L-2/T-2/URP **Date : 15/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2015-2016

Sub : **PLAN 215** (Urban Planning Techniques)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What do you understand by the term 'Transit Oriented Development'? How do neotraditional neighborhood concepts differ from traditional neighborhoods in terms of various parameters? **(5+10=15)**

   (b) Briefly discuss the laws and policies to conserve and manage flood zones of Dhaka Metropolitan Area. **(10)**

   (c) Explain the term "Urban Growth Boundary". Show the hierarchy of Land Classification categories with a neat diagram. **(3+7=10)**

2. (a) What are the locational principles for open space? Discuss the recommended order of categories of landuse for urban landuse design. **(4+8=12)**

   (b) What do you understand by the term "imageability of a city"? In case of Dhaka, which elements of the city give you a sense imageability? Discuss with relevant examples. **(4+10=14)**

   (c) "The landuse design and development management plan should be mutually supportive" — Do you agree? Explain in favor of your opinion. **(9)**

3. (a) Four perspectives are considered for landuse information - briefly discuss these perspectives. **(23)**

   (b) Which pattern of development is usually found in the periphery of urban areas? Discuss the characteristics of such development. **(4+8=12)**

4. (a) What is 'sustainable development'? What are the three principles inherent to sustainable development? **(3+12=15)**

   (b) Define 'Biocapacity' and 'Ecological Overshoot'. How can ecological footprint measure guide policy makers while planning for a city? **(8+6=14)**

   (c) Give example of two strategies that could be adopted to conserve historic buildings of Dhaka by upholding the interests of the private owners of those buildings. **(6)**

Contd P/2

PLAN 215

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What are the objectives of preparing master plan for a city? **(6)**

(b) Briefly explain the process to be followed by any developing authority to prepare a development plan for its jurisdiction area. **(20)**

(c) Write down the categories of local plan with appropriate examples. **(9)**

6. (a) Differentiate between: **(7×2=14)**

(i) Site and services scheme and land readjustment technique.

(ii) Settlement upgrading and guided land development.

(b) Define land sharing. Which characteristics make any area suitable for land sharing projects? **(9)**

(c) Discuss how taxation policy can reduce the problems relating to land market and housing supply. **(12)**

7. (a) Describe the key elements of land readjustment technique. **(6)**

(b) Define urban renewal. Discuss the issues those create the necessity of urban renewal in the context of a particular area in Dhaka city. **(12)**

(c) Describe the systematic process of applying land readjustment technique to a fringe area of Dhaka city. **(17)**

8. (a) Explain the key components of site and services scheme adopted under Dhaka Urban Infrastructure Improvement Program. Give your opinion regarding the success of this program. **(10+10=20)**

(b) Discuss the urban renewal strategies which played an effective role in the revival of many city centres all over the world. **(15)**

L-2/T-2/URP **Date : 21/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2015-2016

Sub : **PLAN 261** (GIS and Remote Sensing)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

The abbreviations and terms have their usual meanings.

1. (a) Briefly explain the applications of remote sensing techniques in urban and regional planning. **(7)**

   (b) Differentiate between: **(7×3=21)**

   (i) Active sensor and passive sensor

   (ii) Across track scanner and along track scanner

   (iii) Polar satellite and geo-stationary satellite.

   (c) Draw a diagram illustrating the key elements of remote sensing technique. **(7)**

2. (a) What do you understand by "false color" and "natural-like" band composite? What information can be extracted from LANDSAT7 satellite images using these two band compositions? **(10)**

   (b) Describe different sensor parameters used to enhance the quality of satellite images. **(12)**

   (c) You will conduct a study on spatio-temporal changes in vegetation cover for a particular area of 2000 sq. km. In this purpose, you are required to collect satellite images of year 1985 and 2005. What type of satellite images would you choose for such analysis and why? **(13)**

3. (a) Define radiometric and geometric error. Explain how different techniques can eliminate radiometric error. **(6+7=13)**

   (b) Briefly discuss the categories of contrast stretching with necessary illustrations. **(12)**

   (c) Explain the concept of Principal Component Analysis (PCA) and explain why it is useful in remote sensing. **(10)**

4. (a) Draw a diagram illustrating the stages of supervised classification. Explain any two mathematical approaches used for classifying spectral patterns into categories. **(7+8=15)**

   (b) The following table provides an error matrix resulting from a supervised image classification. **(10+5+5=20)**

   (i) Estimate the user, producer and overall accuracy for the classification.

