PUNYASHLOK AHILYADEVI HOLKAR

SOLAPUR UNIVERSITY, SOLAPUR

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।

NAAC Accredited-2015
'B' Grade (CGPA 2.62)

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: BIOSTATISTICS

Name of the Course: M.Sc. Part-I

(Syllabus to be implemented from w.e.f. June 2020)

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

SCHOOL OF COMPUTATIONAL SCIENCES

DEPARTMENT OF STATISTICS

Syllabus of M.Sc. (Biostatistics)

(Choice Based Credit System)

1) **Title of the course:** M.Sc. (Biostatistics).
2) **Duration of course**: Two years.
3) **Pattern:** Semester and Credit system.
4) **Eligibility:**
   1. Bachelor Degree in Statistics
   2. Bachelor Degree in any science subject with Statistics as ancillary /allied subject.
   3. Bachelor Degree in Engineering or Pharmacy with at least two full papers of Mathematics or Statistics.

5)Strength of the Students: 20

M. Sc. program in Biostatistics consists of 100 credits. Credits of a course are specified against the title of the course.

A Four Semester M.Sc. Biostatistics Course

Semester	No. of Papers/ Practicals / Seminar	Marks	Credits
Semester I			
• Theory Papers	04	400	16
• Practical Paper	04	200	08
• Seminar/Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester II			
• Theory Papers	04	400	16
• Practical Paper	04	200	08
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester III			
• Theory papers	04	400	16
• Practical Paper	04	200	08
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Semester IV			
• Theory papers	04	400	16
• Practical Paper	04	200	08
• Seminar/ Tutorial/Home Assignment /Field Tour/ Industrial Visit	01	25	01
Total marks and credits for M.Sc. Course		**2500**	**100**

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY

M.Sc. Part-I (BIOSTATISTICS) CBCS Structure (w.e.f. June 2020-21)

Semester	Code	Title of the Paper	Semester Examination			L	T	P	Credits
			Theory	IA	Total				
Sem-I		**Hard Core**							
	HCT1.1	Probability Distributions	80	20	100	4	--	--	4
	HCT1.2	Sample Survey Methods	80	20	100	4	--	--	4
	HCT1.3	Basic Epidemiology	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT1.1	Statistical Ecology	80	20	100	4	--	--	4
	SCT1.2	Design of Experiments and Bioassay	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/ Field Tour	---	25	25	--	1	--	1
	HCP1.1	Introduction to MSEXCEL&SYSTAT	40	10	50	--	--	03	2
	HCP1.2	Introduction to R Software	40	10	50	--	--	03	2
	HCP1.3	Statistical Data Analysis -I (Based on HCT 1.1 and HCT 1.2)	40	10	50	--	--	03	2
	HCP1.4	Statistical Data Analysis -II (Based on HCT 1.3 and SCT 1.1 / SCT 1.2)	40	10	50	--	--	03	2
	Total for Semester-I		**480**	**145**	**625**	**--**	**--**	**--**	**25**
Sem-II		**Hard Core**							
	HCT2.1	Stochastic Processes	80	20	100	4	--	--	4
	HCT2.2	Statistical Inference-I	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT2.1	Statistical Genetics	80	20	100	4	--	--	4
	SCT2.2	Linear Algebra and Regression Techniques	80	20	100	4	--	--	4
		Open Elective(Any one)							
	OET2.1	Statistical Methods	80	20	100	4	--	--	4
	OET2.2	Vital Statistics	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/ Field Tour	---	25	25	--	1	--	1
	HCP2.1	Introduction to Minitab and Matlab	40	10	50	--	--	03	2
	HCP2.2	Introduction to SPSS	40	10	50	--	--	03	2
	HCP2.3	Statistical Data Analysis -III (Based on HCT 2.1, HCT2.2 and SCT2.1 / SCT 2.2)	40	10	50	--	--	03	2
	OEP2.1	Basic Statistical Computing (Based on OET2.1/ OET 2.2	40	10	50	--	--	03	2
	Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

HCT: Hard Core Theory HCP: Hard Core Practical SCT: Soft Core Theory
OET: Open Elective TheoryOEP: Open Elective PracticalIA: Internal Assessment
L:Lecture T:Tutorials P:Practical

Evaluation Scheme:

Each theory paper will have 100 marks out of which 80 marks will be for Term End examination and 20 marks for Internal Assessment. The candidate has to appear for internal evaluation of 20 marks and external evaluation (University Examination) of 80 marks for each theory paper.

