### UNIVERSITY OF RUHUNA

# 2016/2017 Academic Year BA (Special) Degree - 2000 Level 2<sup>nd</sup> Semester Examination - May 2018

### STS 22613 – Inferential Statistics

Use	of (	Calcu	lators are allowed Answer <u>any six (06) questions</u> only	Time: 03 Hours.
1	2			
1.	a.	Defin	ne the term "inferential Statistics" with an example.	
				[03 Marks]
	b.	"A s	ample statistic is a random variable". Comments the given	statement.
				[04 Marks]
	c.	How	do you distinguish between "Parameter" and "Statistic"?	
				[03 Marks]
2.	a.	A sta	atistics class has six students and their ages are given below	v below.
		Ages	s: 18 18 19 20 20 21	
		Cons	struct a sampling distribution of the mean age for samples of	Size $(n=2)$ without
	,	repla	acement.	
				[07 Marks]
	b.	Wha	t are the components you should know to form a sampling	distribution?
				[03 Marks]
3.	a.	Desc	ribe the term following terms with relevant examples	
		i).	. Point estimator	
		ii).	. Interval Estimation	
		iii).	. Estimate	
8				[06 Marks]

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b. A researcher has collected data on student's marks at final examination and has analyzed using Minitab software. The following output is an illustration of a part of the data analysis.

#### **Statistics**

Variable	Mean S	E Mean	StDev	Variance	CoefVar	Sum	Minimum	Q1	Median	Q3
C1	52.17	3.92	21.10	445.29	40.45	1513.00	23.00	35.00	54.00	67.00
					N for					
Variable	Maximun	n Range	IQR	Mode	Mode					
C1	95.0	0 72.00	32.00	36	3					

Identify the estimates for

- i). Population Mean
- ii). Population variance

[02 Marks]

c. Give Minitab command path to obtain the above results.

[02 Marks]

4. a. What do you mean by efficient estimator?

[02 Marks]

b. Let  $X_1 X_2 X_3 \dots X_{20}$  is random sample from a Poisson distribution with  $p.d.f. X \sim Po(x; \lambda)$ . Show that sample mean  $\bar{X}$  is a minimum variance unbiased point estimator for population parameter  $\lambda$ .

[08 Marks]

5.

- a. State whether the following expressions are true or false
  - i). "X," and "n-X" are less than five is one assumption underlying the construction of confidence interval estimate for the proportion using the normal distribution.
  - ii). The Z-critical values used when computing confidence intervals for the proportion vary by degrees of freedom.

- iii). The confidence interval estimate of the population mean is constructed around the sample mean
- iv). The confidence interval obtained will always correctly estimate the true population parameter.
- v). A 100% confidence interval can be calculated for large samples such that the resulting interval is guaranteed to contain the population parameter.

[05 Marks]

b. A random sample of 30 households was selected as part of a study on electricity usage, and the number of kilowatt-hours (kWh) was recorded for each household in the sample for the March quarter of 2006. The average usage was found to be 375kWh. In a very large study in the March quarter of the previous year it was found that the standard deviation of the usage was 81kWh. Assuming the standard deviation is unchanged and that the usage is normally distributed, calculate and interpret a 99% confidence interval for the mean usage in the March quarter of 2006.

[05 Marks]

a. What do you mean by an unbiased estimator?

6.

[02 marks]

b. Give three examples for unbiased estimators

[03 Marks]

c. Let  $x_1$ ,  $x_2$ ,  $x_3$ ,  $x_4$  be a random sample from a population with mean  $\mu$  and variance  $\sigma^2$ . Show that the sample mean of the above sample is an unbiased estimator for the population mean  $\mu$ .

[05 Marks]

7.

a. An engineer wishes to show that the new formula that was just developed results in a quicker-drying paint. State the null and alternative hypotheses.

[02 Marks]

b. An e-commerce research company claims that 60% or more graduate students have bought merchandise on-line. A consumer group is suspicious of the claim and thinks that the proportion is lower than 60%. A random sample of 80 graduate students show that only 22 students have ever done so. Is there enough evidence to show that the true proportion is lower than 60%? Conduct the test at 10% Type I error rate.

