UNIVERSITY OF CALCUTTA

NotificationNo.CSR/18/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 17.07.2023 approved the syllabus of the under mentioned subjects semester wise Four-year (Honours & Honours with Research) /Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022, under this University, as laid down in the accompanying pamphlet.

SL.NO.	NAME OF SUBJECTS
1.	ENVIRONMENTAL Science
2.	Physics
3.	French
4.	Sanskrit (Honours)
5.	Arabic
6.	Library & Information Studies
7.	Statistics
8.	Electronics
9.	Household Art (Minor/MDC)
10.	Microbiology (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
11.	Psychology (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
12.	Hindi (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
13.	B.B.A. (Honours syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)

The above shall be effective from the academic session 2023-2024.

24.7.2023

SENATE HOUSE

KOLKATA-700 073

The 24th July, 2023

Prof.(Dr.) Debasis Das

Registrar

UNIVERSITY OF CALCUTTA

Syllabus for Four-year B.Sc. (Honours & Honours with Research) Courses of Studies

in

STATISTICS

(Under Curriculum & Credit Framework, 2022)

COURSE STRUCTURE-CCF, 2022

	DSCC/ Core (Major)	Minor (m1 & m2)	IDC	AEC	SEC	CVAC	Summer Internship	Dissertation/ Research work	Total Credit
Semester	22x4= 88	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3=3	(1x4= 4)+ (1x8= 8) = 12	172
1	1x4= 4 3TH+1P/TU	1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4			21
2	1x4= 4 3TH+1P/TU	1x4= 4 (m1) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2= 4			21
3	2x4= 8 2x(3TH+ 1P/TU)	1x4= 4 (m2) 3TH+1P/TU	1x3= 3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4				21
4	4x4= 16 4x(3TH+ 1P/TU)	1x4= 4 (m2) 3TH+1P/TU		1x2= 2 2TH +0P/TU					22
5	4x4= 16 4x(3TH+ 1P/TU)	m1+m2 2x4= 8 2x(3TH+ 1P/TU)							24
6	3x4= 12 3x(3TH+ 1P/TU)	2x4= 8 m1+m2 2x(3TH+ 1P/TU)							20
7	4x4= 16 4x(3TH+1P/ TU)							1x4*	20
8	3x4= 12 3x(3TH+1P/ TU)							1x8 *	20
Credits	22x4= 88	8x4= 32	3x3= 9	4x2= 8	3x4= 12	4x2= 8		(1x4)+(1X8)= 12	169+3= 172
Marks	22x100= 2200	8x100=800	3x75= 225	4x50= 200	3x100= 300	4x50 = 200		1x100+1x200= 300	Total Marks =4300

Marks= 25 marks per credit.

*Students who will not pursue Dissertation/ Research work then the candidate will have to study additional 1 DSC/Core paper o f 4 credits in the 7th Semester & 2 DSC/ Core Papers of 4 Credits each in the 8th Semester.

Minor courses will come from two subjects of same broad discipline as Major (m1, m2).