Each practical paper will have 50 marks out of which 40 marks will be for Term End examination and 10 marks for Internal Assessment. The candidate has to appear for internal evaluation of 10 marks and external evaluation (University Examination) of 40 marks for each practical paper.

Internal Evaluation:

- In case of theory papers internal examinations will be conducted by department / school.
- In case of practical papers, 5 marks shall be for day-to-day journal and 5 marks shall be for internal test, which will be conducted by the department / school.

External Evaluation (End of Term University Examination):

I) Nature of Theory question paper:

Each Theory paper is of 80 marks and of three hours duration.

II) Nature of Practical question paper: (End of Term Examination) Sem-I and II

Practical examination will be conducted for 40 marks and is of two hours duration. There shall be 05 questions each of 10 marks, of which student has to attempt any 03 questions. VIVA will be for 10 marks.

Equivalence in accordance with titles and contents of theory papers for old and new syllabus.

M.Sc. Biostatistics Semester-I			
Old Syllabus		**New Syllabus**	
Paper Code	Title of Paper	Paper Code	Title of Paper
HCT 1.1	Introduction to Bio-Statistics	HCT 1.3	Basic Epidemiology
HCT 1.2	Design of Sample Surveys	HCT 1.2	Sample Survey Methods
HCT 1.3	Probability and distributions	HCT 1.1	Probability Distributions
SCT 1.1	Data Analysis using Software	SCT 1.2	Design of Experiments and Bioassay
SCT 1.2	Introduction to Ecology	SCT 1.1	Statistical Ecology
M.Sc. Biostatistics Semester-II			
HCT 2.1	Introduction to Basic Epidemiology	HCT 2.1	Stochastic Processes
HCT 2.2	Statistical Inference-I	HCT 2.2	Statistical Inference-I
SCT 2.1	Linear Algebra and Regression Techniques	SCT 2.1	Linear Algebra and Regression Techniques
SCT 2.2	Introduction to Statistical Genetics	SCT 2.2	Statistical Genetics
OET 2.1	Vital Statistics	OET 2.2	Vital Statistics
OET 2.2	Statistical Methods	OET 2.1	Statistical Methods

M.Sc. Part-I (BIOSTATISTICS)
SEMESTER-I

Hard Core	HCT 1.1: PROBABILITY DISTRIBUTIONS	No. of credits: 04

Unit-1: Random variables (discrete and continuous), Distribution function and its properties, Relation of distribution function with uniform variate. Review of univariate discrete and continuous distributions with special reference to biostatistics; Bernoulli, Binomial, Poisson, Hyper-geometric, Geometric, Negative binomial, Discrete uniform, Power series, Continuous uniform, Normal, Exponential, Gamma, Beta, Cauchy, Weibull, Pareto, Laplace and Lognormal (elementary properties and applications only), Truncated distributions, Compound distributions. (15L)

Unit-2: Functions of random variables, their distributions in case of univariate random variables and its applications. Exponential family of distributions.Location and scale families, non-regular families.Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples.Order statistics-their distributions and properties.Joint and marginal distributions of order statistics. (15L)

Unit-3: Expectation and moments, probability generating function, moment generating function, convolution and examples. Moment inequalities: Markov, Chebychev, Holder, Minkowski and Jensen inequalities with their applications. Basic inequality of Liapunov's. (15L)

Unit-4: Bivariate discrete and continuous distributions, marginal and conditional distributions. Distribution function of bivariate random variable using Jacobian of transformation. Multinomial distribution, Bivariate Poisson, Bivariate exponential (Marshall and Olkin), Bivariate Normal distributions and their properties. (15L)

Recommended Books:

1. Rohtagi V.K. and. Saleh A. K. M. E (2015): An Introduction to Probability Theory and Mathematical Statistics, 3rd Edition, Wiley.
2. Miller I. and Miller M. (1999): Mathematical Statistics, 6th Edition, Oxford & IBH Pub.
3. Ross S. M. (2014): Introduction to Probability Models, 11th Edition, Academic Press.
4. Dudewicz E. J. and S. N. Mishra S. N. (1988): Modern Mathematical Statistics, Wiley International Student Edition.

