L-2/T-2/URP **Date: 30/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2021-2022

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** Questions.

1. (a) "Land use planning considers the needs of the natural system, the human activity system, and the market or economic system." Explain the statement with an example. **(10)**

   (b) Compare "site and service scheme" and "slum upgrading" in terms of their merits and demerits. **(20)**

   (c) Why enhancing the productivity of the urban poor is important for successful slum upgrading? Explain. **(5)**

2. (a) Discuss the situation of land use classification in Bangladesh in light of the principles of a standard land use classification system with appropriate examples. **(23)**

   (b) Appraise the need for urban renewal in Dhaka city with appropriate examples. **(12)**

3. (a) Suppose that any city development authority asks your opinion as an urban planner on the possibility of implementing a land-sharing project on a particular site. Explain how you will decide on it. **(17)**

   (b) Fundamental to the success of a Transfer of Development Rights (TDR) program is that there has to be sufficient demand for the TDR credits generated. Illustrate how can the authority modify this demand? **(18)**

4. (a) Analyze the role of "land readjustment technique" as a tool to solve the problems of the spontaneous and haphazard growth of informal settlements in urban areas. **(15)**

   (b) Demonstrate how taxation can help to achieve the desirable land use zoning in an area. **(10)**

   (c) Interpret the challenges behind the successful implementation of Transfer of Development Rights (TDR) in the context of Dhaka. **(10)**

Contd P/2

PLAN 215/URP

SECTION – B

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

5. (a) Land use design process is a highly analytical and creative task -explain with example. **(8)**

(b) Formulate a list of tasks those are needed to be undertaken to achieve the targets of SDG 11 for Bangladesh. **(17)**

(c) The form of cities-their densities, sizes, building forms, configurations and layouts - can contribute to their sustainability - elaborate this statement. **(10)**

6. (a) Critically discuss the urbanization trend in Asia from the following perspectives. **(2×6=12)**

i) Demographic and spatial impacts of urbanization

ii) Urban environment.

(b) Analyze the contemporary urbanization trend in Bangladesh and associated consequences. **(16)**

(c) Discuss the recommended order of land uses to be followed for land use design process. **(7)**

7. (a) Suppose you are assigned to prepare a land use plan for residential use for a paurasava. Briefly discuss the steps you would follow to perform the following tasks: **(2×7=14)**

i) Formulating locational requirement

ii) Deriving space requirement for residential areas.

(b) Briefly discuss the social and ecological impacts of sprawl development. **(14)**

(c) Write a short note on primacy of Dhaka. **(7)**

8. (a) Illustrate the contrast of urbanization trend in 'developed' and 'developing' countries. **(8)**

(b) Compare the characteristics of plot based and block based development. **(15)**

(c) Many cities have adopted incentive programs to encourage smart growth, briefly discuss four such examples. **(3×4=12)**

L-2/T-2/URP **Date: 3/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2021-2022

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** Questions.

1. (a) Explain the main characteristics of geographic information system. **(10)**

   (b) Demonstrate why different types of ellipsoids are used in GIS. **(05)**

   (c) Appraise the importance of metadata in GIS. **(05)**

   (d) Compare the applications of different types of overlay techniques in land use planning. **(15)**

2. (a) Describe the use of integer raster and floating-point raster data in urban planning. **(08)**

   (b) Interpret the importance of local datum in preparing a GIS database. **(07)**

   (c) Differentiate between locational error and topological error in a vector data. **(10)**

   (d) Suppose you want to identify the spatial pattern of Dengue outbreak in Dhaka. To continue this task, you have to hypothesize the spatial relationship within data. Deduce which technique you may adopt for conceptualization. **(10)**

3. (a) Suppose you have to prepare a land cover map of an area. Which data model would you prefer? Discuss the advantages of your selected data model. **(12)**

   (b) Prepare a list of components to express a geographic coordinate system. **(05)**

   (c) Compare the techniques available for simplifying the line features of vector data. **(08)**

   (d) Differentiate between the applications of average nearest neighborhood technique and spatial autocorrelation in pattern analysis. **(10)**

4. (a) Suppose you are working in a development project of Cox's Bazar district. Illustrate which projection system would you choose for your study area. **(12)**

   (b) Identify the disadvantages of using a shapetile as vector data model. **(05)**

   (c) detect the common applications of spatial joining in analyzing a land use database. **(08)**

   (d) Differentiate between DEM and TIN. **(10)**

Contd P/2

PLAN 261

SECTION – B

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

Terms and abbreviations have their usual meanings.

5. Elon Mask declared to send man to the Mars by the end of next decade. Mapping of Mars is needed to identify suitable site for man-landing. In this regard, he is looking for personnel who could do mapping of the Mars. You are invited for interview and they ask you the following questions.