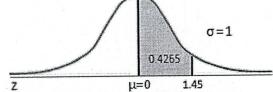
[08 Marks]

- 8. Describe following concepts using relevant examples and diagrams whenever necessary
  - a. Shape of the sampling distribution of sample proportion
  - b. The width of the confidence interval
  - c. Test statistic in hypothesis testing
  - d. Margin of error

			[10 Marks]

## Areas Under the One-Tailed Standard Normal Curve

This table provides the area between the mean and some Z score. For example, when Z score = 1.45 the area = 0.4265.



0.0         0.0000         0.0040         0.0080         0.0120         0.0160         0.0199         0.0239         0.0279         0.0319         0.0358           0.1         0.0398         0.0438         0.0478         0.0517         0.0557         0.0596         0.0636         0.0675         0.0714         0.0715           0.2         0.0793         0.0832         0.0871         0.0910         0.0948         0.0987         0.1026         0.1064         0.1130         0.1131           0.3         0.1179         0.1217         0.1255         0.1234         0.1331         0.1368         0.1406         0.1443         0.14480         0.1550           0.4         0.1554         0.1591         0.1628         0.1664         0.1706         0.1236         0.14180         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.14480         0.1551         0.0521         0.2624         0.27240         0.2734         0.27254         0.27590         0.2232         0.2451         0.2254						. 2		μ-0	1.45		
0.0         0.0000         0.0400         0.0808         0.0120         0.0150         0.0239         0.0239         0.0279         0.0319         0.0375           0.1         0.0338         0.0478         0.0517         0.0557         0.05636         0.0675         0.0714         0.075           0.2         0.0793         0.0832         0.0871         0.0910         0.0948         0.0987         0.1026         0.1064         0.1113         0.1143         0.1143           0.3         0.1179         0.1217         0.1255         0.1293         0.1331         0.1368         0.1406         0.1443         0.1480         0.151           0.4         0.1554         0.1551         0.1628         0.2019         0.2024         0.2088         0.2123         0.2157         0.2190         0.2264           0.6         0.2557         0.2291         0.2345         0.2861         0.2611         0.2627         0.2387         0.2324         0.2744         0.2764         0.2744         0.2764         0.2784         0.2764         0.2294         0.2823         0.2824           0.8         0.2881         0.2910         0.2939         0.2267         0.2385         0.3231         0.3740         0.3798	Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.1         0.0398         0.0438         0.0478         0.0517         0.0557         0.0596         0.0636         0.0675         0.0714         0.075           0.2         0.0793         0.0832         0.0871         0.0910         0.0948         0.0876         0.1066         0.1064         0.1103         0.1143           0.3         0.1179         0.1255         0.1293         0.1331         0.1368         0.1406         0.1434         0.1480         0.1551           0.4         0.1554         0.1591         0.1985         0.2019         0.2084         0.2088         0.2123         0.2157         0.2190         0.2527           0.5         0.1915         0.1950         0.1985         0.2019         0.2084         0.2088         0.2123         0.2157         0.2591         0.2324         0.2327         0.2724         0.2764         0.2764         0.2246         0.2219         0.2527         0.2734         0.2764         0.2764         0.2784         0.2764         0.2784         0.2764         0.2784         0.2764         0.2784         0.2764         0.2784         0.2764         0.2784         0.2784         0.2784         0.2784         0.2784         0.2766         0.2783         0.2812			0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.2         0.0793         0.0832         0.0871         0.0910         0.0948         0.0987         0.1026         0.1064         0.1103         0.11103         0.1143           0.3         0.1179         0.1217         0.1255         0.1293         0.1331         0.1366         0.1406         0.1443         0.1480         0.1511           0.4         0.1554         0.1591         0.1268         0.1664         0.1700         0.1736         0.1772         0.1838         0.1844         0.1875           0.5         0.1915         0.1950         0.1955         0.2019         0.2054         0.2088         0.2123         0.2157         0.2190         0.2224           0.6         0.2257         0.2291         0.2324         0.2357         0.2389         0.2422         0.2454         0.2486         0.2517         0.254           0.8         0.2881         0.2611         0.2624         0.2673         0.2794         0.2724         0.2746         0.2794         0.2823         0.2821         0.3353         0.3551         0.3363         0.3166         0.3166         0.3232         0.3231         0.3351         0.3343         0.3633         0.3622         0.3333         0.3525         0.3331         0.				0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.3         0.1179         0.1217         0.1255         0.1293         0.1381         0.1368         0.1406         0.1443         0.1480         0.151           0.4         0.1554         0.1591         0.1628         0.1664         0.1700         0.1736         0.1772         0.1808         0.1844         0.1871           0.5         0.1915         0.1950         0.1985         0.2019         0.2054         0.2088         0.2123         0.2157         0.2190         0.2257           0.6         0.2257         0.2291         0.2324         0.2357         0.2389         0.2422         0.2454         0.2454         0.2264         0.2580           0.8         0.2881         0.2910         0.2939         0.2957         0.2935         0.3023         0.3015         0.3078         0.3160         0.313           0.9         0.3159         0.3186         0.3212         0.3238         0.3264         0.3329         0.3315         0.3378         0.3507         0.362           1.1         0.3643         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.333           1.2         0.3849         0.3859 <t< td=""><td></td><td></td><td>0.0832</td><td>0.0871</td><td>0.0910</td><td>0.0948</td><td>0.0987</td><td>0.1026</td><td>0.1064</td><td>0.1103</td><td>0.1141</td></t<>			0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.4         0.1554         0.1591         0.1628         0.1664         0.1700         0.1736         0.1772         0.1808         0.1844         0.1875           0.5         0.1915         0.1950         0.1985         0.2019         0.2054         0.2088         0.2123         0.2157         0.2190         0.2254           0.6         0.2527         0.2291         0.2324         0.2357         0.2389         0.2422         0.2454         0.2486         0.2517         0.2524           0.7         0.2580         0.2611         0.2642         0.2673         0.2704         0.2734         0.2764         0.2794         0.2283         0.3619         0.3819         0.3169         0.3186         0.3212         0.3238         0.3264         0.3289         0.3315         0.3300         0.3365         0.3531         0.3431         0.3433         0.3461         0.3485         0.3508         0.3531         0.3577         0.3599         0.3621           1.1         0.3643         0.3865         0.3866         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.3831           1.2         0.3843         0.3865         0.3686         0.3780         0.3729         0.			