Total credit=169+3 (for summer internship) = 172

Structure of Statistics Honours Courses

Semester	Course / Paper Code	Course Name
1	STAT-H-CC1-1-Th / P	Descriptive Statistics I & Probability I
	STAT-H-SEC1-1-Th / P	Numerical Computations with C
2	STAT-H-CC2-2-Th / P	Descriptive Statistics II & Probability II
	STAT-H-SEC2-2-Th	Artificial Intelligence for Everyone
3	STAT-H-CC3-3-Th / TU	Real Analysis I
	STAT-H-CC4-3-Th / P	Statistical Inference I
	STAT-H-SEC3-3-Th / P	Introduction to R
4	STAT-H-CC5-4-Th / P	Linear Algebra
	STAT-H-CC6-4-Th / P	Probability III
	STAT-H-CC7-4-Th / P	Sampling Distributions and Statistical Inference II
	STAT-H-CC8-4-Th / P	Design of Experiments I and Sample Survey I
5	STAT-H-CC9-5-Th / P	Multivariate Analysis I
	STAT-H-CC10-5-Th / P	Statistical Inference III
	STAT-H-CC11-5-Th / P	Linear Models
	STAT-H-CC12-5-Th / P	Demography
6	STAT-H-CC13-6-Th / P	Applied Multivariate Analysis
	STAT-H-CC14-6-Th / P	Index Numbers and Psychometry
	STAT-H-CC15-6-Th / P	Time Series Analysis
7	STAT-H-CC16-7-Th / P	Real Analysis II
	STAT-H-CC17-7-Th / P	Statistical Inference IV
	STAT-H-CC18-7-Th / P	Design of Experiments II
	STAT-H-CC19-7-Th / P	Sample Survey II
	STAT-H-CC20-7-P OR STAT-H-CC20-D-7-P	Project Work OR Dissertation
8	STAT-H-CC21-8-Th / P	Multivariate Analysis II
	STAT-H-CC22-8-Th / P	Regression Analysis
	STAT-H-CC23-8-Th / P	Statistical Quality Control
	STAT-H-CC24A-8-Th / P OR STAT-H-CC24B-8-Th / P OR STAT-H-CC24-D-8-P	Operations Research OR Development Statistics OR Dissertation
	STAT-H-CC25A-8-Th / P OR STAT-H-CC25B-8-Th / P OR STAT-H-CC25-D-8-P	Statistical Computing with Python OR Reliability Theory OR Dissertation

Structure of Statistics Minor Courses

Semester	Course / Paper Code	Course Name
1	STAT-H-MC1-1-Th / P	Descriptive Statistics I & Probability I
2	STAT-H-MC2-2-Th / P	Descriptive Statistics II & Probability II
3	STAT-H-MC1-3-Th / P	Descriptive Statistics I & Probability I
4	STAT-H-MC2-4-Th / P	Descriptive Statistics II & Probability II
5	STAT-H-MC3-5-Th / P	Statistical Inference I
6	STAT-H-MC4-6-Th / P	Design of Experiments I and Sample Survey I

Structure of Statistics Interdisciplinary Course

Semester	Course / Paper Code	Course Name
1	STAT-H-IDC1-1-Th / P	Statistics for Practitioners
2	STAT-H-IDC2-2-Th / P	
3	STAT-H-IDC3-3-Th / P	

STAT-H-CC1-1-Th / STAT-H-MC1-1-Th / STAT-H-MC1-3-Th **3 Credits**

(Descriptive Statistics I & Probability I) **THEORY**

Statistics: Definition and scope. Concepts of statistical population and sample. Data: quantitative and qualitative, cross-sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays. (10)

Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Mean deviation, Standard deviation, Coefficient of variation, Ginis Coefficient, Lorenz Curve. Moments, skewness and kurtosis. Quantiles and measures based on them. Box Plot. Outliers. (15)

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability: classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications. (20)

STAT-H-CC1-1-P / STAT-H-MC1-1-P / STAT-H-MC1-3-P **1 Credit**

(Descriptive Statistics I & Probability I) **PRACTICAL**

List of Suggested Practical

- Diagrammatic representation of data.
- Problems based on construction of frequency distributions, cumulative frequency distributions and their graphical representations, stem and leaf plot.
- Problems based on measures of central tendency.
- Problems based on measures of dispersion.
- Problems based on combined mean and variance and coefficient of variation.
- Problems based on moments, skewness and kurtosis.
- Problems related to quantiles and measures based on them, construction of box plot.
- Application problems based on Classical Definition of Probability.
- Application problems based on Bayes' Theorem.

Reference Books:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Tukey, J.W.(1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

Freedman, D., Pisani, R. and Purves, R. (2014): Statistics, 4th Edition, W. W. Norton & Company.

Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.

Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.

Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.

Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley.

Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.

Cacoullos, T. (1973): Exercises in Probability, Narosa.

Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffin.

Ross, S. (2002): A First Course in Probability, Prentice Hall.