(a) Describe the advantages Mars have over Earth in terms of remote sensing system considering Mars have little or no atmosphere. **(05)**

(b) Describe also the advantages Earth posses over Mars considering Mars is located around 16 light-meter away from Earth. **(05)**

(c) The following table (Table -1) provides the spectral reflectance ratio of two objects, X and Y that are abundantly found in the Mars.

i) Draw the spectral signatures of the objects. **(08)**

ii) Explain the band(s) which would be suitable to identify and differentiate X and Y. **(07)**

Table : Spectral Ratio of X & Y

Wave length →	0.3 µm - 0.5 µm	0.5 µm - 0.7 µm	0.7 µm - 0.9 µm	0.9 µm - 1.1 µm	1.1 µm - 1.3 µm	1.3 µm - 1.5 µm	1.5 µm – 1.7 µm	1.7 µm – 1.9 µm	1.9 µm – 2.1 µm	2.1 µm - 2.3 µm	2.3 µm - 2.5 µm
X	28	40	45	70	75	20	17	30	55	65	28
Y	32	36	79	77	81	22	34	35	38	36	32

(d) Your task would be to deliniate the coast from the sea of the Mars, using Remotely Sensed Image. Which technique you would consider? Describe and defend your answer. **(2+4+4=10)**

6. Forest department is planning to undertake a mapping project. You are working in the team who are designing the project.

(a) One of the objectives of the project is to determine the deforestation trend over the last fifty years in Bangladesh. Describe the criteria you would use to determine the satellite that to be used. And based on the criteria which satellite you would choose? **(18+3=21)**

Contd P/3

PLAN 261

Contd... Q. No. 6

(b) The project also aims to identify areas for reforestation in earstwhile Chunti mangrove forest (An area around 50 square kilometer in Cox'sbazar coast). Would you use the same satellite mentioned in question 6(a) or choose a different satellite. Prepare your arguments on the choice. **(09)**

(c) Should you use any panchromatic image in any of the tasks mentioned in question 6(a) and 6(b)? Discuss your arguments. **(5)**

7. You are working in a masterplan project as remote sensing expert.

(a) The project bought image with geometric error. How you would solve the error using GCP? **(09)**

(b) You found that you have to conduct contrast manipulation for image classification and interpretation. Examine the different types of contrast manipulation you could conduct. **(10)**

(c) Analyze with example how you can visually interpret the remotely sensed image using different elements. **(16)**

8. (a) Discuss why there is a need for 'false color imaging' in the application of remotely sensed image. **(04)**

(b) Explain the implications of different kinds of scattering on image. **(09)**

(c) Describe the advantages of using SPOT data over Landsat data in detailed area/local area planning. **(06)**

(d) One of the first tasks in supervised classification is trainning data set. Break down the sequences of steps that you have to follow for trainning data set. Report the characteristics the training data set should contain. **(12+4=16)**

L-2/T-2/URP **Date: 19/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2021-2022

Sub: **PLAN 293** (Statistics for Planning 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** Questions.

1. Samia noted the hours of sunshine VS the numerical of ice creams were sold at the shop from Monday to Friday.

X Hours of Sunshine	Y Ice creams Sold
3	5
4	6
6	8
8	11
9	14

(a) Calculate the best slope (m) and y-intercept (b) that suits that data. (y-mx+b) **(15)**

(b) Diagram these points and the least-square regression line in the same graph. **(10)**

(c) Calculate the trend line from the following data by semi-average method. **(10)**

Year	1989	1990	1991	1992
Production (M.Ton.)	150	152	153	151

Year	1993	1994	1995	1996
Production (M.Ton.)	154	153	156	158

2. (a) Calculate the correlation coefficient of the given data. **(25)**

x	41	42	43	44	45
y	3.2	3.3	3.4	3.5	3.6

(b) Catagorize the short-term and long-term methods of population forecasting. **(10)**

3. (a) Considering the following data, predict the population for the year 2021, 2031, and 2041 using geometrical progression method. **(20)**

Contd P/2

PLAN 293

Contd... Q. No. 3(a)

Year	Population
1961	858545
1971	1015672
1981	1201553
1991	1691538
2001	2077820
20011	2585862

(b) Shortly appraise the four components of time series. **(15)**

4. (a) Find population of 2011 by using the logistic curve method from the following table. **(15)**

Year	Population in Lakh
1971	31.78
1981	41.64
1991	55.33
2001	72.32

(b) Calculate next 10 years population by using the cohort survival projection method from the following table. **(20)**

