Vidyasagar University

Curriculum for B.Sc. Honours in Statistics [Choice Based Credit System]

Semester-I

Sl.No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
C1	**C1T:** Descriptive Statistics	Core Course-1		4	0	0	6	75
	C1P: Descriptive Statistics Lab	Core Course1 [Practical]		0	0	4		
C2	**C2T:** Probability and Probability Distribution-1	Core Course-2		4	0	0	6	75
	C2P: Probablity and Probability Distribution -1 Lab	Core Course-2 [Practical]		0	0	4		
GE-1	GE-1	GE					4/5	75
	GE-1	GE					2/1	
AECC	English	AECC					2	50
							Total Credits =20	

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: English /Modern Indian Language.

<u>Interdisciplinary/Generic Elective (GE) from other Department</u>

[**Four papers are to be taken and each paper will be of 6 credits**]:

[Papers are to be taken from any of the following discipline (**GE-1 from Mathematics**)]: **Mathematics/Physics/Chemistry/Computer Sc/Geology/Electronics/Economics/Zoology/Botany/ Physiology**

Semester-1

Core Courses

CC-1: Descriptive Statistics   **Credits 06**

C1T1 : Descriptive Statistics   **Credits 04**

Descriptive Statistics	
	4 Credits
Unit 1	
Statistics: Definition and scope, concepts of statistical population and sample. Data: quantitative and qualitative,scales of measurement: nominal, ordinal, interval and ratio. Frequency distribution. Presentation: tabular and graphical, including histogram and ogives.	
Unit 2	
Measures of Central Tendency: Mean, Median, Mode. Measures of Dispersion: range, mean deviation, standard deviation, coefficient of variation, Gini's Coefficient, Lorenz Curve. Moments, skewness and kurtosis, Quantiles and measures based on them. Box Plot. Outlier Detection. Quantile-Quantile Plot.	
Unit 3	
Bivariate data: Definition, scatter diagram, simple correlation, linear regression, principle of least squares. Analysis of Categorical Data:Contingency table, association of attributes, odds ratio, Pearson's measure, Goodman-Kruskal's γ. Binary response and logistic regression. Spearman'sRank correlation.	
Unit 4	
Index Numbers: Weighted means, price and quantity index numbers, choice of weights, Laspeyres' and Paasche's index numbers. Tests of index numbers and Fisher's ideal index number.	
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. Freund's 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.

C1P1: Descriptive Statistics Lab   **Credits 02**

Descriptive Statistics	
	2 Credits

List of Practical
1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of quadratic and exponential function.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman's rank correlation.
11. Box Plot and Q-Q Plot.
12. Calculation of price and quantity index numbers.

CC-2: Core T2 –Probability and Probability Distributions-I   Credits 06

C2T2: Probability and Probability Distributions-I   Credits 04

Probability and Probability Distributions-I	
	4Credits
Unit 1	
Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic.	
Unit 2	
Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.	
Unit 3	
Random variables: discrete random variables, p.m.f. and c.d.f., statement of properties of c.d.f, illustrations and properties of random variables. Standard discrete probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform.	
Unit 4	
Twodimensional random variables: discrete type, joint, marginal and conditional p.m.f and c.d.f., statement of properties of c.d.f, independence of variables, trinomial distribution.	
Reference Books	
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, Griffen.

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

C2P2: Probability and Probability Distributions-I Lab   Credits 02

Probability and Probability Distributions-I	
	2 Credits
List of Practical	

1. Application problems based on Classical Definition of Probability.
2. Application problems based on Bayes Theorem.
3. Fitting of binomial distributions for n and p = q = ½.
4. Fitting of binomial distributions for given n and p.
5. Fitting of binomial distributions after computing mean and variance.
6. Fitting of Poisson distributions for given value of lambda.
7. Fitting of Poisson distributions after computing mean.
8. Fitting of negative binomial distribution.
9. Fitting of suitable distribution.
10. Application problems based on binomial distribution.
11. Application problems based on Poisson distribution.
12. Application problems based on negative binomial distribution.

Generic Elective Syllabus

GE-1 [Interdisciplinary for other department]

GE-1: Statistical Methods   Credits 06

GE-1T1 –Statistical Methods   Credits 04

Statistical Methods	
	4 Credits

Unit 1

Introduction: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement - nominal, ordinal, interval and ratio. Frequency distribution, Presentation: tabular and graphic, including histogram and ogives.

Unit 2

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.

Unit 3

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation (Spearman). Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

Unit 4

Theory of attributes, consistency of data, independence and association of attributes, measures of association and contingency.