STAT-H-SEC1-1-Th **2 Credits**

(Numerical Computations with C) **THEORY**

Approximation of numbers and functions. Absolute and Relative errors. Interpolation: Polynomial approximation, Weierstrass Theorem (Statement). Difference Table, Newton's Forward and Backward interpolation formulae and Lagrange's general interpolation formula, Error terms. Numerical Differentiation and its applications. Numerical Integration: Trapezoidal and Simpson's 1/3rd rules. Numerical solution of equations: method of fixed point iteration and Newton-Raphson method in one unknown, conditions of convergence (statement only). (15)

Components, basic structure programming, character set, C/C++ tokens, Keywords and Identifiers and execution of a C/C++ program. Data types: Basic data types, enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, symbolic constants, overflow and underflow of data. Operators and expressions: library functions. Managing input and output operations: reading and printing formatted and unformatted data. Decision making and

branching - if...else, nesting of if...else, else if ladder, switch. Looping in C/C++: for, nested for, while, do...while, and jumps in and out of loops. Arrays: Declaration and initialization of one-dim and two-dim arrays. User-defined functions. (15)

STAT-H-SEC1-1-P **2 Credits**

(Numerical Computations with C) **PRACTICAL**

List of Suggested Practical

- Finding values of a function $y = f(x)$ for given values of x.
- Roots of a quadratic equation (with imaginary roots also).
- Sorting of an array and hence finding median.
- Mean, median and mode of a grouped frequency Data.
- Variance and coefficient of variation of a grouped frequency data.
- Preparing a frequency table.
- Numerical methods: Interpolation by Lagrange's formula, Solving one-variable equations using Newton-Raphson and iteration methods.
- Trapezoidal and Simpson's 1/3rd rule for numerical integration with convergence.
- Storing the C output in a file.

Reference Books:

Kernighan, B.W. and Ritchie, D.(1988): C Programming Language, 2nd Edition, Prentice Hall.

Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition Tata McGraw Hill.

Gottfried, B.S. (1998): Schaums Outlines: Programming with C, 2nd Edition, Tata McGraw Hill.

Jain, M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.

Mukherjee, Kr. Kalyan (1990): Numerical Analysis, New Central Book Agency.

Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del.

Scarborough, J.B. (1966): Numerical Mathematical Analysis, Oxford and IBH Publishing.

STAT-H-CC2-2-Th / STAT-H-MC2-2-Th / STAT-H-MC2-4-Th **3 Credits**

(Descriptive Statistics II & Probability II) **THEORY**

Bivariate data: Definition, scatter diagram, simple correlation, linear regression, principle of least squares, fitting of polynomial and exponential curves, correlation ratio, correlation index, intraclass correlation. Rank correlation: Spearman's and Kendall's measures. (15)

Analysis of Categorical Data: Contingency table, independence & association of attributes. (5)

Random Variables: Definition of discrete and continuous random variables, cumulative distribution function (c.d.f.) and its properties (without proof), probability mass function (p.m.f.) and probability density function (p.d.f.). Expectation and Variance. Standard probability distributions: Discrete Uniform, Binomial, Poisson, and Normal. (25)

STAT-H-CC2-2-P / STAT-H-MC2-2-P / STAT-H-MC2-4-P **1 Credit**

(Descriptive Statistics II & Probability II) **PRACTICAL**

List of Suggested Practical

- Problems based on analysis of bivariate data.
- Problems based on measures of rank correlation.
- Problems based on analysis of categorical data.
- Finding expectation, variance from a given probability distribution.
- Fitting of binomial distributions for n and $p = q = 1/2$.
- Fitting of binomial distributions for given n and p.
- Fitting of binomial distributions after computing mean and variance.
- Fitting of Poisson distributions for given value of mean.
- Fitting of Poisson distributions after computing mean.
- Application problems based on binomial distribution.
- Application problems based on Poisson distribution.
- Problems based on area property of normal distribution.
- To find the ordinate for a given area for normal distribution.
- Application based problems using normal distribution.
- Fitting of normal distribution when parameters are given.
- Fitting of normal distribution when parameters are not given.

Reference Books:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Tukey, J.W.(1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.

Freedman, D., Pisani, R. and Purves, R. (2014): Statistics, 4th Edition, W. W. Norton & Company.

Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.

Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.

Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.

Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley.

Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.

Cacoullos, T. (1973): Exercises in Probability, Narosa.

Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffin.

Ross, S. (2002): A First Course in Probability, Prentice Hall.

Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

STAT-H-SEC2-2 **4 credits**

(Artificial Intelligence for Everyone)

Offered centrally by the University.

STAT-H-IDC1-1-Th / STAT-H-IDC2-2-Th / STAT-H-IDC3-3-Th **2 Credits**

(Statistics for Practitioners) **THEORY**

Understanding univariate data: Variable, notion of population and sample, different types of data, methods of collecting primary and secondary data, presentation of data, summary measures on data with central tendency (arithmetic mean, median, mode), dispersion (range, quartile deviation, standard deviation, coefficient of variation), ideas of skewness and kurtosis (only through diagrams), Exploratory Data Analysis. (8)

Understanding bivariate data: Paired data and ideas (without mathematical details) of different measures of associations, primarily Pearson's correlation coefficient, Spearman's Rank correlation (no tie), measures of association of attributes through contingency table, two-variable linear regression and multiple (three-variable only) linear regression (without derivation of the regression coefficients' formulae). (8)

Statistical Inference (testing of hypothesis): Basic idea of binomial and normal populations (graphical idea only, derivation of the properties excluded). Concepts of hypotheses, knowledge on test statistic and decision making in terms of critical value and p-value for some standard testing problems like test for proportion/proportions, mean based on single (normal) sample, test on comparing means based on two-sample and paired sample data. (7)

Miscellaneous discussion: Applications of one-way and two-way ANOVA with one observation per cell (without derivation and details) assuming normality, Kruskal-Wallis test (without derivation and details), sample size determination, estimation of population mean and variability for finite population, idea and application of logistic regression for binary response data. (7)

STAT-H-IDC1-1-P / STAT-H-IDC2-2-P / STAT-H-IDC3-3-P **1 Credit**

(Statistics for Practitioners) **PRACTICAL**

List of Suggested Practical

- Measures of mean, median, mode, range, QD, SD, CV for univariate data case.
- Fitting of linear regression on bivariate and on three-variable multivariate data, measures of Pearsons correlation coefficients, Spearman's Rank correlation, measures of association of attributes through contingency table.
- Tests for proportion/proportions, tests of means for single sample, two-sample, and paired sample data on normal response using p-value approach.
- Applications of ANOVA and Kruskal-Wallis test.
- Sample size determination, estimation of population mean and variability for finite population.
- Fitting of logistic regression for binary response data.

Reference Books:

Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. I, 9th Edition World Press, Kolkata.

Das, N.G.: Statistical Methods, Vol I, Tata McGraw Hill Pub. Co. Ltd.

Johnson, R.A. and Wichern, D.W.: Applied Multivariate Statistical Analysis, PHI.

Hardle W. and Simar, L.: Applied Multivariate Statistical Analysis.

Kutner, M.H. et.al.: Applied Linear Statistical Models.

Belsley D.A. et.al.: Regression Diagnostics.

Draper N.R. and Smith, H.: Applied Regression Analysis.

UNIVERSITY OF CALCUTTA

Syllabus for Three-year B.Sc. Multidisciplinary Courses of Studies

in

STATISTICS

(Under Curriculum & Credit Framework, 2022)

COURSE STRUCTURE-MDC

	CC1	CC2	Minor	IDC	AEC	SEC	CVAC	Summer Internship	Total Credit
Semester	8x4= 32	8x4= 32	6x4= 24	3x3=9	4x2= 8	3x4=12	4x2=8	1x3= 3	128
1	1x4= 4 3TH+ 1P/TU	1x4= 4 3TH+ 1P/TU		1x3=3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2=4		21
2	1x4= 4 3TH+ 1P/TU	1x4= 4 3TH+ 1P/TU		1x3=3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4	2x2=4		21
3	1x4= 4 (3TH+ 1P/TU)	1x4= 4 3TH+ 1P/TU	1x4= 4 3TH+1P/ TU	1x3=3 2TH +1P/TU	1x2= 2 2TH +0P/TU	1x4= 4			21
4	2x4=8 4x(3TH+ 1P/TU)	2x4= 8 2x(3TH+ 1P/TU	1x4= 4 (3TH+1P/ TU)		1x2= 2 2TH +0P/TU				22
5	2x4= 8 2x(3TH+ 1P/TU)	1x4= 4 3TH+ 1P/TU	2x4= 8 2x(3TH+ 1P/TU						20
6	1x4= 4 (3TH+ 1P/TU)	2x4= 8 2x(3TH+ 1P/TU)	2x4= 8 2x(3TH+ 1P/TU)						20
Credits	8x4= 32	8x4= 32	6x4= 24	3x3= 9	4x2= 8	3x4= 12	4x2= 8	1x3= 3	128
Marks	8x100= 800	8x100= 800	6x100= 600	3x75= 225	4x50= 200	3x100= 300	4x50= 200	3x25= 75	Total Marks =3200