0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.5         0.1915         0.1950         0.1985         0.2019         0.2054         0.2088         0.2123         0.2157         0.2190         0.2257           0.6         0.2257         0.2291         0.2324         0.2357         0.2389         0.2422         0.2454         0.2486         0.2517         0.2546           0.7         0.2580         0.2611         0.2622         0.2673         0.2704         0.2734         0.2744         0.2744         0.2744         0.2724         0.2823         0.2823           0.8         0.2881         0.2910         0.2939         0.2967         0.2995         0.3023         0.3051         0.3078         0.3106         0.3136           1.0         0.3413         0.3438         0.3461         0.3485         0.3508         0.3531         0.3554         0.3577         0.3399         0.362           1.1         0.3643         0.3665         0.3686         0.3708         0.3729         0.3790         0.3790         0.3110         0.3333           1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3997         0.311           1.3         0.4032         0.40466					0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.6         0.2257         0.2291         0.2324         0.2357         0.2389         0.2422         0.2454         0.2486         0.2517         0.2542           0.7         0.2580         0.2611         0.2642         0.2673         0.2704         0.2734         0.2764         0.2794         0.2823         0.2851           0.9         0.3159         0.3186         0.3212         0.3238         0.3264         0.3289         0.3315         0.3343         0.3365         0.3881         0.3413         0.3438         0.3461         0.3485         0.3508         0.3531         0.3554         0.3577         0.3599         0.362           1.1         0.3643         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.3831           1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.39379         0.4311           1.3         0.4032         0.40490         0.4066         0.4082         0.4099         0.4115         0.4141         0.4142         0.4412           1.4         0.4192         0.4207         0.4222         0.4226         0.4251 <td></td> <td></td> <td></td> <td>0.1985</td> <td>0.2019</td> <td>0.2054</td> <td>0.2088</td> <td>0.2123</td> <td>0.2157</td> <td>0.2190</td> <td>0.2224</td>				0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.7         0.2580         0.2611         0.2642         0.2673         0.2704         0.2734         0.2764         0.2794         0.2823         0.285           0.8         0.2881         0.2910         0.2939         0.2967         0.2995         0.3023         0.3051         0.3078         0.3106         0.313           0.9         0.3159         0.3186         0.3212         0.3238         0.3264         0.3289         0.3315         0.3365         0.3365           1.0         0.3443         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.3831           1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.3997         0.4011           1.3         0.4032         0.4049         0.4066         0.40422         0.40499         0.4115         0.4131         0.4147         0.4162         0.4131           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4292         0.4306           1.5         0.4332         0.4345         0.4373         0.4324			-	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.8         0.2881         0.2910         0.2939         0.2967         0.2995         0.3023         0.3051         0.3078         0.3106         0.3136           0.9         0.3159         0.3186         0.3212         0.3238         0.3264         0.3289         0.3315         0.3340         0.3365         0.3365           1.0         0.3413         0.3438         0.3465         0.3686         0.3708         0.3729         0.3779         0.3770         0.3599         0.3810           1.1         0.3643         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3801         0.3831           1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.3997         0.4011           1.3         0.4032         0.4049         0.4066         0.4082         0.4099         0.4115         0.4131         0.4147         0.4162         0.417           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4222         0.4304           1.5         0.4332         0.4463         0.4447         0.4484			0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.9         0.\$1559         0.3186         0.3212         0.3238         0.3264         0.3289         0.3315         0.3340         0.3365         0.3385           1.0         0.\$413         0.3438         0.3461         0.3485         0.3508         0.3531         0.3577         0.3577         0.3599         0.3625           1.1         0.\$403         0.3665         0.3688         0.3907         0.3925         0.3944         0.3962         0.3980         0.3997         0.4011           1.2         0.\$4932         0.4049         0.4066         0.4082         0.4099         0.4115         0.4131         0.4147         0.4162         0.4171           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4292         0.4306         0.4311           1.5         0.4332         0.4345         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4442           1.6         0.4452         0.4463         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4627           1.7         0.4554         0.4564         0.4573				0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