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. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

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

► Goon A.M., Gupta M.K. and Dasgupta B. : Basic Statistics. The World Press, Kolkata.

► Chakraborty, Arnab (2016) : Probability and Statistics. Sarat Book House.

GE-1 P1 – Statistical Methods   Credits 02

Statistical Methods Lab	
	2 Credits

List of Practical

1. Graphical representation of data

2. Problems based on measures of central tendency

3. Problems based on measures of dispersion

4. Problems based on combined mean and variance and coefficient of variation

5. Problems based on moments, skewness and kurtosis

6. Fitting of polynomials, exponential curves

7. Karl Pearson correlation coefficient

8. Partial and multiple correlations

9. Spearman rank correlation with and without ties.

10. Correlation coefficient for a bivariate frequency distribution

11. Lines of regression, angle between lines and estimated values of variables.

12. Checking consistency of data and finding association among attributes.

Vidyasagar University

Curriculum for B.Sc. Honours in Statistics [Choice Based Credit System]

Semester-II

Sl. No.	Name of the Subject	Nature	Code	Teaching Scheme in hour per week			Credit	Marks
				L	**T**	**P**		
C3	**C3T:** Mathematical Analysis	Core Course-3		5	1	0	6	75
C4	**C4T:** Probability and Probability Distributions-II	Core Course-4		4	0	0	6	75
	C4P: Probability and Probability Distributions-II Lab	Core Course-4 [Practical]		0	0	4		
GE-2	GE-2	GE					4/5	75
	GE-2	GE					2/1	
AECC -2	Environmental Studies	AECC					4	100
						Total Credits =22		

L=Lecture, T=Tutorial, P=Practical

AECC- Ability Enhancement Compulsory Course: Environmental Studies.

Interdisciplinary/Generic Elective (GE) from other Department

[**Four papers are to be taken and each paper will be of 6 credits**]:

[Papers are to be taken from any of the following discipline (**GE-2 from Mathematics**)]: **Mathematics/Physics/Chemistry/Computer Sc/Geology/Electronics/Economics /Zoology/Botany/Physiology**

Semester-II

Core Courses

Core-3

CC-3 : Mathematical Analysis   **Credits 06**

C3 T – Mathematical Analysis

Representation of real numbers as points on a line. Algebraic, Order and Completeness properties of **R** (Concepts only). Bounded and unbounded sets, neighbourhood of a point, Supremum and infimum. Functions, Countable, Uncountable sets and Uncountability of **R**. Sequences and their convergence, monotonic sequences, bounded sequences, squeeze theorem Limits of some special sequences such as r^n, $(1 + \frac{1}{n})^n$, $n^{\frac{1}{n}}$. Infinite series, positive termed series and their convergence, Comparison test, ratio test and root test. Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence.

Unit 2
Review of limit, continuity and differentiability. Indeterminate form, L' Hospital's rule. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's form of remainder(without proof). Taylor's series expansions of sinx, cosx, e^x, $(1 + x)^n$, log (1+x).Maxima and Minima of Functions. Successive Differentiation.

Unit 3
Integral Calculus: definite integral (definition). Statements of properties, Fundamental Theorem of Integral Calculus.
Improper Integral, Beta and Gamma functions: properties and relationship between them.

Unit 4
Functions of two variables and Partial Derivatives. Maxima and Minima of such Functions. Constrained Maximization and minimization, use of Lagrange Multiplier. Double Integral (intuitive-graphical approach),change of order of integration, transformation of variables and Jacobians (statement of relevant theoremsand their uses).

Reference Books
- Malik S.C. and Savita Arora (1994): Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
- Somasundram, D. And Chaudhary, B(1987).: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi.
- Gupta S.L. and Nisha Rani(1995): Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi.
- Apostol, T.M(1987).: Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi.
- Shanti Narayan(1987): A course of Mathematical Analysis, 12th revised Edition,

S. Chand & Co. (Pvt.) Ltd., New Delhi.

- Singa,l M.K. and Singal A.R (2003): A First Course in Real Analysis, 24th Edition, R. Chand& Co., New Delhi.
- Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
- Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
- Chakraborty, Arnab (2014): Real Analysis, volumes 1,2,3, second edition. Sarat Book House.

