BSC MATHS (COMPLEMENTARY)

2017-18, 2018-19

BASIC STATISTICS AND PROBABILITY(STA1C01)

Module 1: Population, sample, , measures of central tendency,arithmetic mean,weighted arithmetic mean, geometric mean, harmonic mean, median, mode, partition values,quartile,percentile, measures of deviations,variance, standard deviation, mean deviation about mean, quartile deviation, coefficient of variation
20 hours

Module 2: Fitting of straight line, parabola, exponential, polynomial, (least square method), correlation, regression, two regression lines, regression coefficients,properties.rank correlation, partial and multiple correlation (3variables)
15 hours

Module 3: Random experiment, Sample space, event, classical definition of probability, statistical regularity, relative frequency definition, field, sigma field, axiomatic definition of probability and simple properties, concept of probability measure, addition theorem (two and three events), conditional probability of two events, multiplication theorem, independence of events(pair wise and mutual), Bayes theorem. –numerical problems
25 hours

Module 4: Random variable,discrete and continuous, probability mass function (pmf) and probability density function (pdf)properties and examples, cumulative Distribution function and its properties, change of variable (univariate case)
12 hours

References

5. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
6. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chan and Sons
7. A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
8. John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

II-PROBABILITY DISTRIBUTIONS (STA2C02)

Module 1: Mathematical expectations (univariate): Definition, raw and central moments (definition and relationships), moment generating function and properties, characteristic function (definition and use only), Skewness and kurtosis (using moments)
15 hours

Module 2: Bivariate random variable: joint pmf and joint pdf, marginal and conditional probability, independence of random variables, function of random variable. Bivariate Expectations, conditional mean and variance, covariance, Karl Pearson Correlation coefficient, independence of random variables based on

expectation.
15 hours

Module 3: Standard distributions: Discrete type Bernoulli,Binomial, Poisson, Geometric, negative binomial (definition, properties and applications), Uniform (mean, variance and mgf), Continuous type Uniform,exponential, gamma, Beta, Normal (definition, properties and applications), Lognormal, Pareto and Cauchy (Definition only)
30 hours

Module 4:Chebyshev's inequality, variables, Convergence in probability weak law of large numbers (iid case), Bernoulli law of large numbers, example only), Central limit theorem (Lindberg Levy iid case)
12 hours

References

9. V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
10.S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons
11.A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
12.John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

III. STATISTICAL INFERENCE (STA3C03)

Module 1: Sampling distributions: Statistic, Sampling distribution of a statistic, Standard error, Sampling from normal distribution, distribution of sample mean, sample variance, chi square distribution, t distribution, and F distribution (definition, derivations and relationships only).
25 hours

Module 2: Theory of Estimation: Point Estimation, desirable properties of a good estimator, unbiasedness, consistency, sufficiency, Fisher Neyman factorization theorem, efficiency.Methods of Estimation:Method of maximum likelihood, method of moments.
20 hours

Module 3: Interval Estimation: Interval estimates of mean, difference of means, variance, proportions and difference of proportions. Derivation of exact confidence intervals for means, variance and ratio of variances based on normal, t, chi square and F distributions
15 hours

Module 4: Testing of Hypotheses: concept of testing hypotheses, simple and composite hypotheses, null and alternative hypotheses, type I and II errors, critical region, level of significance and power of a test. Neyman Pearson approach: Large sample tests concerning mean equality of means, proportions, equality of proportions, Small sample tests based on t distribution for mean, equality of means and paired t test. Tests based on F distribution for ratio of variances. Tests based on

Chi square distribution for variance, goodness of fit and for independence of attributes:
30 hours

References

V. K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
S.C.Gupta and V. K. Kapoor Fundamentals of Mathematical Statistics, Sultan Chand and Sons
A.M. Mood, F.A. Graybill and D C Bose, Introduction to Theory of Statistics, McGraw Hill
John E Freund, Mathematical Statistics (6th edn), Pearson Edn, NewDelhi

IV: APPLIED STATISTICS (STA4C04)

Module 1:Census and Sampling, Principal steps in a sample survey, different types of sampling, Organisation and execution of large scale sample surveys, errors in sampling (Sampling and non sampling errors) preparation of questionnaire, simple random sampling with and without replacement, Systematic,stratified and cluster sampling (concept only)
20 hours

Module 2:Analysis of variance; one way, two way classifications. Null hypothesis, total, between and within sum of squares. Assumptions ,ANOVA table.
15 hours