Cohort i	Age group	Population to	Survival rate	Birth rate	Net migration
1	0-9	4900	0.979	0	5
2	10-19	4200	0.999	0.011	0
3	20-29	4400	0.998	0.081	50
4	30-39	3200	0.988	0.038	35
5	40-49	2700	0.996	0.007	10
6	50-59	1800	0.971	0	0
7	60-69	1100	0.975	0	-20
8	70-79	600	0.916	0	0
9	80+	180	0.88	0	0

Contd P/3

PLAN 293

SECTION – B

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

Six pages of statistical tables and formulas

5. (a) A city planner is investigating whether there is a significant difference in the daily commute times between residents in two different neighborhoods, Neighborhood x and Neighborhood Y. The planner collects data or the time (in minutes) it takes for residents to commute to work from each neighborhood. Here are commute time data for 10 residents from each neighborhood: **(18)**

Neighborhood X: 28, 35, 40, 32, 45, 38, 50, 48, 42, 30

Neighborhood Y: 22, 18, 25, 28, 32, 20, 24, 27, 30, 21

Use the appropriate statistical Test to analyze this data to determine if there is a statistically significant difference in commute times between the two neighborhoods at $\alpha = 0.05$.

(b) An environmental scientist is studying the impact of three different types of fertilizer on the growth of a specific plant species. They have collected data on the height (in cm) of 30 plants, with 10 plants treated with each type of Fertilizer. The data is as follows: **(17)**

Fertilizer Type A.

Plant height (cm): 30, 32, 34, 28, 31, 33, 29, 35, 32, 30

Fertilizer Type B.

Plant height (cm): 36, 37, 35, 39, 38, 40, 34, 36, 38, 35

Fertilizer Type C.

Plant height (cm): 27, 26, 25, 28, 29, 27, 26, 30, 28, 31

Develop a statistical test to determine if there is a significant difference in plant height among the three fertilizer types. Use $\alpha = 0.05$.

6. (a) A company conducted a study to investigate whether the choice of advertising platform (TV, radio, or social media) is independent of age group (youth, middle-aged, or senior citizens) when it comes to influencing purchase decisions. The following data represents the results: **(18)**

	TV	Radio	Social Media
Youth	60%	25%	15%
Middle-aged	40%	35%	25%
Senior-citizens	30%	40%	30%

Is there a significant relationship between the choice of advertising platform and age group? Compute a chi-square test of independence at a 1% level of significance.

Contd P/4

PLAN 293

Contd... Q. No. 6(b)

(b) A disaster preparedness organization expects that 40% of households need, 30% water, and 30% medical supplies during a disaster. They surveyed 200 house holds after a disaster and found that 80 needed food, 60 needed water, and 60 needed medical supplies. Use a chi-square Goodness-of-Fit test at a 0.05 significance level to determine if the distribution of needs aligns with their expectations. **(17)**

7. (a) Explain the difference between the Kruskal-wallis Test and the Mann-Whitney U-Test with appropriate examples. **(10)**

(b) Describe the Type I and Type II errors in hypothesis testing with relevant examples. **(10)**

(c) An electricity service provider wants to determine if a new energy-saving technology significantly reduce electricity consumption in a residential household, they collect the following data before and after installation from the 15 households. Develop a hypothesis test at 5% significance level to draw a conclusion. **(15)**

Household	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Before(kWh)	600	720	580	690	620	580	730	640	690	610	700	630	720	600	710
After (kWh)	550	680	530	640	590	540	700	610	650	570	670	590	690	560	670

8. (a) A regional planning agency surveyed households in Region X and Y to determine the proportion with high-speed internet access. In Region X, 280 out of 400 households have high-speed internet, while in Region Y, 330 out of 450 households have it. Examine whether there is enough evidence to suggest a significant difference in the proportions of households with high-speed internet access between two regions at a 99% confidence level. **(18)**

(b) Compare the sanitation inspection scores of 30 fast food restaurants (mean = 85, std = 6.5) with those of 30 fine dining restaurants (mean = 90, std = 5.2) to determine if there is a significant difference at a 5% significance level. **(17)**

Formulas for Answering the Questions of Section B

Standardized Test Statistics for Large Sample Hypothesis Tests Concerning a Single Population Mean

$$\text{If } \sigma \text{ is known: } Z = \frac{\bar{x} - \mu_0}{\sigma \Big/ \sqrt{n}}$$

$$\text{If } \sigma \text{ is unknown: } Z = \frac{\bar{x} - \mu_0}{s \Big/ \sqrt{n}}$$

The test statistic has the standard normal distribution.