Hard Core	HCT 1.2: SAMPLE SURVEY METHODS	No. of credits: 04

Unit-1: Concepts of population and sample, need for sampling, census and sample surveys, designing of a questionnaire, sampling and non-sampling errors, sample size determination, finite population sampling techniques-SRSWR, SRSWOR, estimation of mean and total in each case and their variances. (15L)

Unit-2: Stratified sampling, allocation problems in stratified sampling, estimation of mean or total in each case and their variances. Systematic sampling: Linear and circular systematic sampling. The sample mean and its variance, comparison of systematic sampling with random sampling, comparison of systematic sampling with stratified sampling, Examples from health sciences. (15L)

Unit-3: Unequal probability sampling: PPSWR Methods: cumulative total method, Lahiri's method, related estimation problems, PPSWOR method and related estimation of a finite population mean, Horvitz-Thompson estimator of a finite population total/mean and expressions for variance and its unbiased estimator. Non-probability sampling: Incidental sampling, quota sampling, purposive sampling, snowball sampling, convenience sampling, consecutive sampling. Examples based on biostatistical experiments. (15L)

Unit-4: Auxiliary information in sample surveys, Ratio and regression estimators based on SRSWOR method of sampling, Double sampling, Cluster sampling, Two-stage sampling with equal number of second stage units. Examples based on biostatistical experiments. (15L)

Reference Books:

1. Sukhatme P.V., Sukhatme B.V., Sukhatme S. and Ashok C. (1997): Sampling Theory of Surveys and Applications-Piyush Publications.
2. Des Raj and P. Chandhok (1998*):* Sample Survey Theory. Narosa publishing House.
3. William G. Cochran (1977): Sampling Techniques, 3rd edition- John Wiley & Sons.
4. ParimalMukhopadhyay (1988): Theory and methods of Survey sampling, Prentice Hall of India Pvt. Ltd.
5. Murthy M.N. (1977): Sampling Theory and Methods, Statistical publishing Society, Calcutta.

Hard Core	HCT 1.3: BASIC EPIDEMIOLOGY	No. of credits: 04

Unit-1: Basic concepts and ethics of epidemiology, Measures of exposure and outcome: History of Epidemiology, Emergence of modern epidemiology, Measures of Exposures, Types of exposures, Sources of exposures, Measures of outcome. Measures of exposure effect, relative and absolute measures of effect. Communicable and non-communicable diseases. (15L)

Unit-2: Disease registries, International classification of diseases. Measures of disease frequency: Prevalence, Incidence, Risk, Odds of disease, Incidence time, Relationship between prevalence, rate and risk, measures of disease occurrence, direct and indirect method of standardization, cumulative rate, cumulative risk, proportional incidence. Confidence intervals and significance tests for measures of occurrence and effect.(15L)

Unit-3: Type of study design: Observational study, Intervention studies, Cohort studies, case-control studies, cross-sectional studies, ecological studies, Prospective and retrospective study. (15L)

Unit-4: Validity and reliability of measures of exposure and outcome: Sensitivity, Specificity, positive predictive value and negative predictive value, Intra and Inter-observer reliability, Kappa statistic. (15L)

Reference Books:

1. DeeptiShyam Sunder (2019) :Fundamentals of Epidemiology and Biostatistics, CBS Publishers & Distributors.
2. Alan J. Silman : Epidemiological Studies, Cambridge University Press
3. K. Park (2013):Parks's Textbook of Preventive and Social Medicine, BanarasidasBhanot Publishers, Jabalpur.