Module 3: Time series :Components of time series, additive and multiplicative models, measurement of trend, moving averages, seasonal indices, simple average, ratio to moving average.Index numbers: meaning and definition ,uses and types, problems in the construction of index numbers different types of simple and weighted index numbers. Test for an ideal index number, time and factor reversal test.
30 hours

Module 4:Statistical Quality Control: Concept of statistical quality control, assignable causes and chance causes, process control. Construction of control charts, 3sigma limits. Control chart for variables, Mean chart and Range chart. Control chart for attributes, pchart,d or np chart and chart
25 hours

References

1. S.C.Gupta and V. K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand and Sons
2. Grant E L, Statistical quality control, McGraw Hill
3. Duncan A J, Quality Control and Industrial Statistics, Taraporewala and sons
4. Montegomery D C, Introduction to Statistical Quality Control, John Wiley and sons
5. S.P.Gupta: statistical methods

2019-20, 2020-21, 2021-22

I. **INTRODUCTORY STATISTICS (CODE: STA1C01)**

Module 1: Official statistics: The Statistical system in India: The Central and State Government organizations, functions of the Central Statistical Office (CSO), National Sample Survey Organization (NSSO) and the Department of Economics and Statistics.

7 hours

Module 2: Introduction to Statistics: Nature of Statistics, Uses of Statistics, Statistics in relation to other disciplines, Abuses of Statistics. Concept of primary and secondary data. Designing a questionnaire and a schedule. Concepts of statistical population and sample from a population, quantitative and qualitative data, Nominal, ordinal and time series data, discrete and continuous data. Presentation of data by table and by diagrams, frequency distributions by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods) and ogives. Measures of central tendency (mean, median, mode, geometric mean and harmonic mean) with simple applications. Absolute and relative measures of dispersion (range, quartile deviation, mean deviation and standard deviation) with simple applications. Co-efficient of variation, Box Plot. Importance of moments, central and non-central moments, and their interrelationships. Measures of skewness based on quartiles and moments; kurtosis based on moments.

30 hours

Module 3: Correlation and Regression: Scatter Plot, Simple correlation, Simple regression, two regression lines, regression coefficients. Fitting of straight line, parabola, exponential, polynomial (least square method).

15 hours

Module 4: Time series: Introduction and examples of time series from various fields, Components of times series, Additive and Multiplicative models. Trend: Estimation of trend by free hand curve method, method of semi averages, method of moving averages and fitting various mathematical curves. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend. Index numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's.

20 hours

References:

1. S.C. Gupta and V.K. Kapoor. Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi

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

3. Mukhopadhyay P. (2011): Applied Statistics, 2nded. Revised reprint, Books and Allied

4. Hoel P.G. Introduction to mathematical statistics, Asia Publishing house.

5. Chatfield.C. The Analysis of Time Series: An Introduction, Chapman & Hall

6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.

II. PROBABILITY THEORY (CODE: STA2C02)

Module 1: Introduction to Probability: Random experiment, Sample space, events, classical Definition of probability, statistical regularity, field, sigma field, axiomatic definition of Probability and simple properties, addition theorem (two and three events), conditional Probability of two events, multiplication theorem, independence of events-pair wise and Mutual, Bayes theorem and its applications.

25 hours

Module 2: Random variables: Discrete and continuous, probability mass function (pmf) and Probability density function (pdf)-properties and examples, Cumulative distribution function And its properties, change of variables (univariate case only)
12 hours

Module 3: Mathematical expectations (univaraite): Definition, raw and central Moments(definition and relationships), moment generation function and properties, Characteristic function (definition and use only), Skewness and kurtosis using moments

15 hours

Module 4: Bivariate random variables: Joint pmf and joint pdf, marginal and conditional Probability, independence of random variables, function of random variable. Bivariate Expectations, conditional mean and variance, covariance, Karl Pearson Correlation Coefficient, independence of random variables based on expectation.

20 hours

References :

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

2.S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand And Sons.

3.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.