1.0         0.3413         0.3438         0.3461         0.3485         0.3508         0.3531         0.3554         0.3577         0.3599         0.3621           1.1         0.3643         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.3831           1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.3977         0.4011           1.3         0.4032         0.4049         0.4069         0.4036         0.4021         0.4031         0.4117         0.4162         0.4171           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4255         0.4279         0.4306         0.4311           1.5         0.4332         0.43435         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4442           1.6         0.4452         0.4463         0.4474         0.4484         0.4495         0.4505         0.4515         0.4525         0.4535           1.7         0.4554         0.4564         0.4573         0.4582         0.4591			0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.1         0.\$643         0.3665         0.3686         0.3708         0.3729         0.3749         0.3770         0.3790         0.3810         0.3831           1.2         0.\$849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.3997         0.4011           1.3         0.4032         0.4049         0.4066         0.4082         0.4035         0.4115         0.4131         0.4147         0.4162         0.4311           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4292         0.4306         0.4311           1.5         0.4332         0.4345         0.4357         0.4370         0.4382         0.4265         0.4279         0.4292         0.4306         0.4311           1.6         0.4452         0.4463         0.4474         0.4484         0.4495         0.4505         0.4515         0.4525         0.4535         0.4541           1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4625         0.4633           1.8         0.4641         0.4649				0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.2         0.3849         0.3869         0.3888         0.3907         0.3925         0.3944         0.3962         0.3980         0.3997         0.4011           1.3         0.4032         0.4049         0.4066         0.4082         0.4099         0.4115         0.4131         0.4147         0.4162         0.417.           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4292         0.4306         0.4311           1.5         0.4332         0.4345         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4418           1.6         0.4524         0.4463         0.4474         0.4484         0.4495         0.4555         0.4555         0.4553         0.4554           1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4508         0.4616         0.4625         0.4631           1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.4701           1.9         0.4772         0.4778         0.4783         0.4793		-	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.3         0.4032         0.4049         0.4066         0.4082         0.4099         0.4115         0.4131         0.4147         0.4162         0.417           1.4         0.4192         0.4207         0.4222         0.4236         0.4251         0.4265         0.4279         0.4292         0.4306         0.4311           1.5         0.4332         0.4345         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4441           1.6         0.4522         0.4463         0.4474         0.4484         0.4495         0.4505         0.4515         0.4525         0.4535         0.4541           1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4625         0.4581           1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.4701           1.9         0.4772         0.4778         0.4783         0.4788         0.4793         0.4744         0.4750         0.4761         0.4761           2.0         0.4772         0.4778         0.4783			0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.5         0.4332         0.4385         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4442           1.6         0.4452         0.4463         0.4474         0.4484         0.4495         0.4505         0.4515         0.4525         0.4535         0.4545           1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4625         0.4631           1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.470           1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.476           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4798         0.4803         0.4808         0.4812         0.481           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4855         0.485           2.2         0.4861         0.4864         0.4868 <t< td=""><td></td><td>0.4032</td><td>0.4049</td><td>0.4066</td><td>0.4082</td><td>0.4099</td><td>0.4115</td><td>0.4131</td><td>0.4147</td><td>0.4162</td><td>0.4177</td></t<>		0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.5         0.4332         0.4345         0.4357         0.4370         0.4382         0.4394         0.4406         0.4418         0.4429         0.4441           1.6         0.4452         0.4463         0.4474         0.4484         0.4495         0.4505         0.4515         0.4525         0.4535         0.4541           1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4625         0.4631           1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.470           1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.476           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4798         0.4803         0.4812         0.481           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4848         0.4851         0.4854         0.4852           2.2         0.4861         0.4866         0.4898         <		0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.7         0.4554         0.4564         0.4573         0.4582         0.4591         0.4599         0.4608         0.4616         0.4625         0.4631           1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.4701           1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.4762           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4798         0.4803         0.4808         0.4812         0.481           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4850         0.4854         0.4852           2.2         0.4861         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4884         0.4887         0.4885           2.3         0.4833         0.4896         0.4898         0.4901         0.4904         0.4906         0.4909         0.4911         0.4913         0.4913           2.4         0.4918         0.4920		0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.4701           1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.4762           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4798         0.4803         0.4808         0.4812         0.4812           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4854         0.4852           2.2         0.4861         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4884         0.4887         0.4892           2.3         0.4893         0.4940         0.4904         0.4906         0.4999         0.4911         0.4913         0.4913         0.4922         0.4925         0.4927         0.4929         0.4931         0.4932         0.4934         0.4945         0.4946         0.4948         0.4949         0.4931         0.4931         0.4932         0.4934         0.4932         0.4946         0.4948         0.	