Soft Core	SCT 1.1: STATISTICAL ECOLOGY	No. of credits: 04

Unit-1: Introduction to ecology and evolution, population dynamics: single species Exponential, Logistic and Gompertz models, Leslie matrix model for age and stage Structured population, survivorship curves-Constant, monotone and bath tub shaped hazard rates. (15L)

Unit-2: Two Species: Lotka-Volterra equations, isoclines. Abundance estimation: Capture-recapture, Nearest Neighbor, line transect sampling, indirect methods. Ecological Diversity: Species abundance curve, indices of diversity (Simpson's index, Shannon Wiener index). (15L)

Unit-3: Game Theory in Ecology - Evolutionarily stable strategy, its properties, simple games such as Hawk-Dove game, Prisoner's dilemma, etc. Preservation of ecology and biodiversity. (15L)

Unit-4: Statistics for Ecology- Analysis of variance: basic assumptions and its violations, one and two way classified data. Multivariate analysis: discriminant analysis, hypothesis testing. (15L)

Reference Books:

1. Gore, A.P. and Paranjpe S.A. (2001): A course on Mathematical and Statistical Ecology- Kluwer Academic Publishers.
2. Pielou, E.C. (1977) An Introduction to Mathematical Ecology-Wiley
3. Hilborn and Mangel (1997): The Ecological Detective: Confronting Models with Data- Princeton University Press.
4. Henry M. and Stevens H. (2009): A primer of ecology with R- Springer.

Soft Core	SCT 1.2: DESIGN OF EXPERIMENTS AND BIOASSAY	No. of credits: 04

Unit-1: One way classification, Analysis of variance (ANOVA): One-way and Two-way, Single factor ANOVA, Two-factor ANOVA with unequal and equal replication (with/without interactions). Three basic principles of design of experiments: Randomization, replication and local control. Designs of Experiments: Completely Randomized Designs (CRD), Randomized Block Designs (RBD), Latin Square Designs (LSD). (15L)

Unit-2: Advanced Designs for Analysis, Repeated measures designs, ANCOVA (for CRD and RBD), Factorial Designs (2^2 and 3^2). (15L)

Unit-3: Introduction, component of bioassay, role of statistics in bioassay, Type of biological assays: direct assays, indirect assays, parallel line assays, ratio estimators, asymptotic distributions, Filler's theorem. (15L)

Unit-4: Dose response relationship, regression approaches to estimate dose response relationships, Logit and probit approaches when dose response curve for standard preparation is unknown, quantal response, method of estimation of parameters. (15L)

Reference Books:

1. Kempthorne O. (2007): Design and Analysis of Experiments, 2nd Edition, Vol I-II, Wiley.
2. Montgomery D. C. (2008): Design and Analysis of Experiment, 7th Edition, John Wiley & sons.
3. Dass M. N. and Giri N. C. (1986): Design and Analysis of Experiments, 2nd Edition, Wiley.
4. Pandey M. (2015): Biostatistics-Basic and Advanced-MV Learning.
5. Govindarajulu Z. (2000): Statistical Techniques in Bioassay, S. Kargar
6. Zar, J.H. (2007): Biostatistical Analysis, Pearson Education 4th edition.

M.Sc. Part-I (BIOSTATISTICS) SEMESTER-I (PRACTICAL PAPERS)

Hard Core	HCP 1.1: INTRODUCTION TO MS-EXCEL AND SYSTAT	No. of credits: 02

1. MS-EXCEL: Introduction to MS-Excel. Cell formatting, conditional formatting, Data manipulation using EXCEL: sort and filter, find and replace, text to columns. Built-in mathematical and statistical functions for obtaining descriptive statistic, computing PMF/PDF, CDF and quantiles of the well-known distributions, rand function, Logical functions: if, true, false, and, or, not. Lookup functions: choose hlookup, vlookup, index. Formula Errors, Creating and working with basic charts, Excel add-ins: analysis tool pack. Pivot tables and charts. Introduction to Excel macro.

2. SYSTAT: Data Editor, opening and saving a data file. Data Manipulation tools: List, Sort, Transform. Grouping variable, Category variable, Labeling Matrix: Read, Save, Standard matrix operations, Inverse, Characteristic roots and vectors, Spectral decomposition. Graphics: Bar, Histogram. Pie Chart, and Scatter plot. Descriptive statistics, Fitting of Distributions, Cross Tables, Correlations and Regression, Hypothesis Testing, ANOVA.