Standardized Test Statistics for Small Sample Hypothesis Tests Concerning a Single Population Mean

$$\text{If } \sigma \text{ is known: } Z = \frac{\bar{x} - \mu_0}{\sigma \Big/ \sqrt{n}}$$

$$\text{If } \sigma \text{ is unknown: } T = \frac{\bar{x} - \mu_0}{s \Big/ \sqrt{n}}$$

The first test statistic (σ known) has the standard normal distribution.

The second test statistic (σ unknown) has Student's t-distribution with $n-1$ degrees of freedom.

The population must be normally distributed.

Standardized Test Statistic for Large Sample Hypothesis Tests Concerning a Single Population Proportion

$$Z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$$

The test statistic has the standard normal distribution.

$$\left[\hat{p} - 3\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}, \hat{p} + 3\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\right]$$

Standardized Test Statistic for Hypothesis Tests Concerning the Difference Between Two Population Means: Large, Independent Samples

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

The test statistic has the standard normal distribution.

The samples must be independent, and *each* sample must be large: $n_1 \geq 30$ and $n_2 \geq 30$.

Standardized Test Statistic for Hypothesis Tests Concerning the Difference Between Two Population Means: Small, Independent Samples

$$T = \frac{(\bar{x}_1 - \bar{x}_2) - D_0}{\sqrt{s_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad \text{where } s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}$$

The test statistic has Student's t-distribution with $df = n_1 + n_2 - 2$ degrees of freedom.

The samples must be independent, the populations must be normal, and the population standard deviations must be equal. "Small" samples means that either $n_1 < 30$ or $n_2 < 30$.

Standardized Test Statistic for Hypothesis Tests Concerning the Difference Between Two Population Means: Paired Difference Samples

$$T = \frac{\bar{d} - D_0}{s_d \Big/ \sqrt{n}}$$

where there are n pairs, $\bar{d}$ is the mean and s_d is the standard deviation of their differences.

The test statistic has Student's t-distribution with $df = n-1$ degrees of freedom.

The population of differences must be normally distributed.

Test Statistic for Testing the Independence of Two Factors

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

where the sum is over all core cells of the table.

If

1. the two study factors are independent, and
2. the observed count O of each cell in Table 11.5 "Updated General Contingency Table" is at least 5,

then χ^2 approximately follows a chi-square distribution with $df = (I-1) \times (J-1)$ degrees of freedom.

Formulas for Answering the Questions of Section B

Standardized Test Statistic for Hypothesis Tests Concerning the Difference Between Two Population Proportions

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - D_0}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}}$$

The test statistic has the standard normal distribution.

The samples must be independent, and *each* sample must be large: each of the intervals

$$\left[\hat{p}_1 - 3\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1}}, \hat{p}_1 + 3\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1}}\right]$$

and

$$\left[\hat{p}_2 - 3\sqrt{\frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}, \hat{p}_2 + 3\sqrt{\frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}\right]$$

must lie wholly within the interval $[0,1]$.

Test Statistic for Testing Goodness of Fit to a Discrete Probability Distribution

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

where the sum is over all the rows of the table (one for each value of X).

If

1. the true probability distribution of X is as assumed, and
2. the observed count O of each cell in [redacted] "Simplified Updated General Contingency Table" is at least 5,

then χ^2 approximately follows a chi-square distribution with $df = l-1$ degrees of freedom.

Test Statistic for Testing the Null Hypothesis that K Population Means Are Equal

$$F = \frac{MST}{MSE}$$

If the K populations are normally distributed with a common variance and if $H_0 : \mu_1 = \cdots = \mu_K$ is true then under independent random sampling F approximately follows an F-distribution with degrees of freedom $df_1 = K-1$ and $df_2 = n - K$.

The test is right-tailed: H_0 is rejected at level of significance α if $F \geq F_\alpha$.

The combined sample size:

$$n = n_1 + n_2 + \cdots + n_K$$

The mean of the combined sample of all n observations:

$$\overline{x} = \frac{\Sigma x}{n} = \frac{n_1\overline{x}_1 + n_2\overline{x}_2 + \cdots + n_K\overline{x}_K}{n}$$

The mean square for treatment:

$$MST = \frac{n_1(\overline{x}_1 - \overline{x})^2 + n_2(\overline{x}_2 - \overline{x})^2 + \cdots + n_K(\overline{x}_K - \overline{x})^2}{K-1}$$

The mean square for error:

$$MSE = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2 + \cdots + (n_K-1)s_K^2}{n-K}$$