1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.8         0.4641         0.4649         0.4656         0.4664         0.4671         0.4678         0.4686         0.4693         0.4699         0.470           1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.476           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4893         0.4808         0.4812         0.481           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4850         0.4851         0.4878         0.4878         0.4846         0.4850         0.4851         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4844         0.4887         0.4889           2.3         0.4893         0.4920         0.4922         0.4925         0.4927         0.4929         0.4931         0.4931         0.4931         0.4931         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.4952           2.6         0.4953         0.4966         0.4967         0.4968         0.4969         0.497	1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.9         0.4713         0.4719         0.4726         0.4732         0.4738         0.4744         0.4750         0.4756         0.4761         0.4762           2.0         0.4772         0.4778         0.4783         0.4788         0.4793         0.4798         0.4803         0.4808         0.4812         0.4812           2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4850         0.4854         0.4851           2.2         0.4861         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4884         0.4887         0.4893           2.3         0.4893         0.4896         0.4898         0.4901         0.4904         0.4906         0.4909         0.4911         0.4913         0.4923         0.4934         0.4934         0.4933         0.4934		0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
2.1         0.4821         0.4826         0.4830         0.4834         0.4838         0.4842         0.4846         0.4850         0.4854         0.4852           2.2         0.4861         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4884         0.4887         0.489           2.3         0.4893         0.4896         0.4898         0.4901         0.4904         0.4906         0.4909         0.4911         0.4913         0.4912           2.4         0.4918         0.4920         0.4922         0.4925         0.4927         0.4929         0.4931         0.4932         0.4934         0.4932           2.5         0.4938         0.4940         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.4952           2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.4962           2.7         0.4965         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.4973         0.4973         0.4977         0.4977         0.4977         0.4977		0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.2         0.4861         0.4864         0.4868         0.4871         0.4875         0.4878         0.4881         0.4884         0.4887         0.4897           2.3         0.4893         0.4896         0.4898         0.4901         0.4904         0.4906         0.4909         0.4911         0.4913         0.4912           2.4         0.4918         0.4920         0.4922         0.4925         0.4927         0.4929         0.4931         0.4932         0.4934         0.493           2.5         0.4938         0.4940         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.4952           2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.4962           2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.4973         0.4973         0.4974         0.4975         0.4982         0.4983         0.4984         0.4984         0.4985         0.4985         0.4986         0.4988           3.0         0.4987         0.4987         0.4988	2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808		0.4817
2.3         0.4893         0.4896         0.4898         0.4901         0.4904         0.4906         0.4909         0.4911         0.4913         0.491           2.4         0.4918         0.4920         0.4922         0.4925         0.4927         0.4929         0.4931         0.4932         0.4934         0.493           2.5         0.4938         0.4940         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.495           2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.4962           2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.4973           2.8         0.4974         0.4975         0.4966         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4983           2.9         0.4981         0.4982         0.4982         0.4983         0.4988         0.4984         0.4985         0.4985         0.4986         0.498           3.0         0.4987         0.4987 <t< td=""><td>2.1</td><td>0.4821</td><td>0.4826</td><td>0.4830</td><td>0.4834</td><td>0.4838</td><td>0.4842</td><td>0.4846</td><td>0.4850</td><td>0.4854</td><td>0.4857</td></t<>	2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.4         0.4918         0.4920         0.4922         0.4925         0.4927         0.4929         0.4931         0.4932         0.4934         0.493           2.5         0.4938         0.4940         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.4955           2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.4963           2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.4973           2.8         0.4974         0.4975         0.4976         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4980           2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4985         0.4985         0.4986         0.498           3.0         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4989         0.4999         0.4993         0.4993           3.1         0.4993         0.4993         0.4994	2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.5         0.4938         0.4940         0.4941         0.4943         0.4945         0.4946         0.4948         0.4949         0.4951         0.4952           2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.4966           2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.497           