Hard Core	HCP 1.2: INTRODUCTION TO R SOFTWARE	No. of credits: 02

Getting Started with R: download and installation, introduction to components of R. Working with data in R: input from keyboard, import file-.xlx, .xlsx, .txt, .csv, etc.Creating vectors, performing arithmetic operations, adding elements to a vector, creating a matrix, matrix operations, extracting elements from a matrix, creating data frame, extracting elements from a data frame, Dealing with missing data. Programming in R: understanding the flow, operators-comparison and logical, looping, for loop, while loop, repeat loop, if loop. Creating your own function in R and export data from R to another format like .xlx, .xlsx, .csv, .txt. Statistical analysis in R: descriptive statistics, creating tables and graphs, correlation and regression, performing t-tests, ANOVA.

Recommended Books:

1. Larry Pace (2012), Beginning R: An Introduction to Statistical Programming, A press.
2. S.R. Deshmukh and S. Purohit. (2007) Microarray Data: Statistical Data Analysis using R, Alpha Science International.

Hard Core	HCP 1.3: STATISTICAL DATA ANALYSIS-I	No. of credits: 02

This paper includes practical problems using data from Biostatistical contexts based on papers HCT1.1 and HCT1.2. There will be at least eight practicals based on HCT1.1 and HCT1.2. Data Analysis using Microsoft Excel, SYSTAT and R software is expected.

Hard Core	HCP 1.4: STATISTICAL DATA ANALYSIS-II	No. of credits: 02

This paper includes practical problems using data from Biostatistical contexts based on papers HCT1.3 and SCT1.1/SCT 1.2. There will be at least eight practicals based on HCT1.3 and SCT1.1/ SCT1.2. Data Analysis using Microsoft Excel and R software is expected.

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M.Sc. Part-I (BIOSTATISTICS)
SEMESTER-II

Hard Core	HCT 2.1: STOCHASTIC PROCESSES	No. of credits: 04

Unit-1: Definition of Stochastic process, Finite dimensional distributions. Examples of various stochastic processes.Markov chain and its Examples.Chapman-Kolmogorov equation, calculation of n-step transition probabilities.Classification of states of Markov chain, irreducible Markov chain, period of the state,First entrance theorem, First passage time distribution. Long run distribution of Markov chain, relation of mean recurrence time and stationary distribution. (15L)

Unit-2: Random walk and gambler's ruin problem.Discrete state space continuous time Markov chain.Poisson process and related results. Birth and death processes and associated cases. M/M/1, M/M/S queuing models and related properties.(15L)

Unit-3:Galton-Watson branching process. Probability of ultimate extinction, distribution of population size and associated results. Simulation of Markov chain, Poisson process, branching process (Algorithms) (15L)

Unit-4: Brownian motion, Hitting Time, Maximum, Reflection PrincipleStopping Time and Strong Markov Property, Reflection Principle.(15L)

Reference Books:

1. Medhi. J. (1982).Stochastic Process- Wiley Eastern.
2. Parzen E. (1962).Stochastic Process-Holden-Pay.
3. Karlin& Taylor (1975).A First Course in Stochastic Processes-Vol-I Academic Press.
4. Cinlar E. (1975).Introduction to Stochastic Process.Prentice Hall.
5. Srinivas and Mehta (1976).Stochastic Processes-Tata MgGraw-Hill.
6. Adke and Manjunath (1984).An introduction to finite Markov Processes- Wiley Eastern.
7. Bhat B.R. (2000). Stochastic Model: Analysis and Application, New Age International.
8. Sheldon Ross: Introduction to Probability Models, 11th Edition, Academic Press Publication.