Core Course

CC-4 : Probability and Probability Distributions-II   **Credits 06**

C4 T – Probability and Probability Distributions-II   **Credits 04**

Continuous random variables, p.d.f. and c.d.f., illustrations and properties, univariate transformations with illustrations. Two dimensional random variables: continuous type, joint, marginal and conditional, p.d.f., and c.d.f..Independence of two variables.
Unit 2

Mathematical Expectation (discrete and continuous): Single & bivariate random variables and their properties.Probability generating function. Moments.Moment generating function. Correlation coefficient, Conditional expectation and variance. Probability Inequalities: Markov & Chebyshev.
Unit 3

Standard continuous probability distributions: uniform, normal, exponential, Cauchy, beta, gamma, lognormal, logistic, double exponentialand Pareto along with their properties and limiting/approximation cases.
Unit 4

 Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN.

Reference Books

- Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
- Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
- 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. 2ndEdn. (Reprint) John Wiley and Sons.
- Ross, S. (2002): A First Course in Probability, Prentice Hall.
- Feller, W. (1968): An Introduction to Probability Theory & its Applications, Vol-I, John Wiley.

C4 P – Probability and Probability Distributions-II Lab   Credits 02

1. Problems based on area property of normal distribution.
2. To find the ordinate for a given area for normal distribution.
3. Application based problems using normal distribution.
4. Fitting of normal distribution when parameters are given.
5. Fitting of normal distribution when parameters are not given.
6. Problems similar to those in 1 to 5 in cases of other continuous distributions.

Generic Elective Syllabus

GE-2 [Interdisciplinary for other department]

GE-2: Introductory Probability   Credits 06

GE 2T – Introductory Probability   Credits 04

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.

Unit 2

Random Variables: Discrete and continuous random variables, p.m.f., p.d.f., c.d.f. Illustrations of random variables and its properties. Expectation, variance, moments and moment generating function.

Unit 3

Convergence in probability, almost sure convergence, Chebyshev's inequality, weak law of large numbers, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem (C.L.T).

Unit 4

Standard probability distributions: Binomial, Poisson, geometric, negative binomial, hypergeometric, uniform, normal, exponential, beta, gamma.

Reference Books

- Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
- Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
- Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi
- Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I& II, 8th Edn. The World Press, Kolkata.
- Chakraborty, Arnab (2016) : Probability and Statistics. Sarat Book House.
- Ross, S. (2002): A First Course in Probability, Prentice Hall.

GE2P – Introductory Probability (Lab)   Credits 02

1. Fitting of binomial distributions for n and p = q = ½ given
2. Fitting of binomial distributions for n and p given
3. Fitting of binomial distributions computing mean and variance
4. Fitting of Poisson distributions for given value of lambda
5. Fitting of Poisson distributions after computing mean
6. Application problems based on binomial distribution
7. Application problems based on Poisson distribution
8. Problems based on area property of normal distribution
9. To find the ordinate for a given area for normal distribution
10. Application based problems using normal distribution
11. Fitting of normal distribution when parameters are given
12. Fitting of normal distribution when parameters are not given

Vidyasagar University

Curriculum for B.Sc (Honours) in Statistics
[Choice Based Credit System]

Semester-III

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC-5		**C5T:**Linear Algebra and Numerical Analysis	Core Course - 5	5	1	0	6	75
CC-6		**C6T:**Demography and Vital Statistics	Core Course - 6	4	0	0	6	75
		C6P: Demography and Vital Statistics Lab		0	0	4		
CC-7		**C7T:**Statistical Computing Using C/C++ Programming	Core Course - 7	4	0	0	6	75
		C7P: Statistical Computing Using C/C++ Programming Lab		0	0	4		
GE-3	TBD		Generic Elective -3				4/5	75
							2/1	
SEC-1		**SEC1T:**Statistical Data Analysis using R	Skill Enhancement Course-1	1	1	0	2	50
Semester Total							**26**	**350**

L=Lecture, **T**= Tutorial, **P**=Practical, **CC** = Core Course, **GE**= Generic Elective, **SEC** = Skill Enhancement Course, **TBD =** to be decided
Generic Elective (GE)(Interdisciplinary) from other Department [**Four papers are to be taken and each paper will be of 6 credits**]:
Papers are to be taken from any of the following discipline:
Mathematics/Physics/Chemistry/Computer Sc/Geology/Electronics/Economics/ Zoology/Botany/Physiology

Modalities of selection of Generic Electives (**GE**): A student shall have to choose **04** Generic Elective (GE1 to GE4) strictly from **02** subjects / disciplines of choice taking exactly **02** courses from each subjects of disciplines. Such a student shall have to study the curriculum of Generic Elective (GE) of a subject or discipline specified for the relevant semester.