2.8         0.4974         0.4975         0.4976         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4981           2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4984         0.4985         0.4985         0.4986         0.498           3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4990         0.4993         0.4991         0.4991         0.4991         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4993         0.4993         0.4993         0.4993         0.4994         0.49	2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.6         0.4953         0.4955         0.4956         0.4957         0.4959         0.4960         0.4961         0.4962         0.4963         0.496           2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.497           2.8         0.4974         0.4975         0.4976         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4980           2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4985         0.4985         0.4986         0.4988           3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4990         0.4990           3.1         0.4990         0.4991         0.4991         0.4991         0.4991         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4993         0.4995         0.4993         0.4994         0.4994         0.4994         0.4995         0.4995         0.4995         0.4996         0.49	2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.7         0.4965         0.4966         0.4967         0.4968         0.4969         0.4970         0.4971         0.4972         0.4973         0.497           2.8         0.4974         0.4975         0.4976         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4980           2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4984         0.4985         0.4985         0.4986         0.4986           3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4999         0.4990         0.4991         0.4991         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4993         0.4993         0.4993         0.4993         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997	2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.8         0.4974         0.4975         0.4976         0.4977         0.4977         0.4978         0.4979         0.4979         0.4980         0.4988           2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4984         0.4985         0.4985         0.4986         0.4988           3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4989         0.4999         0.4990         0.4990         0.4991         0.4991         0.4991         0.4992         0.4993         0.4993         0.4993         0.4993         0.4993         0.4993         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.	2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.9         0.4981         0.4982         0.4982         0.4983         0.4984         0.4984         0.4985         0.4985         0.4986         0.4988           3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4989         0.4990         0.4990         0.4991         0.4991         0.4991         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4993         0.4993         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4995         0.4995         0.4995         0.4995         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4996         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4998         0.4998         0.4998         0.4998         0.4998         0.4998         0.4999         0.4999         0.4999         0.4999         0.4999         0.4999         0.4999         0.4999	2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971			0.4974
3.0         0.4987         0.4987         0.4987         0.4988         0.4988         0.4989         0.4989         0.4989         0.4989         0.4990         0.4990         0.4991         0.4991         0.4991         0.4992         0.4993         0.4993         0.4993         0.4993         0.4993         0.4993         0.4993         0.4993         0.4994         0.4995         0.4997         0.4997         0.4997 <td>2.8</td> <td>0.4974</td> <td>0.4975</td> <td>0.4976</td> <td>0.4977</td> <td></td> <td></td> <td></td> <td>A STATE OF THE STA</td> <td></td> <td>0.4981</td>	2.8	0.4974	0.4975	0.4976	0.4977				A STATE OF THE STA		0.4981
3.1         0.4990         0.4991         0.4991         0.4991         0.4992         0.4992         0.4992         0.4992         0.4992         0.4992         0.4993         0.4993         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4994         0.4995         0.4995         0.4995         0.4996         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4997         0.4998         0.4998         0.4998         0.4998         0.4998         0.4999         0.4999         0.4999         0.4999         0.4999         0.4999 <td>2.9</td> <td>0.4981</td> <td>0.4982</td> <td>0.4982</td> <td>0.4983</td> <td></td> <td></td> <td>10.00</td> <td></td> <td></td> <td>0.4986</td>	2.9	0.4981	0.4982	0.4982	0.4983			10.00			0.4986
3.2       0.4993       0.4993       0.4994       0.4994       0.4994       0.4994       0.4994       0.4995       0.4995       0.4995         3.3       0.4995       0.4995       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4996       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4999	3.0	0.4987	0.4987	0.4987							0.4990
3.3       0.4995       0.4995       0.4995       0.4996       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4997       0.4999       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4998       0.4999	3.1	0.4990	0.4991	0.4991	0.4991		0.4992				0.4993
3.4     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4997     0.4999     0.4999     0.4999     0.4999     0.4998     0.4998     0.4998     0.4998     0.4998     0.4999	3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	100000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		0.4995
3.5     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4998     0.4999	3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996				0.4997
3.6     0.4998     0.4998     0.4999	3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997		0.4997		0.4998
3.7	3.5	0.4998	0.4998	0.4998	0.4998	0.4998					0.4998
3.8 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999 0.4999	3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999		0.4999		0.4999
3.0 0.000 0.000 0.000 0.000 0.000 0.000	3.7	0.4999	0.4999	0.4999	0.4999	0.4999					0.4999
3.9 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000 0.5000	3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999				0.4999
"	3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