K Statistic

$$K = \frac{12}{n(n+1)}\sum\frac{R_j^2}{n_j} - 3(n+1)$$

Mann-Whitney U Test

Test statistics U

$$U = \min(U_1, U_2)$$

$$U_1 = n_1n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

Expected value of U

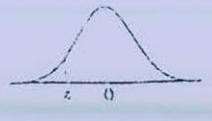
$$\mu_U = \frac{n_1 \cdot n_2}{2}$$

Standard error of U

$$\sigma_U = \sqrt{\frac{n_1 \cdot n_2 \cdot (n_1 + n_2 + 1)}{12}}$$

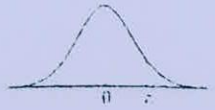
z-value

$$z = \frac{U - \mu_U}{\sigma_U}$$



Cumulative Probability $P(Z \le z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
−3.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
−3.8	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.7	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.6	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
−3.5	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641



Cumulative Probability $P(Z \le z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8304	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Critical Values of t

df	$t_{0.200}$	$t_{0.100}$	$t_{0.050}$	$t_{0.025}$	$t_{0.010}$	$t_{0.005}$	$t_{0.0025}$	$t_{0.001}$	$t_{0.0005}$
1	1.376	3.078	6.314	12.706	31.821	63.657	127.321	318.309	636.619
2	1.061	1.886	2.920	4.303	6.965	9.925	14.089	22.327	31.599
3	0.978	1.638	2.353	3.182	4.541	5.841	7.453	10.215	12.924
4	0.941	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	0.920	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	0.906	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	0.896	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	0.889	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	0.883	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	0.879	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	0.876	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	0.873	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	0.870	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	0.868	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	0.866	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	0.865	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	0.863	1.333	1.740	2.110	2.576	2.898	3.222	3.646	3.965
18	0.862	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	0.861	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	0.860	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	0.859	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	0.858	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	0.858	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.768
24	0.857	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	0.856	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	0.856	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	0.855	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	0.855	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	0.854	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	0.854	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
31	0.853	1.309	1.696	2.040	2.453	2.744	3.022	3.375	3.633
32	0.853	1.309	1.694	2.037	2.449	2.738	3.015	3.365	3.622
33	0.853	1.308	1.692	2.035	2.445	2.733	3.008	3.356	3.611
34	0.852	1.307	1.691	2.032	2.441	2.728	3.002	3.348	3.601
35	0.852	1.306	1.690	2.030	2.438	2.724	2.996	3.340	3.591
36	0.852	1.306	1.688	2.028	2.434	2.719	2.990	3.333	3.582
37	0.851	1.305	1.687	2.026	2.431	2.715	2.985	3.326	3.574
38	0.851	1.304	1.686	2.024	2.429	2.712	2.980	3.319	3.566
39	0.851	1.304	1.685	2.023	2.426	2.708	2.976	3.313	3.558
40	0.851	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
41	0.851	1.303	1.683	2.020	2.421	2.701	2.967	3.301	3.544
42	0.851	1.302	1.682	2.018	2.418	2.698	2.963	3.296	3.538
43	0.851	1.302	1.681	2.017	2.416	2.695	2.959	3.291	3.532
44	0.850	1.301	1.680	2.015	2.414	2.692	2.956	3.286	3.526
45	0.850	1.301	1.679	2.014	2.412	2.690	2.952	3.281	3.520
46	0.850	1.300	1.679	2.013	2.410	2.687	2.949	3.277	3.515
47	0.849	1.300	1.678	2.012	2.408	2.685	2.946	3.273	3.510
48	0.849	1.299	1.677	2.011	2.407	2.682	2.943	3.269	3.505
49	0.849	1.299	1.677	2.010	2.405	2.680	2.940	3.265	3.500
50	0.849	1.299	1.676	2.009	2.403	2.678	2.937	3.261	3.496