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Semester-III
Core Course (CC)

CC-5: Linear Algebra and Numerical Analysis   **6 credits**

C5T:Linear Algebra and Numerical Analysis

Linear Algebra and Numerical Analysis

Unit 1
Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem. Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, Adjoint and inverse of a matrix and related properties.

Unit 2
Determinants of Matrices: Definition, properties and applications of determinants for $3^{rd}$and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

Unit 3
Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Quadratic forms: Classification & canonical reduction. Linear transformation. Applications of Linear Algebra in Statistics.

Unit 4
Numerical Analysis: Polynomials and Difference Tables. Approximation of functions and Weierstrass Theorem (statement).Lagrange and Newton formulae for Interpolation. Trapezoidal and Simpson's 1/3 Rulesfor approximations of definite integrals. Approximate solutions of Numerical Equations by Fixed-point Iteration and Newton-Raphson methods. Conditions of convergence.

Reference Books
- Lay David C (2000).: Linear Algebra and its Applications, Addison Wesley.
- Schaum's Outlines (2006): Linear Algebra, Tata McGraw-Hill Edition, 3^{rd}Edition.
- Krishnamurthy, V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).
- Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International.
- Gupta, S.C(2008).: An Introduction to Matrices (Reprint). Sultan Chand & Sons.
- Artin, M (1994): Algebra. Prentice Hall of India.
- Datta, K.B (2002): Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd.
- Hadley, G (2002) : Linear Algebra. Narosa Publishing House (Reprint).
- Searle, S.R (1982).: Matrix Algebra Useful for Statistics. John Wiley &Sons.

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- Chakraborty, Arnab (2014): Linear Algebra, first edition. Sarat Book House.
- 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.

CC-6: Demography and Vital Statistics   Credits 06

C6T: Demography and Vital Statistics   Credits 04

Demography and Vital Statistics

Unit 1

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekaran-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

Unit 2
Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality, Rate (IMR) and Standardized Death Rates.

Unit 3
Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality) Tables: Assumption, description, construction of Life Tables and Uses of Life Tables. Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR).

Unit 4
Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net
Reproduction Rate (NRR). Population Estimation, Projection and Forecasting: Use of A.P. and G.P. methods for population estimates,
Fitting of Logistic curve for population forecasting using Rhode's method.

Reference Books

- Mukhopadhyay, P. (1999): Applied Statistics, Books and Allied (P) Ltd.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2008): Fundamentals of Statistics, Vol. II, 9th Edition, World Press.
- Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.

- Keyfitz, N and Caswell. H (2005): Applied Mathematical Demography (3rd edition), Springer.
- Chattopadhyay, A.K. and Saha, A.K. (2012): Demography: Techniques and Analysis, Viva Books.
- Ramakuar, R. and Gopal, Y.S. (1986):Technical Demography. Wiley Eastern Ltd.

C6P: Demography and Vital Statistics Lab **Credits 02**

Demography and Vital Statistics Lab

List of Practical

1. To calculate CDR and Age Specific death rate for a given set of data
2. To find Standardized death rate by:-
   a. Direct method
   b. Indirect method
3. To construct a complete life table.
4. To fill in the missing entries in a life table.
5. To calculate CBR, GFR, SFR, TFR for a given set of data.
6. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data.
7. To calculate GRR and NRR for a given set of data and compare them.
8. Population Estimation.

CC-7: Statistical Computing Using C/C++ Programming **Credits 06**

C7T: Statistical Computing Using C/C++ Programming **Credits 04**

Statistical Computing Using C/C++ Programming

Unit 1
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: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data

Unit 2
Decision making and branching - if…else, nesting of if…else, else if ladder, switch, conditional (?) operator. 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. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).

Unit 3
User- defined functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions : no arguments and no return values, arguments but no return values , arguments with return values, no arguments but returns a value, functions that return multiple values. Recursion function. Passing arrays to functions, Storage class of Variables.

Unit 4
Pointers: Declaration and initialization of pointer variables, accessing the address of a variable, accessing a variable through its pointer, pointer expressions, pointer increments/decrement and scale factor. Pointers and arrays, arrays of pointers, pointers as function arguments, functions returning pointers

Structure: Definition and declaring, initialization, accessing structure members, copying and comparison of structure variables, array of structures, structure pointers. Dynamic memory allocation functions: malloc, calloc and free.

Pre-processors: Macro substitution, macro with argument
File inclusion in C/C++: Defining and opening a file (only r, w and a modes), closing a file, I/O operations on files-fscanf and fprintf functions.