Marks= 25 marks per credit.

Total credit=125+3 (for summer internship) = 128
Summer Internship: As mentioned in clause no. 8 (G)

Structure of Core Courses in Statistics for MDC

Semester	Course / Paper Code	Course Name
1	STAT-MD-CC1-1-Th / P	Descriptive Statistics I & Probability I
2	STAT-MD-CC2-2-Th / P	Descriptive Statistics II & Probability II
3	STAT-MD-CC3-3-Th / P	Statistical Inference I
4	STAT-MD-CC4-4-Th / P	Design of Experiments I and Sample Survey I
	STAT-MD-CC5-4-Th / P	Descriptive Statistics III & Probability III
5	STAT-MD-CC6-5-P	Project Work
5 OR 6	STAT-MD-CC7-5-Th / P OR STAT-MD-CC7-6-Th / P	Applications of Statistics I
6	STAT-MD-CC8-6-Th / P	Applications of Statistics II

Structure of Minor Courses in Statistics for MDC

Semester	Course / Paper Code	Course Name
3	STAT-MD-MC1-3-Th / P	Descriptive Statistics I & Probability I
4	STAT-MD-MC2-4-Th / P	Descriptive Statistics II & Probability II
5	STAT-MD-MC3-5-Th / P	Statistical Inference I
	STAT-MD-MC4-5-P	Project Work
6	STAT-MD-MC5-6-Th / P	Design of Experiments I and Sample Survey I
	STAT-MD-MC6-6-Th / P	Descriptive Statistics III & Probability III

Structure of Skill Enhancement Courses in Statistics for MDC

Semester	Course / Paper Code	Course Name
1	STAT-MD-SEC1-1-Th / TU	An Introduction to R
2	STAT-MD-SEC2-2-Th / TU	
3	STAT-MD-SEC3-3-Th / TU	

Structure of Interdisciplinary Courses in Statistics for MDC

Semester	Course / Paper Code	Course Name
1	STAT-MD-IDC1-1-Th / P	Statistics for Practitioners
2	STAT-MD-IDC2-2-Th / P	
3	STAT-MD-IDC3-3-Th / P	

STAT-MD-CC1-1-Th / STAT-MD-MC1-3-Th **3 Credits**

(Descriptive Statistics I & Probability I) **THEORY**

Statistics: Definition and scope. Concepts of statistical population and sample. Data: quantitative and qualitative, cross-sectional and time-series, discrete and continuous. Scales of measurement: nominal, ordinal, interval and ratio. Presentation of data: tabular and graphical. Frequency distributions, cumulative frequency distributions and their graphical representations. Stem and leaf displays. (10)

Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: Range, Mean deviation, Standard deviation, Coefficient of variation, Ginis Coefficient, Lorenz Curve. Moments, skewness and kurtosis. Quantiles and measures based on them. Box Plot. Outliers. (15)

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability: classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications. (20)

STAT-MD-CC1-1-P / STAT-MD-MC1-3-P **1 Credit**

(Descriptive Statistics I & Probability I) **PRACTICAL**

List of Suggested Practical

- Diagrammatic representation of data.
- Problems based on construction of frequency distributions, cumulative frequency distributions and their graphical representations, stem and leaf plot.
- Problems based on measures of central tendency.
- Problems based on measures of dispersion.
- Problems based on combined mean and variance and coefficient of variation.
- Problems based on moments, skewness and kurtosis.
- Problems related to quantiles and measures based on them, construction of box plot.
- Application problems based on Classical Definition of Probability.
- Application problems based on Bayes' Theorem.