   (ii) Estimate the K_{hat} statistics for the classification.

   (iii) Interpret your result comparing the K_{hat} statistics and overall accuracy.

Contd P/2

PLAN 261

Contd... Q. No. 4(b)

	Built-up	Agricultural	Forest	Vegetation	Barren Land	Water Body
Built-up	1971	19	1	8	0	1
Agricultural	16	1940	2	23	9	10
Forest	8	3	1891	87	0	11
Vegetation	2	25	159	1786	16	12
Barren Land	0	24	4	8	1958	6
Water Body	11	12	29	11	11	1926

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define topology. State the basic rules of topology. Write down the applications of topology in GIS with examples. **(2+3+3=8)**

   (b) Compare the advantages and disadvantages of vector and raster data. **(12)**

   (c) What are the basic elements of raster data model? **(10)**

   (d) What do you understand by spatial interpolation? Name different types of spatial interpolation techniques. **(5)**

6. (a) Why it is important to define datum in GIS. Differentiate between global and local datum. **(2+8=10)**

   (b) Explain how a zone is defined in UTM projection system. What are the parameters those need to be specified while defining UTM projection system in GIS. **(15)**

   (c) What do you understand by geometric transformation of vector data? Compare among different geometric transformation methods. **(2+8=10)**

7. (a) Describe different methods to correct digitizing errors. **(8)**

   (b) Explain the similarity as well as the difference between join and relate operations for attribute data. **(5)**

   (c) State some applications of buffer analysis in planning with practical examples. **(6)**

   (d) Explain different types of map overlay techniques with diagram. How overlay operation can be applied for land suitability analysis. **(16)**

8. (a) What is Nearest Neighbor Analysis? How can you interpret the result of Nearest Neighbor Analysis? State some of its possible applications in planning. **(2+3+3=8)**

   (b) How local raster operations can be used for spatial and temporal analysis in planning? Explain with proper examples. **(10)**

   (c) Write down the applications of zonal operation. Explain the process with an example. **(3+6=9)**

   (d) What do you understand by DEM and TIN? Compare between DEM and TIN for terrain modeling. **(4+4=8)**

L-2/T-2/URP **Date : 30/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B.URP. Examinations 2015-2016

Sub : **ARCH 233** (Landscape Planning and Design)

Full Marks: 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Define Landscape Planning and Design. Discuss principles of Japanese garden. **(2⅓+6=8⅓)**

   (b) Illustrate the typical features and elements of Italian garden. Differentiate between Classical and Contemporary styles of Italian garden. **(10+5=15)**

2. (a) Briefly explain landscape design considerations in the context of Tropical climate. **(13⅓)**

   (b) How the landscape in Coastal regions of Bangladesh is different from other parts of the country? Explain with appropriate example. **(10)**

3. (a) "Soil organism, in their multiplicity, join in complex food webs" — explain. **(6⅓)**

   (b) Why functional biodiversity is more important than number of species? **(8)**

   (c) How ecosystems are organized in tropic levels? Explain using Lindeman's diagram. **(9)**

4. How the followings influence organization of space? Use illustrations if necessary.**(9⅓+7+7=23⅓)**

   (a) Spatial impact

   (b) Spatial quality

   (c) The elements of containment.