Reference Books
- Kernighan, B.W. and Ritchie, D.(1988): CProgramming Language,2^{nd}Edition, Prentice Hall.
- Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition Tata McGraw Hill.
- Gottfried, B.S. (1998): Schaum's Outlines: Programming with C, 2^{nd}Edition, TataMcGraw Hill.

C7P: Statistical Computing Using C/C++ Programming Lab   Credits 02

Statistical Computing Using C/C++ Programming

List of Practical
1. Plot of a graph y = f(x).
2. Roots of a quadratic equation (with imaginary roots also).
3. Sorting of an array and hence finding median.
4. Mean, Median and Mode of a Grouped Frequency Data.
5. Variance and coefficient of variation of a Grouped Frequency Data.
6. Preparing a frequency table.
7. Random number generation from uniform, exponential, calculate sample mean and variance and compare with population parameters.
8. Matrix addition, subtraction, multiplication, Transpose and Trace.
9. Fitting of Binomial, Poisson distribution.
10. Compute ranks and then calculate rank correlation (without tied ranks).
11. Fitting of lines of regression.

12. Numerical methods: Solving one-variable equations using Newton-Raphson method.
13. Trapezoidal rule for numerical integration.
14. Solving a linear system of equation.

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Generic Elective Syllabus
GE-3 [Interdisciplinary for other department]

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GE-3: Basics of Statistical Inference   **Credits 06**

GE3T: Basics of Statistical Inference   **Credits 04**

Basics of Statistical Inference

Unit 1
Population and Sample, Parameter and Statistic, Population distribution and Sampling distribution.
Statistical Inference: Point Estimation, Interval Estimation and Testing of Statistical Hypothesis.
Four useful distributions for statistical Inference; Normal, χ^2 , t and F (Statement of the pdf's & shape of the curves)
Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). The basic idea of significance test. Null and alternative hypothesis. Type I& Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).

Unit 2
Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi-square test.

Unit 3
Tests for the significance of correlation coefficient. Sign test. Wilcoxon two-sample test.

Unit 4
Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, Statistical concepts of "treatment", "plot" and "block". Analysis of completely randomized design, randomized complete block design.

Reference Books

- Daniel, Wayne W., Bio-statistics (2005): A Foundation for Analysis in the Health Sciences. John Wiley .
- Goon, A.M., Gupta M.K. & Das Gupta (2005):Fundamentals of statistics, Vol.-I & II.
- Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
- Dunn, O.J (1977):   Basic Statistics: A   primer for the Biomedical Sciences. John Wiley.
- Bancroft, Holdon Introduction to Bio-Statistics (1962) P.B. Hoebar New York.
- Goldstein, a Biostatistics-An introductory text (1971). The Macmillion New York.

GE3P: Basics of Statistical Inference Lab   **Credits 02**

Basics of Statistical Inference Lab

List of Practical
1. Estimators of population mean.
2. Confidence interval for the parameters of a normal distribution (one sample and two sample problems).
3. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).
4. Chi-square test of proportions.
5. Chi-square tests of association.
6. Chi-square test of goodness-of-fit.
7. Test for correlation coefficient.
8. Sign test for median.
9. Sign test for symmetry.
10. Wilcoxon two-sample test.
11. Analysis of Variance of a one way classified data
12. Analysis of Variance of a two way classified data.
13. Analysis of a CRD.
14. Analysis of an RBD.

Skill Enhancement Course (SEC)

SEC-1: Statistical Data Analysis using R   **Credits 02**

SEC1T: Statistical Data Analysis using R

Statistical Data Analysis Using R

Unit 1
Introduction to R: Installation, commandline 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.

Unit 2
The different types of numbers in R: Division by zero leading to Inf or -Inf. NaN. NA. No need to go into details.
Variables. Creating a vector using c(), seq() and colon operator. How functions map overvectors.
Functions to summarise a vector: sum, mean, sd, medianetc. Extracting a subset from the vector (by index, by property).
R as a graphing calculator: Introduction to plotting. Plot(), lines(), abline(). No detailsabout the graphics parameters except colour and line width.Barplot, Pie chart and Histogram. Box plot. Scatter plot and simple linear regression using lm(y~x).

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Unit 3

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.

Unit 4

Problems on discrete and continuous probability distributions.

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. New York
- A simple introduction to R by Arnab Chakraborty (freely   available at http://www.isical.ac.in/~arnabc/)
- R for beginners by Emmanuel Paradis (freely available at   ftp://cran.r-project.org/pub/R/doc/contrib/Paradis-rdebuts_en.pdf)

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