Reference Books:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

Freedman, D., Pisani, R. and Purves, R. (2014): Statistics, 4th Edition, W. W. Norton & Company.

Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.

Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.

Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.

Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley.

Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.

Cacoullos, T. (1973): Exercises in Probability, Narosa.

Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffin.

Ross, S. (2002): A First Course in Probability, Prentice Hall.

STAT-MD-CC2-2-Th / STAT-MD-MC2-4-Th **3 Credits**

(Descriptive Statistics II & Probability II) **THEORY**

Bivariate data: Definition, scatter diagram, simple correlation, linear regression, principle of least squares, fitting of polynomial and exponential curves, correlation ratio, correlation index, intraclass correlation. Rank correlation: Spearman's and Kendall's measures. (15)

Analysis of Categorical Data: Contingency table, independence & association of attributes. (5)

Random Variables: Definition of discrete and continuous random variables, cumulative distribution function (c.d.f.) and its properties (without proof), probability mass function (p.m.f.) and probability density function (p.d.f.). Expectation and Variance. Standard probability distributions: Discrete Uniform, Binomial, Poisson, and Normal. (25)

STAT-MD-CC2-2-P / STAT-MD-MC2-4-P **1 Credit**

(Descriptive Statistics II & Probability II) **PRACTICAL**

List of Suggested Practical

- Problems based on analysis of bivariate data.
- Problems based on measures of rank correlation.
- Problems based on analysis of categorical data.
- Finding expectation, variance from a given probability distribution.
- Fitting of binomial distributions for n and p = q = 1/2.
- Fitting of binomial distributions for given n and p.
- Fitting of binomial distributions after computing mean and variance.
- Fitting of Poisson distributions for given value of mean.
- Fitting of Poisson distributions after computing mean.
- Application problems based on binomial distribution.
- Application problems based on Poisson distribution.
- Problems based on area property of normal distribution.
- To find the ordinate for a given area for normal distribution.
- Application based problems using normal distribution.
- Fitting of normal distribution when parameters are given.
- Fitting of normal distribution when parameters are not given.

Reference Books:

Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freunds Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

Tukey, J.W. (1977): Exploratory Data Analysis, Addison-Wesley Publishing Co.

Agresti, A. (2010): Analysis of Ordinal Categorical Data, 2nd Edition, Wiley.

Freedman, D., Pisani, R. and Purves, R. (2014): Statistics, 4th Edition, W. W. Norton & Company.

Chung, K.L. (1983): Elementary Probability Theory with Stochastic Process, Springer / Narosa.

Feller, W. (1968): An Introduction to Probability Theory & its Applications, John Wiley.

Goon, A.M., Gupta, M.K. & Dasgupta, B. (1994): An Outline of Statistical Theory (Vol-1), World Press.

Parzen, E. (1972): Modern Probability Theory and its Applications, John Wiley.

Uspensky, J.V. (1937): Introduction to Mathematical Probability, McGraw Hill.

Cacoullos, T. (1973): Exercises in Probability, Narosa.

Rahman, N.A. (1983): Practical Exercises in Probability and Statistics, Griffin.

Ross, S. (2002): A First Course in Probability, Prentice Hall.

Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.

Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

Rohatgi, V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2nd Edn. (Reprint) John Wiley and Sons.

STAT-MD-IDC1-1-Th / STAT-MD-IDC2-2-Th / STAT-MD-IDC3-3-Th **2 Credits**

(Statistics for Practitioners) **THEORY**

Understanding univariate data: Variable, notion of population and sample, different types of data, methods of collecting primary and secondary data, presentation of data, summary measures on data with central tendency (arithmetic mean, median, mode), dispersion (range, quartile deviation, standard deviation, coefficient of variation), ideas of skewness and kurtosis (only through diagrams), Exploratory Data Analysis. (8)

Understanding bivariate data: Paired data and ideas (without mathematical details) of different measures of associations, primarily Pearson's correlation coefficient, Spearman's Rank correlation (no tie), measures of association of attributes through contingency table, two-variable linear regression and multiple (three-variable only) linear regression (without derivation of the regression coefficients' formulae). (8)