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define 'Ecosystem based landscape conservation planning. **(6⅓)**

   (b) Briefly explain the critical issues for healthy natural environment of Dhaka and their landscape conservation strategies according to 'Dhaka structure plan 2016-2035'. **(17)**

6. Discuss the considerations of landscape Design process in Urban scale for Residential Environment. **(23⅓)**

7. Explore the potential and design of path in urban context using appropriate illustrations. **(23⅓)**

8. (a) Mention the information needed for site planning. **(8⅓)**

   (b) How characteristics of plants guide landscape design criteria? **(15)**

L-2/T-2/URP **Date : 25/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2015-2016

Sub : **PLAN 293** (Statistics for Planners II)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. Write short notes on the following–

   (a) Geometric trend line method of population projection. **(10)**

   (b) Residual method of forecasting migration. **(8)**

   (c) Seasonal Index. **(10)**

   (d) Relative Cyclical Residual Method. **(7)**

2. (a) Distinguish between 'standard error of estimates' and 'standard deviation'. **(10)**

   (b) Following table (Table 1) provides data on female population of an area according to age cohort. Project the number of total female children who will be going to school in the year 2025 if 50% of the total female children of age group 5-14 are considered as the school going children. Assume there is no migration and all births survive. **(25)**

Table 1

Cohort	Age Groups	Population ('000) (2010)	Death ('000) (2010-2015)	Birth ('000) (2010-2015)
1	0 – 4	1,000	100	0
2	5 – 9	1,000	100	0
3	10 –14	900	90	0
4	15 – 19	1,000	70	0
5	20 – 24	960	90	210
6	25 – 29	1,000	60	390
7	30 – 34	900	100	280
8	35 – 39	660	80	214
9	40 – 44	620	100	0
10	45 & above	2,000	850	0

3. The following table (Table 2) presents experience and salary structure of Planners in different Development Agencies in 2014-2015. The variables are–

   y = salary (thousands of Taka)

   x = years of experience

Contd P/2

PLAN 293

Contd... Q. No. 3

Table 2

y	x	y	x	y	x	y	x
63.0	43	44.5	22	45.0	18	51.3	12
54.3	32	43.0	21	50.7	17	50.3	12
51.0	32	46.8	20	37.5	17	62.4	10
39.0	30	42.4	20	61.0	16	39.3	10
52.0	26	56.5	19	48.1	16	43.2	9
55.0	25	55.0	19	30.0	16	40.4	7
41.2	23	53.0	19	51.5	15	37.7	6
47.7	22	55.0	18	40.6	13	27.7	3

(a) Calculate a regression of y on x. **(12)**

$$y = \alpha + \beta x + u$$

(b) Construct a 95% confidence interval for β. **(8)**

(c) Calculate the error 'u' to see whether the mean of the error is zero. **(12+3=15)**

4. A City Transport Authority (CTA) is interested in changing old type of taxi to a newer type because the Authority argues that the newer type gives evidence of being more economical. Because passenger carried for the past few weeks are readily available, the CTA has decided to compare the weekly passenger carried by the old and new taxis. Table 3 shows the records. Can the Authority conclude at a significance level of 0.10 that the change in type of taxis has reduced the number of passengers? **(35)**

Table 3

Old taxis		New taxis	
99	96	96	95
94	88	105	90
93	97	91	93
102	94	85	
89	87	79	
98	101	91	
101	89	87	
125		90	

Contd P/3

PLAN 293

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Starting salary of planning graduates in a city are assumed to be the same as the starting salary of Architects working in that city. A random sample of 41 planning graduates from the city produced a mean salary of Tk. 20,500/- per month and a standard deviation of Tk. 400/-. A random sample of 33 Architects from the city produced a mean salary of Tk. 20,300/- and a standard deviation of Tk. 360/-.

(i) State the null and alternate hypotheses **(2)**

(ii) What is the decision rule at 5% level of significance **(5)**

(iii) Calculate the test statistic **(8)**

(iv) Make a decision regarding the null and alternate hypotheses. **(2½)**

(b) Mr. Karim is the Chief Executive of a Water Utility of a city. He is interested in the percentage of water users who are totally satisfied with the performance of the Water Utility in the current year. In the previous year 86 percent of the water users were totally satisfied. Mr. Karim feels that the same is true in the current year. He sampled 187 water users and found 157 were totally satisfied. At the 1 percent significance level, is there evidence that what Mr. Karim felt is valid?

(i) State the null and alternate hypotheses **(2)**

(ii) What is the decision rule **(5)**

(iii) Calculate the test statistic **(8)**

(iv) Make a decision regarding the null and alternate hypotheses. **(2½)**

6. The following table shows the number of apartments of same size and quality sold by a real estate company in four years in three different locations of Dhaka city.