Critical Values of t

df	$t_{0.200}$	$t_{0.100}$	$t_{0.050}$	$t_{0.025}$	$t_{0.010}$	$t_{0.005}$	$t_{0.0025}$	$t_{0.001}$	$t_{0.0005}$
51	0.849	1.298	1.675	2.008	2.402	2.676	2.934	3.258	3.492
52	0.849	1.298	1.675	2.007	2.400	2.674	2.932	3.255	3.488
53	0.849	1.298	1.674	2.006	2.399	2.672	2.929	3.251	3.484
54	0.848	1.297	1.674	2.005	2.397	2.670	2.927	3.248	3.480
55	0.848	1.297	1.673	2.004	2.396	2.668	2.925	3.245	3.476
56	0.848	1.297	1.673	2.003	2.395	2.667	2.923	3.242	3.473
57	0.848	1.297	1.672	2.002	2.394	2.665	2.920	3.239	3.470
58	0.848	1.296	1.672	2.002	2.392	2.663	2.918	3.237	3.466
59	0.848	1.296	1.671	2.001	2.391	2.662	2.916	3.234	3.463
60	0.848	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
61	0.848	1.296	1.670	2.000	2.389	2.659	2.913	3.229	3.457
62	0.848	1.295	1.670	1.999	2.388	2.657	2.911	3.227	3.454
63	0.847	1.295	1.669	1.998	2.387	2.656	2.909	3.225	3.452
64	0.847	1.295	1.669	1.998	2.386	2.655	2.908	3.223	3.449
65	0.847	1.295	1.669	1.997	2.385	2.654	2.906	3.220	3.447
66	0.847	1.295	1.668	1.997	2.384	2.652	2.904	3.218	3.444
67	0.847	1.294	1.668	1.996	2.383	2.651	2.903	3.216	3.442
68	0.847	1.294	1.668	1.995	2.382	2.650	2.902	3.214	3.439
69	0.847	1.294	1.667	1.995	2.382	2.649	2.900	3.213	3.437
70	0.847	1.294	1.667	1.994	2.381	2.648	2.899	3.211	3.435
71	0.847	1.294	1.667	1.994	2.380	2.647	2.897	3.209	3.433
72	0.847	1.293	1.666	1.993	2.379	2.646	2.896	3.207	3.431
73	0.847	1.293	1.666	1.993	2.379	2.645	2.895	3.206	3.429
74	0.847	1.293	1.666	1.993	2.378	2.644	2.894	3.204	3.427
75	0.846	1.293	1.665	1.992	2.377	2.643	2.892	3.202	3.425
76	0.846	1.293	1.665	1.992	2.376	2.642	2.891	3.201	3.423
77	0.846	1.293	1.665	1.991	2.376	2.641	2.890	3.199	3.421
78	0.846	1.292	1.665	1.991	2.375	2.640	2.889	3.198	3.420
79	0.846	1.292	1.664	1.990	2.374	2.640	2.888	3.197	3.418
80	0.846	1.292	1.664	1.990	2.374	2.639	2.887	3.195	3.416
81	0.846	1.292	1.664	1.990	2.373	2.638	2.886	3.194	3.415
82	0.846	1.292	1.664	1.989	2.373	2.637	2.885	3.193	3.413
83	0.846	1.292	1.663	1.989	2.372	2.636	2.884	3.191	3.412
84	0.846	1.292	1.663	1.989	2.372	2.636	2.883	3.190	3.410
85	0.846	1.292	1.663	1.988	2.371	2.635	2.882	3.189	3.409
86	0.846	1.291	1.663	1.988	2.370	2.634	2.881	3.188	3.407
87	0.846	1.291	1.663	1.988	2.370	2.634	2.880	3.187	3.406
88	0.846	1.291	1.662	1.987	2.369	2.633	2.880	3.185	3.405
89	0.846	1.291	1.662	1.987	2.369	2.632	2.879	3.184	3.403
90	0.846	1.291	1.662	1.987	2.368	2.632	2.878	3.183	3.402
91	0.846	1.291	1.662	1.986	2.368	2.631	2.877	3.182	3.401
92	0.846	1.291	1.662	1.986	2.368	2.630	2.876	3.181	3.399
93	0.846	1.291	1.661	1.986	2.367	2.630	2.876	3.180	3.398
94	0.846	1.291	1.661	1.986	2.367	2.629	2.875	3.179	3.397
95	0.845	1.291	1.661	1.985	2.366	2.629	2.874	3.178	3.396
96	0.845	1.290	1.661	1.985	2.366	2.628	2.873	3.177	3.395
97	0.845	1.290	1.661	1.985	2.365	2.627	2.873	3.176	3.394
98	0.845	1.290	1.661	1.984	2.365	2.627	2.872	3.175	3.393
99	0.845	1.290	1.660	1.984	2.365	2.626	2.871	3.175	3.392
100	0.845	1.290	1.660	1.984	2.364	2.626	2.871	3.174	3.390
∞ [z]	0.842	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Critical Values of Chi-Square Distributions