4.John E Freund, Mathematical Statistics, Pearson Edn, New Delhi

III. PROBABILITY DISTRIBUTIONS AND SAMPLING THEORY. (CODE:STA3C03)

Module 1: Standard distributions: Discrete type-Bernoulli, Binomial, Poisson, Geometric, Negative Binomial (definition only), Uniform (mean, variance and mgf). Continuous type-Uniform, exponential and Normal (definition, properties and applications); Gamma (mean, variance, mgf); Lognormal, Beta, Pareto and Cauchy (Definition only)

30 hours

Practical: construction of graphs of distributions using excel

Module 2: Limit theorems: Chebyshev's inequality, Sequence of random variables, parameter and Statistic, Sample mean and variance, Convergence in probability (definition and example only), weak law of large numbers (iid case), Bernoulli law of large numbers, Convergence in distribution (definition and examples only), Central limit theorem (Lindberg levy-iid case)
25 hours

Module 3: Sampling methods: Simple random sampling with and without replacement, systematic sampling (Concept only), stratified sampling (Concept only), Cluster sampling(Concept only)

10 hours

Module 4: Sampling distributions: Statistic, Standard error, Sampling from normal distribution, distribution of sample mean, sample variance, chi-square distribution, tdistribution, and F distribution (definition, derivations and relationships only).

25 hours

References:

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

2. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons.

3.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.

4.. John E Freund, Mathematical Statistics, Pearson Edn, NewDelhi

5. Cochran W.G. (1984):Sampling Techniques(3rdEd.), Wiley Eastern

IV: STATISTICAL INFERENCE AND QUALITY CONTROL. (CODE: STA4C04)

Module 1: Estimation theory: Parametric space, sample space, point estimation. Nayman Factorization criteria, Requirements of good estimator: Unbiasedness, Consistency, Efficiency, Sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality (definition only). Minimum Variance Bound (MVB) estimators. Methods of estimation: Maximum likelihood estimation and Moment estimation methods (Detailed discussion with problems); Properties of maximum likelihood estimators (without proof); Least squares and minimum variance (concepts only). Interval estimation: Confidence interval (CI);CI for mean and variance of Normal distribution; Confidence interval for binomial proportion and population correlation coefficient when population is normal.

30 hours

Module 2: Testing of Hypothesis: Level of significance, Null and Alternative hypotheses, simple and composite hypothesis ,Types of Errors, Critical Region, Level of Significance, Power and p-values. Most powerful tests, Neyman-Pearson Lemma (without proof), Uniformly Most powerful tests. Large sample tests: Test for single mean, equality of two means, Test for single proportion, equality of two proportions. Small sample tests: t-test for single mean, unpaired and paired t-test. Chi-square test for equality of variances, goodness of fit, test of independence and association of attributes. Testing means of several populations: One Way ANOVA, Two Way ANOVA (assumptions, hypothesis, ANOVA table and problems)

35 hours

Module 3: Non-parametric methods: Advantages and drawbacks; Test for randomness, Median test, Sign test, Mann-Whiteny U test and Wilcoxon test; Kruskal Wallis test (Concept only)

10 hours

Module 4: Quality Control: General theory of control charts, causes of variations in quality, control limits, sub-grouping, summary of out-of-control criteria. Charts of variables - X bar chart, R Chart and sigma chart. Charts of attributes – c-charts, p-chart and np-chart.(Concepts and problems).

15 hours

References:

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

2. Gupta, S.P. Statistical Methods. Sultan Chand and Sons: New Delhi.

3. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons

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

5. John E Freund, Mathematical Statistics, Pearson Edn, NewDelhi

6. Grant E L, Statistical quality control, McGraw Hill

7. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

MSc INTEGRATED BIOLOGY (COMPLEMENTARY)

Code : BST1IC01T

BASIC STATISTICS AND INTRODUCTION TO BIOSTATISTICS

MODULE 1. (1 hr)

Introduction. Definition; scope; role of statistics in life sciences; terminology and variables.

MODULE 2. Types of Data (7 hrs)

Primary and Secondary data; Qualitative and quantitative data; Cross sectional and time series data; raw data, Discrete and Continuous data; Nominal, Ordinal, Ratio and Interval scales; Collection and documentation of data of the experiments. Significance of statistical tools in data interpretation.

MODULE 3. Presentation of data (9 hrs)

Frequency distribution and cumulative frequency distribution; formation of a frequency distribution. Tabular, Graphical and Diagrammatic presentations: histogram, frequency polygon and frequency curve; ogives, line diagram, bar diagram and pie diagram. Construction of histogram, frequency polygon, frequency curve, line diagram, bar diagram and pie diagram.

MODULE 4. Measures of Dispersion (8 hrs)

Measures of Dispersion: (raw data, discrete series data, continuous series data - problems to be discussed) a) Range, b) Mean deviation, c) Standard deviation, d) Standard error. Geometric Mean, Harmonic Mean, Combined Mean, Advantages and disadvantages of each average. Moments about mean and about any point; effect of change of origin and scale on moments.