Hard Core	HCT 2.2: STATISTICAL INFERENCE-I	No. of credits: 04

Unit-1: Sufficiency principle, factorization theorem, minimal sufficiency, minimal sufficient partition, construction of minimal sufficient statistic, minimal sufficient statistic for exponential families, power series family and pitman family. Completeness, bounded completeness, ancillary statistic, Basu's theorem and applications. (15 L)

Unit-2: Problem of point estimation, unbiased estimators, minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their uses. Necessary and sufficient condition for MVUE. Fisher information and information matrix, Cramer-Rao inequality, Bhattacharya bound, their applications.(15 L)

Unit-3: Consistent estimation of real and vector valued parameter, Weak and strong consistency, Joint and marginal consistency, invariance of consistent estimator under continuous transformation, Consistency of estimators by method of moments and method of percentiles, mean squared error criterion, Asymptotic relative efficiency. Consistent asymptotic normal (CAN) estimator, Invariance of CAN estimator under differentiable transformation. (15 L)

Unit-4: Methods of Estimation: Method of maximum likelihood estimation (MLE) and small sample properties of MLE, Method of moments, Method of minimum chi-square, Method of scoring. (15L)

Reference Books:

1. Rohtagi V.K. and Saleh A.K. Md. E (2001): Introduction to Probability Theory and Mathematical Statistics- John Wiley and Sons Inc.
2. Rao C.R. (1973): Linear Statistical Inference and Applications- John Wiley and Sons, Inc.
3. Casella G. and Berger R.L. (2002): Statistical Inference-Duxbury Advanced Series, 2nd ed.
4. Kale B.K. (2005): First Course on Parametric Inference- 2nd ed. Narosa Publishing House.
5. Lehmann E.L. (1983): Theory of Point Estimation- John Wiley and Sons.
6. Pandey M. (2015): Biostatistics-Basic and Advanced-MV Learning
7. Rajgopalan M. and Dhanavanthan p. (2012): Statistical Inference-PHI Learning Pvt. Ltd.
8. Srivastava M. K., Khan A. H. and Srivastava N. (2014): Statistical Inference-Theory of Estimation- PHI Learning Pvt. Ltd.

Soft Core	SCT 2.1: STATISTICAL GENETICS	No. of credits: 04

Unit-1: Basic biological concepts in genetics, Mendel's law, Hardy Weinberg equilibrium, estimation of allele frequency (dominant/co-dominant cases), Approach to equilibrium for X-linked gene. Law of natural selection, mutation, genetic drift. (15L)

Unit-2: Non-random mating ,inbreeding, phenotypic assortative mating. I ,T,O matrices, identity by descent. (15L)

Unit-3: Family data-estimation of segregation ratio under ascertainment bias, pedigree data :Elston - Stewart algorithm for calculation of likelihoods. Linkage, estimation of re-combination fraction, inheritance of quantitative traits.(15L)

Unit-4: Population Genetics: Random mating, genetical variance and correlations, multiple alleles and blood types, maximum likelihood method of estimation, Sex linked genes, Autopolyploid.(15L)

Reference Books:

1. SharadGogate:Preventive Genetics- JAYPEE Publishers.
2. AgarwalB. L. and Agarwal S. P.: Statistical Analysis of Quantitative Genetics- New Age International Publishers
3. Liu B.H. (1998). Statistical Genomics, CRC Press, New York.
4. Falconer D.S. (1970). Introduction to Genetics, Oliver and Boyd.

Soft Core	SCT 2.2: LINEAR ALGEBRA AND REGRESSION METHODS	No. of credits: 04

Unit-1: Vector space, subspace, linear dependence and independence, basis of vector space, dimension of a vector space, orthogonal and orthonormal vectors. Matrix algebra, special types of matrices, orthogonal matrix, idempotent matrix, partitioned matrices, elementary operations, rank of a matrix, and inverse of a matrix (15L)

Unit-2: Simple linear regression model: Assumptions and estimation of model parameters, Standard error of estimators, Testing of hypotheses on slope and intercept. Coefficient of determination (R^2). Multiple linear regression model: Least square estimation of model parameters, variance covariance of least squares estimators, estimation of error variance, tests of hypotheses of regression parameters. (15 L)

Unit-3: Multicollinearity: Consequences, detection and remedies, Autocorrelation, consequences, Durbin-Watson test. Variance stabilizing transformations to linearize the model. Variable Selection: Selection of variables by forward selection, backward elimination and stepwise regression (algorithms only). (15L)

Unit-4: Introduction to Non-linear regression, transformation to a linear model. Introduction to Poisson and Non-parametric regressions. (15L)

Reference Books:

1. Schaum's Outline: Linear Algebra, 3rd edition: Seymour Lipschutz and Marc Lipson
2. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2003): Introduction to Linear regression analysis, John Wiley and Sons, Inc. 3rd edition
3. Draper, N.R. and Smith, H. (2003): Applied Regression Analysis, John Wiley and Sons, Inc. 3rd edition.