Location-A	Location-B	Location-C
20	12	25
15	18	28
24	10	30
18	15	32

A planner wants to know whether there is variation among the locations in terms of the average number of apartments sold.

(i) State the null and alternate hypotheses **(5)**

(ii) Calculate the SST, SSE and SS_{total} **(15)**

(iii) Develop an ANOVA table **(10)**

(iv) At the 0.05 significance level, is there a difference in the mean number of apartments sold in three locations? **(5)**

Contd P/4

PLAN 293

7. A newspaper publisher wanted to know whether newspaper readership in a community is independent of reader's educational achievement. A survey was carried out in the community on the adults for information on their level of education and their frequency of readership. The results are shown in the following table:

	Level of Education			
Frequency of Readership	Master's Degree	Bachelor's Degree	HSC and Lower	Total
Never	10	17	32	59
Sometimes	12	23	23	58
Once in a week	35	38	19	92
Everyday	28	19	13	60
Total	85	97	87	269

(i) State the null and alternate hypotheses **(5)**

(ii) Formulate the decision rule for $\alpha = 0.05$ **(5)**

(iii) Calculate the test statistic **(20)**

(iv) Does the frequency of newspaper readership in the community differ according to the reader's level of education?

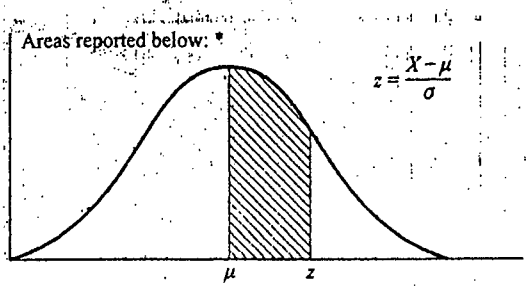
8. A planner was assigned with the task of preparing a redevelopment plan of an old neighbourhood. To prepare his plan he asked the residents to mention their priorities (upto fifth priority) of upgrading against 5 components. The responses were as shown in Table below:

Priority	Frequency of responses against the components of the upgrading for				
	Housing	Water Supply	Gas Supply	Road	Drainage
1	84	113	136	62	09
2	55	64	140	53	45
3	83	30	104	81	86
4	113	23	22	79	112
5	88	63	10	94	116
0	77	207	88	131	132
total	500	500	500	500	500

(i) Construct a suitable scale and specify the computational formula **(10)**

(ii) Calculate the priority indexes against each of the components **(20)**

(iii) Interpret the results. **(5)**



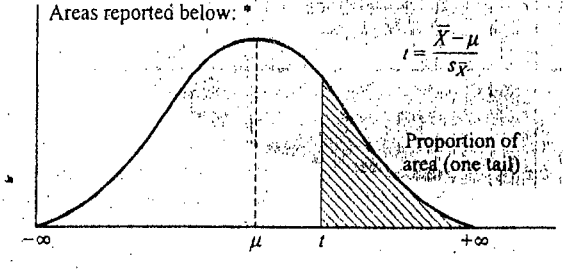
Proportions of Area for the Standard Normal Distribution

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	.2518	.2549
0.7	.2580	.2612	.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	.4014
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	.4983	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987									
3.5	.4997									
4.0	.4999									

*Example: For $z = 1.96$, shaded area is 0.4750 out of the total area of 1.0000.

APPENDIX 5

Student's *t* Distribution



Proportions of Area for the *t* Distributions

df	*0.10*	*0.05*	*0.025*	*0.01*	*0.005*
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
40	1.303	1.684	2.021	2.423	2.704
60	1.296	1.671	2.000	2.390	2.660
120	1.289	1.658	1.980	2.358	2.617
∞	1.282	1.645	1.960	2.326	2.576

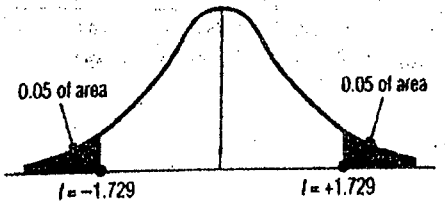
Example: For the shaded area to represent 0.05 of the total area of 1.0, value of t with 10 degrees of freedom is 1.812

Source: Table III of Fisher and Yates, *Statistical Tables for Biological, Agricultural and Medical Research*, 6th ed., 1974, published by Longman Group Ltd., London (previously published by Oliver & Boyd, Edinburgh), by permission of the authors and publishers.