	χ^2 Right-Tail Area									
df	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	0.000	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
31	14.458	15.655	17.539	19.281	21.434	41.422	44.985	48.232	52.191	55.003
32	15.134	16.362	18.291	20.072	22.271	42.585	46.194	49.480	53.486	56.328
33	15.815	17.074	19.047	20.867	23.110	43.745	47.400	50.725	54.776	57.648
34	16.501	17.789	19.806	21.664	23.952	44.903	48.602	51.966	56.061	58.964
35	17.192	18.509	20.569	22.465	24.797	46.059	49.802	53.203	57.342	60.275
36	17.887	19.233	21.336	23.269	25.643	47.212	50.998	54.437	58.619	61.581
37	18.586	19.96	22.106	24.075	26.492	48.363	52.192	55.668	59.893	62.883
38	19.289	20.691	22.878	24.884	27.343	49.513	53.384	56.896	61.162	64.181
39	19.996	21.426	23.654	25.695	28.196	50.660	54.572	58.120	62.428	65.476
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
41	21.421	22.906	25.215	27.326	29.907	52.949	56.942	60.561	64.950	68.053
42	22.138	23.650	25.999	28.144	30.765	54.090	58.124	61.777	66.206	69.336
43	22.859	24.398	26.785	28.965	31.625	55.230	59.304	62.990	67.459	70.616
44	23.584	25.148	27.575	29.787	32.487	56.369	60.481	64.201	68.710	71.893
45	24.311	25.901	28.366	30.612	33.350	57.505	61.656	65.410	69.957	73.166
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Upper Critical Values of *F*-Distributions

F tail area	df_1 / df_2	1	2	3	4	5	6	7	8	9	10	15	20	30	60
0.005	15	10.8	7.70	6.48	5.80	5.37	5.07	4.85	4.67	4.54	4.42	4.07	3.88	3.69	3.48
0.01	15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.52	3.37	3.21	3.05
0.025	15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.86	2.76	2.64	2.52
0.05	15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.40	2.33	2.25	2.16
0.10	15	3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	1.97	1.92	1.87	1.82
0.005	20	9.94	6.99	5.82	5.17	4.76	4.47	4.26	4.09	3.96	3.85	3.50	3.32	3.12	2.92
0.01	20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.09	2.94	2.78	2.61
0.025	20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.57	2.46	2.35	2.22
0.05	20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.20	2.12	2.04	1.95
0.10	20	2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.84	1.79	1.74	1.68
0.005	30	9.18	6.35	5.24	4.62	4.23	3.95	3.74	3.58	3.45	3.34	3.01	2.82	2.63	2.42
0.01	30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.70	2.55	2.39	2.21
0.025	30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.31	2.20	2.07	1.94
0.05	30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.01	1.93	1.84	1.74
0.10	30	2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.72	1.67	1.61	1.54
0.005	40	8.83	6.07	4.98	4.37	3.99	3.71	3.51	3.35	3.22	3.12	2.78	2.60	2.40	2.18
0.01	40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.52	2.37	2.20	2.02
0.025	40	5.42	4.05	3.46	3.13	2.90	2.74	2.62	2.53	2.45	2.39	2.18	2.07	1.94	1.80
0.05	40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	1.92	1.84	1.74	1.64
0.10	40	2.84	2.44	2.23	2.09	2.00	1.93	1.87	1.83	1.79	1.76	1.66	1.61	1.54	1.47
0.005	50	8.63	5.90	4.83	4.23	3.85	3.58	3.38	3.22	3.09	2.99	2.65	2.47	2.27	2.05
0.01	50	7.17	5.06	4.20	3.72	3.41	3.19	3.02	2.89	2.78	2.70	2.42	2.27	2.10	1.91
0.025	50	5.34	3.97	3.39	3.05	2.83	2.67	2.55	2.46	2.38	2.32	2.11	1.99	1.87	1.72
0.05	50	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.03	1.87	1.78	1.69	1.58
0.10	50	2.81	2.41	2.20	2.06	1.97	1.90	1.84	1.80	1.76	1.73	1.63	1.57	1.50	1.42
0.005	60	8.49	5.79	4.73	4.14	3.76	3.49	3.29	3.13	3.01	2.90	2.57	2.39	2.19	1.96
0.01	60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.35	2.20	2.03	1.84
0.025	60	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33	2.27	2.06	1.94	1.82	1.67
0.05	60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.84	1.75	1.65	1.53
0.10	60	2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.60	1.54	1.48	1.40
0.005	100	8.24	5.59	4.54	3.96	3.59	3.33	3.13	2.97	2.85	2.74	2.41	2.23	2.02	1.79
0.01	100	6.90	4.82	3.98	3.51	3.21	2.99	2.82	2.69	2.59	2.50	2.22	2.07	1.89	1.69
0.025	100	5.18	3.83	3.25	2.92	2.70	2.54	2.42	2.32	2.24	2.18	1.97	1.85	1.71	1.56
0.05	100	3.94	3.09	2.70	2.46	2.31	2.19	2.10	2.03	1.97	1.93	1.77	1.68	1.57	1.45
0.10	100	2.76	2.36	2.14	2.00	1.91	1.83	1.78	1.73	1.69	1.66	1.56	1.49	1.42	1.34