OET	OET 2.1: STATISTICAL METHODS	No. of credits: 04

Unit-1: Descriptive Statistics: Measures of central tendency, arithmetic mean, geometric mean, harmonic mean, median and mode for grouped and ungrouped data with examples. Measures of dispersion, range, quartile deviation, variance, standard deviation, coefficient of variation, skewness and kurtosis.Examples and problems.(15L)

Unit-2: Correlation and regression: Scatter diagram, Karl Pearson's coefficient of correlation, rank correlation, regression, lines of regression, regression coefficients, fitting of regression lines. Examples and problems.(15L)

Unit-3: Probability and Probability distributions: Random experiment, Trial, Sample space, Sample point and different types of events. Classical definition of Probability, addition and multiplication rules.Random variable (discrete and continuous) and its probability distribution. Probability mass function and Probability density function. Bernoulli, Binomial, Poisson, Uniform, Exponential and Normal distributions, their means and variances.(15L)

Unit-4: Testing of hypothesis: Notion of hypothesis, null and alternative hypothesis, simple and composite hypothesis, test statistic, critical region, idea of one and two tailed test, type-I and type-II errors, level of significance, Hypothesis testing for mean and proportion. Hypothesis testing for difference of two means and two proportions.chi-square test for independence of attributes, Nonparametric run test, sign test and signed-rank test. (15L)

Reference Books:

1. Gupta S.C. and Kapoor V.K.: Fundamentals of Mathematical Statistics. Sultan Chand & Sons Publications, New Delhi.
2. Kapoor J.N and Saxana H.C : Mathematical Statistics, Sultan Chand &Sons Publications, New Delhi
3. Kulkarni M.B., Gore A.P. and Ghatpande S.B.: Statistical Tests, SatyajeetPrakashan, Pune.

OET	OET 2.2: VITAL STATISTICS	No. of credits: 04

Unit-1: Introduction to Demography, Definition and uses of demographic data, Source of vital statistics: Census method-Registration method, Sources of demography data: secondary sources - SRS– surveys. (15L)

Unit-2: Mortality and Fertility: Nature and uses of mortality statistics, Mortality measures: Crude death rate (CDR) and Age-specific death rates (ASDR), Infant mortality rate(IMR), Fertility measures: Basic terms and concepts used in the study of fertility, Measures of fertility: Crude birth rate(CBR), Age specific fertility rate (ASFR), General fertility rate (GFR), Total fertility rate (TFR). (15L)

Unit-3: Measurement of Population Growth: Pearl's vital index, Gross reproductive rate (GRR) and Net reproductive rate (NRR). Life table: Description of life table, construction of complete and abridged life tables, uses of life table.(15L)

Unit-4: Concept of mobility and migration, types of migration, internal migration and its measurement, migration models, concept of international migration. Net-migration. International and postcensal estimates. Projection method including logistic curve fitting.Decennial population census in India. (15L)

Reference Books:

1. Goon A.M., Gupta M. K., Dasgupta B. (2008): Fundamentals of Statistics, Published by Prentice Hall, 2nd edition.
2. Gupta S.C. and Kapoor V.K. (2000): Fundamentals of Mathematical Statistics, Sultan Chand Sons 10th edition.
3. Pathak, K.B. and Ram F. (1998): Techniques of Demographic Analysis, Mumbai, Himalaya Publishing House.
4. Shrivastava O.S. (1995): Demography and population Studies, Vikas Publishing house private limited, 2nd edition.