DISTRIBUTION OF χ^2

Degrees of Freedom	Probability						
	.50.	.30.	.20.	.10.	.05.	.02.	.01.
1	.455	1.074	1.642	2.706	3.841	5.412	6.635
2	1.386	2.408	3.219	4.605	5.991	7.824	9.210
3	2.366	3.665	4.642	6.251	7.815	9.837	11.345
4	3.357	4.878	5.989	7.779	9.488	11.668	13.277
5	4.351	6.064	7.289	9.236	11.070	13.388	15.086
6	5.348	7.231	8.558	10.645	12.592	15.033	16.812
7	6.346	8.383	9.803	12.017	14.067	16.622	18.475
8	7.344	9.524	11.030	13.362	15.507	18.168	20.090
9	8.343	10.656	12.242	14.684	16.919	19.679	21.666
10	9.342	11.781	13.442	15.987	18.307	21.161	23.209
11	10.341	12.899	14.631	17.275	19.675	22.618	24.725
12	11.340	14.011	15.812	18.549	21.026	24.054	26.217
13	12.340	15.119	16.985	19.812	22.362	25.472	27.688
14	13.339	16.222	18.151	21.064	23.685	26.873	29.141
15	14.339	17.322	19.311	22.307	24.996	28.259	30.578
16	15.338	18.418	20.465	23.542	26.296	29.633	32.000
17	16.338	19.511	21.615	24.769	27.587	30.995	33.409
18	17.338	20.601	22.760	25.989	28.869	33.346	34.805
19	18.338	21.689	23.900	27.204	30.144	33.687	36.191
20	19.337	22.775	25.038	28.412	31.410	35.020	37.566
21	20.337	23.858	26.171	29.615	32.671	36.343	38.932
22	21.337	24.939	27.301	30.813	33.924	37.659	40.289
23	22.337	26.018	28.429	32.007	35.172	38.968	41.638
24	23.337	27.096	29.553	33.196	36.415	40.270	42.980
25	24.337	28.172	30.675	34.382	37.652	41.566	44.314
26	25.336	29.246	31.795	35.563	38.885	42.856	45.642
27	26.336	30.319	32.912	36.741	40.113	44.140	46.963
28	27.336	31.391	34.027	37.916	41.337	45.419	48.278
29	28.336	32.461	35.139	39.087	42.557	46.693	49.588
30	29.336	33.530	36.250	40.256	43.773	47.962	50.892

Appendix L is abridged from Table IV of Fisher and Yates: *Statistical Tables for Biological, Agricultural, and Medical Research*, published by Oliver and Boyd Ltd., Edinburgh, and by permission of the authors and publishers.



Appendix Table 2

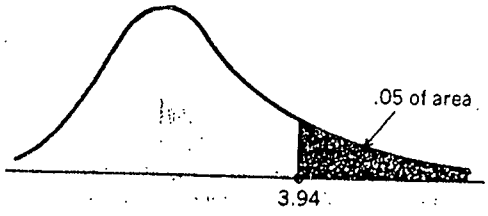
Areas in Both Tails Combined for Student's *t* Distribution

Example: To find the value of *t* that corresponds to an area of 0.10 in both tails of the distribution combined, when there are 19 degrees of freedom, look under the 0.10 column, and proceed down to the 19 degrees of freedom row; the appropriate *t* value there is 1.729.