MODULE 5. Skewness and Kurtosis (4 hrs)

Skewness and Kurtosis- Pearson's and Bowley's coefficient of skewness, Percentile Measure of Kurtosis. Coefficients of Skewness and Kurtosis with their interpretations.

MODULE 6. Probability (7 hrs)

Concepts in Probability: Random experiment / trial; Definition of probability - classical, relative frequency; statistical and axiomatic approach, conditional probability; addition and multiplication laws of probability. Probability function; probability mass function, probability density function and its properties.

Topics for Assignments/Seminars *(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Prepare a table showing the marks of the students in a class. Calculate the mean, median and mode. Compare the results.
2. Report an experimental data in tabular / graphical form (any of the form they have studied).
3. What are the mathematical properties of Standard Deviation? Compare the properties with that of Mean Deviation and Range.
4. Calculate the arithmetic mean and the SD of the frequency distribution obtained from a sample of data.

REFERENCES

- Antonisamy B, Prasanna S. Premkumar and Solomon Christopher (2017) Principles and Practice of Biostatistics, ISBN-10: 8131248879, Elsevier, 390 pages
- Bailey, N. T. J (1995): Statistical Methods in Biology, 3rd Edition, CUP, 272 pages
- Green, R. H. (1979) Sampling design and Statistical Methods for Environmental Biologists. ISBN 978-0-471-03901-3, J.W. & S. 272 pages
- Goon A. M., Gupta M. K., and Dasgupta, B. (2008). Fundamentals of Statistics. Published by Prentice Hall, 2nd Edn.
- Gupta, S. P. (2018) Statistical Methods. 45th Revised Edition, ISBN 978-93-5161-112-7 (506), Sultan Chand & Co.1440 pages
- Gupta, S.C., & Kapoor, V.K. Fundamentals of Applied Statistics. New Delhi: Sultan Chand and Sons.
- Garret, H.E., & Woodworth, R.S. Statistics in Psychology and Education. Bombay: Vakila, Feffex and Simens Ltd.
- Mukhopadhyay,P. Mathematical Statistics. New central Book Agency (P) Ltd: Calcutta.
- Wayne W. Daniel and Chad L. Cross (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10th Edition, ISBN-10: 8126551895, Wiley, 954 pages

SECOND SEMESTER INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME

BIOSTATISTICS ALLIED CORE COURSE II (Theory)

Code : BST2IC02T

ANALYSIS AND STATISTICAL INFERENCE I

MODULE 1. Bivariate random variable (4 hrs)

Bivariate random variable - relationship of variables, joint pmf and joint pdf, marginal and conditional probability, independence of random variables.

MODULE 2. Correlation and Regression analysis (8 hrs)

Correlation analysis, methods of studying correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Calculation of Correlation from a 2-way table, Interpretation of Correlation Coefficient, Rank Correlation and Regression analysis- linear regression, Regression Equation, Identifying the Regression Lines, properties of regression coefficients, numerical problems, probability analysis of variables.

MODULE 3. Sampling and Surveys (10 hrs)

Sample and Sampling: Sample size, sampling errors, methods of sampling. Census and Sampling, principal steps in sample survey-probability sampling, judgment sampling, organization and execution of large sample surveys, sampling and non-sampling errors, preparation of questionnaire. Simple random sampling, Stratified random sampling, Systematic Sampling, Cluster sampling. Random sampling with replacement, Estimation of standard error from a sample, Estimation of a ratio, estimates of means over subpopulations, estimates of totals over subpopulations, Comparison between domain means, Linear estimators of the population mean. Advantages of Sampling method.

MODULE 4. Statistical estimation (9 hrs)

Parameter and statistics, Sampling distribution of statistic, point and interval estimate of a parameter, Concept of bias and standard error of an estimate, Standard errors of sample mean, sample proportion, and standard deviation. Properties of a good estimator – Unbiasedness, Efficiency, Consistency, Sufficiency, Cramer Rao's Inequality, Consistency and asymptotic efficiency, Fisher's Information function, Rao-Blackwell theorem. Methods of Estimation.

MODULE 5. Sample size estimation (5 hrs)

A hypothetical example, Analysis of the problem, the specification of precision, The formula for n in Sampling for proportions, Rare items – Inverse sampling, the formula for n with continuous data. Advance estimates of population variances, The design effect.