This table is referenced in the following topics:

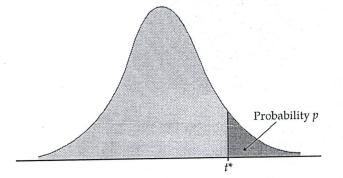


Table entry for p and C is the critical value  $t^*$  with probability p lying to its right and probability C lying between  $-t^*$  and  $t^*$ .

T	ibution critical values Upper-tail probability $p$												
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005	
	.20					12.71	15.00	31.82	63.66	127.3	318.3	636.6	
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89 4.849	6.965	9.925	14.09	22.33	31.60	
2	0.816	1.061	1.386	1.886	2.920	4.303		4.541	5.841	7.453	10.21	12.92	
3	0.765	0.978	1.250	1.638	2.353	3.182	3.482	3.747	4.604	5.598	7.173	8.610	
4	0.741	0.941	1.190	1.533	2.132	2.776	2.999	3.365	4.032	4.773	5.893	6.869	
5	0.727	0.920	1.156	1.476	2.015	2.571	2.757	3.143	3.707	4.317	5.208	5.959	
6	0.718	0.906	1.134	1.440	1.943	2,447	2.612			4.029	4.785	5.408	
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499 3.355	3.833	4.501	5.04	
8	0.706	0.889	1.108	1.397	1.860	2.306	2.449	2.896		3.690	4.297	4.78	
9	0.703	0.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.581	4.144	4.58	
10	0.700	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.497	4.025	4.43	
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.428	3.930	4.31	
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055		3.852	4.22	
13	0.694	0.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.787	4.14	
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.733	4.07	
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286		4.01	
16	0.690	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	3.96	
17	0.689	0.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3,222	3.646	3.92	
18	0.688	0.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611		
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.88	
20	0.687	0.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.85 3.81	
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.79	
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505		
23	0.685	0.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.76	
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.74	
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.72	
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3,435	3.70	
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.69	
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.67	
29	0.683	0.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.65	
30	0.683	0.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.64	
40	0.681	0.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.55	
50	0.679	0.849	. 1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.49	
60	0.679	0.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.46	
80	0.678	0.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.4	
100	0.677	0.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.39	
1000	0.675	0.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.30	
z*	0.674	0.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.29	
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9	