49.63	.37	3.04	49.88	.12
2.69	49.64	.36	3.05	49.89	.11
2.70	49.65	.35	3.06	49.89	.11
2.71	49.66	.34	3.07	49.89	.11
2.72	49.67	.33	3.08	49.90	.10
2.73	49.68	.32	3.09	49.90	.10
2.74	49.69	.31	3.10	49.90	.10
2.75	49.70	.30	3.11	49.91	.09
2.76	49.71	.29	3.12	49.91	.09
2.77	49.72	.28	3.13	49.91	.09
2.78	49.73	.27	3.14	49.92	.08
2.79	49.74	.26	3.15	49.92	.08
2.80	49.74	.26	3.16	49.92	.08
2.81	49.75	.25	3.17	49.92	.08
2.82	49.76	.24	3.18	49.93	.07
2.83	49.77	.23	3.19	49.93	.07
2.84	49.77	.23	3.20	49.93	.07
2.85	49.78	.22	3.21	49.93	.07
2.86	49.79	.21	3.22	49.94	.06
2.87	49.79	.21	3.23	49.94	.06
2.88	49.80	.20	3.24	49.94	.06
2.89	49.81	.19	3.25	49.94	.06
2.90	49.81	.19	3.30	49.95	.05
2.91	49.82	.18	3.35	49.96	.04
2.92	49.82	.18	3.40	49.97	.03
2.93	49.83	.17	3.45	49.97	.03
2.94	49.84	.16	3.50	49.98	.02
2.95	49.84	.16	3.60	49.98	.02
2.96	49.85	.15	3.70	49.99	.01
2.97	49.85	.15	3.80	49.99	.01
2.98	49.86	.14	3.90	49.995	.005
2.99	49.86	.14	4.00	49.997	.003

TABLE C Critical Values of t



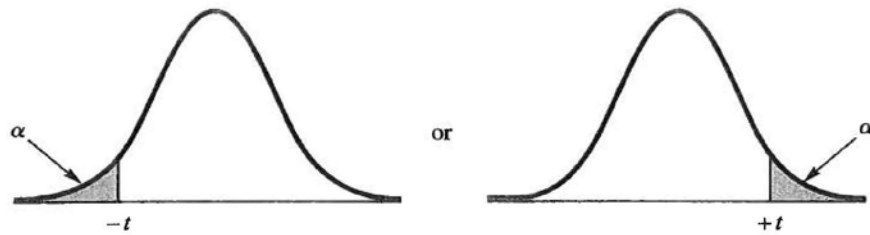
For any given df , the table shows the values of t corresponding to various levels of probability. Obtained t is significant at a given level if it is *larger than* the value shown in the table (ignoring the sign).

Level of Significance for Two-Tailed Test (α)

df	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

Note: The bottom row ($df = \infty$) also equals critical values for z .

TABLE C (continued)

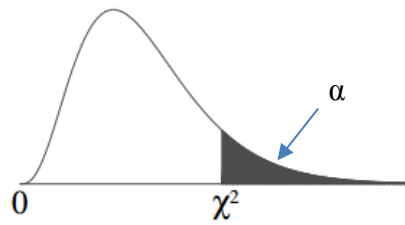


For any given df, the table shows the values of t corresponding to various levels of probability. Obtained t is significant at a given level if it is *larger than* the value shown in the table (ignoring the sign).

Level of Significance for One-Tailed Test (α)

df	.10	.05	.025	.01	.005	.0005
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

Chi-Square Distribution Table



df	α				
	0.2	0.1	0.05	0.02	0.01
1	1.642	2.706	3.841	5.412	6.635
2	3.219	4.605	5.991	7.824	9.210
3	4.642	6.251	7.815	9.837	11.345
4	5.989	7.779	9.488	11.668	13.277
5	7.289	9.236	11.070	13.388	15.086
6	8.558	10.645	12.592	15.033	16.812
7	9.803	12.017	14.067	16.622	18.475
8	11.030	13.362	15.507	18.168	20.090
9	12.242	14.684	16.919	19.679	21.666
10	13.442	15.987	18.307	21.161	23.209
11	14.631	17.275	19.675	22.618	24.725
12	15.812	18.549	21.026	24.054	26.217
13	16.985	19.812	22.362	25.472	27.688
14	18.151	21.064	23.685	26.873	29.141
15	19.311	22.307	24.996	28.259	30.578
16	20.465	23.542	26.296	29.633	32.000
17	21.615	24.769	27.587	30.995	33.409
18	22.760	25.989	28.869	32.346	34.805
19	23.900	27.204	30.144	33.687	36.191
20	25.038	28.412	31.410	35.020	37.566
21	26.171	29.615	32.671	36.343	38.932
22	27.301	30.813	33.924	37.659	40.289
23	28.429	32.007	35.172	38.968	41.638
24	29.553	33.196	36.415	40.270	42.980
25	30.675	34.382	37.652	41.566	44.314
26	31.795	35.563	38.885	42.856	45.642
27	32.912	36.741	40.113	44.140	46.963
28	34.027	37.916	41.337	45.419	48.278
29	35.139	39.087	42.557	46.693	49.588
30	36.250	40.256	43.773	47.962	50.892
40	47.269	51.805	55.758	60.436	63.691
50	58.164	63.167	67.505	72.613	76.154
60	68.972	74.397	79.082	84.580	88.379