Degrees of Freedom	Area in Both Tails Combined			
	0.10	0.05	0.02	0.01
1	6.314	12.706	31.821	63.657
2	2.920	4.303	6.965	9.925
3	2.353	3.182	4.541	5.841
4	2.132	2.776	3.747	4.604
5	2.015	2.571	3.365	4.032
6	1.943	2.447	3.143	3.707
7	1.895	2.365	2.998	3.499
8	1.860	2.306	2.896	3.355
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	3.169
11	1.796	2.201	2.718	3.106
12	1.782	2.179	2.681	3.055
13	1.771	2.160	2.650	3.012
14	1.761	2.145	2.624	2.977
15	1.753	2.131	2.602	2.947
16	1.746	2.120	2.583	2.921
17	1.740	2.110	2.567	2.898
18	1.734	2.101	2.552	2.878
19	1.729	2.093	2.539	2.861
20	1.725	2.086	2.528	2.845
21	1.721	2.080	2.518	2.831
22	1.717	2.074	2.508	2.819
23	1.714	2.069	2.500	2.807
24	1.711	2.064	2.492	2.797
25	1.708	2.060	2.485	2.787
26	1.706	2.056	2.479	2.779
27	1.703	2.052	2.473	2.771
28	1.701	2.048	2.467	2.763
29	1.699	2.045	2.462	2.756
30	1.697	2.042	2.457	2.750
40	1.684	2.021	2.423	2.704
60	1.671	2.000	2.390	2.660
120	1.658	1.980	2.358	2.617
Normal Distribution	1.645	1.960	2.326	2.576

APPENDIX TABLE 6

Values of F for F Distributions with .05 of the Area in the Right Tail.*



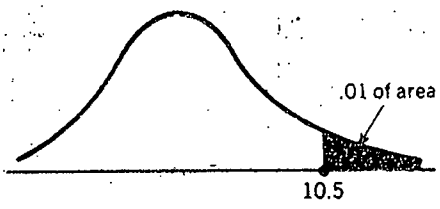
EXAMPLE: For a test at a significance level of .05 where we have 15 degrees of freedom for the numerator and 6 degrees of freedom for the denominator, the appropriate F value is found by looking under the 15 degrees of freedom column and proceeding down to the 6 degrees of freedom row; there we find the appropriate F value to be 3.94.

Degrees of freedom for denominator	Degrees of freedom for numerator																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253	254
2	18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5	19.5
3	10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

* Source: M. Merrington and C. M. Thompson, *Biometrika*, vol. 33 (1943).

=10=

Values of F for F Distributions with .01 of the Area in the Right Tail.



EXAMPLE: For a test at a significance level of .01 where we have 7 degrees of freedom for the numerator and 5 degrees of freedom for the denominator, the appropriate F value is found by looking under the 7 degrees of freedom column and proceeding down to the 5 degrees of freedom row; there we find the appropriate F value to be 10.5.

Degrees of freedom for numerator

	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	4,052	5,000	5,403	5,625	5,764	5,859	5,928	5,982	6,023	6,056	6,106	6,157	6,209	6,235	6,261	6,287	6,313	6,339	6,366
2	98.5	99.0	99.2	99.2	99.3	99.3	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.5	99.5	99.5	99.5	99.5	99.5
3	34.1	30.8	29.5	28.7	28.2	27.9	27.7	27.5	27.3	27.2	27.1	26.9	26.7	26.6	26.5	26.4	26.3	26.2	26.1
4	21.2	18.0	16.7	16.0	15.5	15.2	15.0	14.8	14.7	14.5	14.4	14.2	14.0	13.9	13.8	13.7	13.7	13.6	13.5
5	16.3	13.3	12.1	11.4	11.0	10.7	10.5	10.3	10.2	10.1	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02
6	13.7	10.9	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88
7	12.2	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65
8	11.3	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86
9	10.6	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31
10	10.0	7.56	6.55	6.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.69	3.60
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.45	3.36
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.66	3.59	3.51	3.43	3.34	3.25	3.17
14	8.86	6.51	5.56	5.04	4.70	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.18	3.09	3.00
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.96	2.87
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.93	2.84	2.75
17	8.40	6.11	5.19	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.83	2.75	2.65
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57
19	8.19	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.58	2.49
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.69	2.61	2.52	2.42
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21
25	7.77	5.57	4.68	4.18	3.86	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.53	2.45	2.36	2.27	2.17
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.80
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.38
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00