L-2/T-2/URP **Date: 14/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2021-2022

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

Full Marks: 140 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) Define landscape design and landscape planning. Briefly explain the domains of landscape planning. **($10\frac{1}{3}$)**

   (b) Illustrate features and technologies of French landscape garden style. **(13)**

2. (a) 'Ecosystems are organized in Trophic levels'- explain using Lindeman's diagram. **($10\frac{1}{3}$)**

   (b) How does soil texture and structure influence on ecosystem process? **(13)**

3. Write short notes on the following regarding organization of spaces in landscape planning and design. **($23\frac{1}{3}$)**

   (a) Spatial Impact
   (b) Elements of Containment

4. Appraise a renowned landscape planning case study in respect to its climatic context. **($23\frac{1}{3}$)**

SECTION – B

There are **FOUR** questions in this section.
Answer question No. Five (Q.5) and any **TWO** from the rest

5. What is landscape ecology? How the principles of landscape ecology can guide ecology-responsive landscape conservation planning in the context of Bangladesh? **(30)**

6. What methodology would you adapt to analyze landscape systems of a given terrain? Justify your position with appropriate examples. **(20)**

7. Why the knowledge of 'plant community' is important in landscape planning and design? Propose an appropriate plant community for the 'Modhupur Tract' geological context. **(20)**

8. What are the vitalities of the 'Miyawaki Method' for creating urban forests in the context of Bangladesh? **(20)**

L-2/T-2/URP **Date: 8/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **HUM 221** (Public Finance)

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** Questions.

1. (a) We add the demand of private goods horizontally but add demands of public goods vertically when determining the associated marginal benefit to society. Why do we do this, and why are the procedures different for public and private goods? **(20)**

   (b) Suppose 20 people each have the demand Q = 40 - 2P for streetlights, and 10 people have the demand Q = 36 - 4P for streetlights. The cost of building each streetlight is 20. If it is impossible to purchase a fractional number of streetlights, how many streetlights are socially optimal? **(15)**

2. You have Tk. 10000 to spend on food and clothing. The price of food is Tk. 400, and the price of clothing is Tk. 1000.

   (a) Graph your budget constraint. **(20)**

   (b) Suppose that the government subsidize clothing such that each unit of clothing is half - price, up to the first six units of clothing. Graph you budget constraint in this circumstance. **(15)**

3. (a) What is "externality"? Explain different types of externalities. **(20)**

   (b) Suppose that demand for a product is Q = 2400 - 8P and supply is Q = - 480 + 4P. Furthermore, suppose that the marginal external damage of this product is Tk. 24 per unit. How many more units of this product will the free-market produce than is socially optimal? Calculate the deadweight loss associated with the externality. **(15)**

4. (a) Dhaka City has two regions. In North City Corporation, the marginal benefit associated with pollution cleanup is MB = 30000 - 1000Q, while in South City Corporation, the marginal benefit associated with pollution cleanup is MB = 20000 - 400Q. Suppose that the marginal cost of cleanup is constant at Tk. 12000 per unit. What is the optimal level of pollution cleanup in each of the two regions? **(20)**

   (b) Can an activity generate positive and negative externalities at the same time? Explain **(15)**

Contd …… P/2

SECTION – B

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

5. The demand for potatoes is Q = 4,000 - 600P, and the supply of potatoes is Q = - 200 + 200P. Show your answer both graphically and mathematically.

   (a) Who bears the statutory incidence of a Tk. 5 per unit tax on the sale of potatoes? **(20)**

   (b) Who bears the economic incidence of this tax? **(15)**

6. (a) Luxury goods often have much higher elasticities of demand than do staple goods like basic foods and clothing, which are purchased by a broad base of people . Why, then, are governments more likely to tax luxuries than these "staple goods"? **(20)**

   (b) "The deadweight loss of a given tax is smaller when the demand curve is less elastic than when it is more elastic". Do you agree with the statement? Explain your answer and show graphically. **(15)**

7. The market demand for super-sticky glue is Q = 480 - 12 P and the market supply is Q = - 80 + 4P.

   (a) Calculate the deadweight loss of a tax of Tk. 8 per unit levied on producers of super-sticky glue. **(20)**

   (b) How does deadweight loss change if the tax is levied on consumers of super-sticky glue? **(15)**

8. (a) Define Net Present Value (NPV), Benefits to Cost Ratio (BCR) and Internal Rate of Return (IRR) of public projects. **(20)**

   (b) How do you interpret the following values of NPV, BCR and IRR of a public project? **(15)**

   NPV (Lakh taka): 2075, 681.34

   BCR : 1.841

   IRR : 73.56%