M.Sc. Part-I (BIOSTATISTICS) SEMESTER-II (Practical Papers)

Hard Core	HCP 2.1: INTRODUCTION TO MINITAB AND MATLAB	No. of credits: 02

1. MINITAB: Getting started with Minitab: Menu bar, Worksheet, Minitab commands and sub commands, Data entry into worksheet, Importing data, Saving, Retrieving, Printing file. Operators and functions: Arithmetical operations, Mathematical functions, Column and Row statistics, Comparisons and Logical operations, Coding, Computing ranks, Sorting data, Stacking and Unstacking columns. Exploratory data analysis: Tallying data, Describing data, Histograms, Box plots, Bar charts Pie charts. Correlation and Regression: Correlation: Scatter plots, Karl Pearson correlation coefficient, Regression: Simple and Multiple regression. Matrix operation and Macros: Creating matrices, Commands for matrix operations, Writing simple macros.

2. MATLAB: To Launch the Matlab application to get a command line prompt, Import/export of data from/to external files, Creating and manipulating new variables from the command line, Using the built-in help documentation. Simple linear algebra with matrices: transpose, products, powers, element-by-element products, determinants, inverse, g-inverse, Characteristic roots and related commands, Sort, minimum, maximum. Prepare simple macros in the form of M-files: if-else-end, :for-end, while –end and other statements. Using built-in functions and tool-boxes, creating new function files, Numerical integration, Roots of polynomials and solving complicated equations. 2-D and 3-D Mathematical and Statistical plots. Generating random numbers from different probability distributions, Descriptive Statistics, Hypothesis testing, Linear regression analysis, ANOVA.

Text Books / Reference Books:

1. David Moore, George McCabe: MINITAB Manual Introduction to the Practice of Statistics, Michael Evans University of Toronto.
2. Barbara F. Ryan, Brian L. Joiner, Jonathan D. Cryer: Minitab Handbook- Updated for Release 14, Cengage Learning, 2005.
3. Ruth K. Meyer, David D. Krueger: A Minitab Guide to Statistics, Prentice Hall, 1998.
4. Thomas Arthur Ryan, Brian L. Joiner, Barbara F. Ryan: Minitab student handbook, Duxbury Press, 1976.
5. Enander, Eva Part (1996): Matlab handbook.
6. Hanselman, D (1998):Mastering matlab 5: Prentice Hall
7. Etter, Delores M (1997): Engineering problem solving with matlab, Prentice Hall
8. Pratap, Rudha(2006): Getting started with matlab 7: A quick introduction for scientist and engineers Oxford University Press.
9. Sigh, Y. Kiran (2007): Matlab programming: Prentice Hall

Hard Core	HCP 2.2: INTRODUCTION TO SPSS	No. of credits: 02

Getting started with SPSS: Data editor, Output viewer, Syntax editor, Script window, Variable view. Charts and Graphs: Line chart, Scatter Plots, Histogram, Bar chart, Box Plot, Pie chart. Exploratory data analysis: Sum, Mean, Standard deviation, Variance, Minimum value, Maximum value and Range. Correlation and Regression: Correlation: Scatter plots, Karl Pearson correlation coefficient, Partial correlation, Spearman correlation, Regression: Simple and Multiple regression. Testing of hypotheses: Chi square test for association, Chi-square test goodness of fit, Independent sample t test, Paired sample t test, One sample t test, Report generation.

Text Books / Reference Books:

1. William C. Rinaman: Workshop Statistics: SPSS Software Companion Manual, Key College Publishing, 2004.
2. Ton J. Cleophas, Ton J. M. Cleophas, Aeilko H. Zwinderman: Cookbook for Starters on SPSS, Springer.
3. EelkoHuizingh: Applied Statistics with SPSS, SAGE, 2007.

Hard Core	HCP 2.3: STATISTICAL DATA ANALYSIS-III	No. of credits: 02

This paper includes practical problems using data from Biostatistical contexts based on papers HCT2.1, HCT2.2 and SCT2.1/SCT2.2. There will be at least eight practicals based on HCT2.1, HCT2.2 and SCT2.1/SCT2.2. Data Analysis using Excel/SYSTAT/ R/SPSS software is expected.

OPEN ELECTIVE	OEP 2.1: BASIC STATISTICAL COMPUTING	No. of credits: 02

This paper includes practical problems from papers OET2.1/OET 2.2. There will be at least eight practicals based on OET2.1/OET 2.2. Each practical should consist of problems to be solved using MS-Excel or Scientific calculator.

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