Statistical Inference (testing of hypothesis): Basic idea of binomial and normal populations (graphical idea only, derivation of the properties excluded). Concepts of hypotheses, knowledge on test statistic and decision making in terms of critical value and p-value for some standard testing problems like test for proportion/proportions, mean based on single (normal) sample, test on comparing means based on two-sample and paired sample data. (7)

Miscellaneous discussion: Applications of one-way and two-way ANOVA with one observation per cell (without derivation and details) assuming normality, Kruskal-Wallis test (without derivation and details), sample size determination, estimation of population mean and variability for finite population, idea and application of logistic regression for binary response data. (7)

STAT-MD-IDC1-1-P / STAT-MD-IDC2-2-P / STAT-MD-IDC3-3-P **1 Credit**

(Statistics for Practitioners) **PRACTICAL**

List of Suggested Practical

- Measures of mean, median, mode, range, QD, SD, CV for univariate data case.
- Fitting of linear regression on bivariate and on three-variable multivariate data, measures of Pearson's correlation coefficient, Spearman's Rank correlation, measures of association of attributes through contingency table.
- Tests for proportion/proportions, tests of means for single sample, two-sample, and paired sample data on normal response using p-value approach.
- Applications of ANOVA and Kruskal-Wallis test.
- Sample size determination, estimation of population mean and variability for finite population.
- Fitting of logistic regression for binary response data.

Reference Books:

Gun, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. I, 9th Edition World Press, Kolkata.

Das, N.G.: Statistical Methods, Vol I, Tata McGraw Hill Pub. Co. Ltd.

Johnson, R.A. and Wichern, D.W.: Applied Multivariate Statistical Analysis, PHI.

Hardle W. and Simar, L.: Applied Multivariate Statistical Analysis.

Kutner, M.H. et.al.: Applied Linear Statistical Models.

Belsley D.A. et.al.: Regression Diagnostics.

Draper N.R. and Smith, H.: Applied Regression Analysis.

STAT-MD-SEC1-1-Th / STAT-MD-SEC2-2-Th / STAT-MD-SEC3-3-Th **3 Credits**

(An Introduction to R) **THEORY**

Introduction to R: Installation, command line environment, overview of capabilities, brief mention of open source philosophy. R as a calculator: The four basic arithmetic operations. Use of parentheses nesting up to arbitrary level. The power operation. Evaluation of simple expressions. Quotient and remainder operations for integers. Standard functions, e.g., sin, cos, exp, log. (10)

The different types of numbers in R: Division by zero leading to Infor -Inf. NaN. NA. No need to go into details. Variables. Creating a vector using c(), seq() and colon operator. How functions map over vectors. Functions to summarise a vector: sum, mean, sd, median etc. Extracting a subset from the vector (by index, by property). R as a graphing calculator: Introduction to plotting. Plot(), lines(), abline(). No details about the graphics parameters except colour and line width. Barplot, Pie chart and Histogram. Box plot. (15)

Matrix operations in R: Creation. Basic operations. Extracting submatrices. Loading data from a file: read.table() and read.csv(). Mention of head=TRUE and head=FALSE. Dataframes. Mention that these are like matrices, except that different columns may be of different types. (8)

Numerical Integration in R: Trapezoidal and Simpson's 1/3rd rules. Numerical solution of equations in R: Method of fixed point iteration and Newton-Raphson method in one unknown. Simulation in R: Simulating a coin toss, a die roll and a card shuffle. Finding probabilities of events related to such experiments using simulation. (12)

STAT-MD-SEC1-1-TU / STAT-MD-SEC2-2-TU / STAT-MD-SEC3-3-TU **1 Credit**

(An Introduction to R) **TUTORIAL**

Reference Books:

Gardener, M (2012) Beginning R: The Statistical Programming Language, Wiley Publications.

Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. NewYork.

A simple introduction to R by Arnab Chakraborty (freely available athttp://www.isical.ac.in/~arnabc/)

R for beginners by Emmanuel Paradis (freely available at https://cran.r-project.org/doc/contrib/Paradisrdebuts_en.pdf)