Topics for Assignments/Seminars *(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Prepare a questionnaire for conducting a sample survey in your locality.
2. Conduct a sampling of marks of 10 students from a population of 30 students in a class

REFERENCES

- Murthy M. N. (1967) Sampling theory and methods, Calcutta Statistical Publishing society.
- Daroja Singh and F S Chaudhary (1986) Theory and Analysis of Sample Survey Designs, Wiley Eastern Ltd
- Cochran W.G (1977) Sampling Techniques. Wiley & Sons, 448 pages.
- Daniel, W. W (2005): Biostatistics- A foundation for analysis in the Health Sciences, John Wiley & Sons, 7th edition.
- Hogg, R. V., McKean, J. W. and Craig, A. T. (2006): Introduction to Mathematical Statistics, 6th edition, Pearson Education.
- Rohtagi,V.K. and Saleh, A.K.(2001):An Introduction to Probability and Statistics, John Wiley & Sons.
- Rao, C.R. (2002): Linear Statistical Inference and its applications, Wiley series in Probability and Statistics, 2nd edition
- Levy PS, Lemeshow S (1999): Sampling of Populations: Methods and Applications, New York: Wiley Interscience, 3rd edition.
- Floyd J. Fowler (1995), Improving Survey Questions: Design and Evaluation, Sage Publications, 2nd edition.
- Bailey, N. T. J (1995): Statistical Methods in Biology, 3rd Edition, CUP, 272 pages
- Green, R. H. (1979) Sampling design and Statistical Methods for Environmental Biologists. ISBN 978-0-471-03901-3, J.W. & S. 272 pages
- Goon A. M., Gupta M. K., and Dasgupta, B. (2008). Fundamentals of Statistics. Published by Prentice Hall, 2nd Edn.
- Gupta, S. P. (2018) Statistical Methods. 45th Revised Edition, ISBN 978-93-5161-112-7 (506), Sultan Chand & Co.1440 pages

Code : BST3IC03T

ANALYSIS AND STATISTICAL INFERENCE II

MODULE 1. Introduction to Hypothesis Testing (4 hrs)

Null and Alternative Hypotheses. Simple and Composite Hypothesis. Logical and Statistical Hypothesis. Steps of Hypothesis testing. Critical region, Level of significance, One tailed and two tailed testing, Types of errors- I and II, P value interpretation and associated misconceptions.

MODULE 2. Standard Distributions (6 hrs)

Standard distributions-Discrete type-Bernoulli, Binomial, Poisson, Geometric, negative binomial (definition, properties and applications), Uniform (mean, variance and mgf), Continuous type-Uniform, exponential, gamma, Beta, Normal – definition, properties and applications.

MODULE 3. Tests of Hypotheses (10 hrs)

Tests based on Binomial, Poisson and Normal Distributions. Small Sample tests: Test for means and variances based on t, F, χ^2 distributions. Large Sample tests: Tests and Interval

estimation for Single mean, single proportion, and Two means two proportions; Fisher's Z transformation.

MODULE 4. Non parametric tests (10 hrs)

Test of goodness of fit, Chi square test, Kolmogrov-Smirnov one sample test, Sign test, Paired sample test, Wilcoxon signed rank test, Kolmogrov-Smirnov two sample test, Median test, Mann-Whitney U-test, Wald-Wolfowitz runs test, Kruskal-Wallis H-test.

MODULE 5. Sequential tests (6 hrs)

Sequential methods of drawing inferences, Sequential probability ratio test – definition and basic concepts, SPRT for testing simple hypothesis, Operating Characteristic function, Average sample number function, Applications to Binomial, Poisson and Normal distributions.

Topics for Assignments/Seminars *(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Properties of Normal Distribution and compare the various distribution patterns
2. Parametric and Non-parametric variables
3. Suppose we have two small DNA sequences from two different species that are aligned to each other. Sequence 1. ggagactgtagacagctaatgctata and Seqeunce 2. gaacgccctagccacgagcccttatc. Do the two sequences show significantly more similarity than what is expected from two arbitrary segments of DNA from two species?

REFERENCES

- Driscoll P., Lecky F., Crossby M. (2000). An Introduction to statistical inference. *J. Accid. Emerg. Med.*, 17: 357-363.
- Conover, W.J. (2006). Practical Non-parametric methods in Statistics, 2nd edn.
- Daniel, W.W. (2006). Biostatistics: A foundation for analysis in the Health Sciences, John Wiley and Sons, 7th Edn.
- Rohtagi V.K. (1984). An Introduction to Probability Theory and Mathematical Statistics. Wiley Eastern, 3rd edn.
- Hogg, R. V., McKean, J. W. and Craig, A. T. (2006): Introduction to Mathematical Statistics, 6th edition, Pearson Education.
- Rohtagi,V.K. and Saleh, A.K.(2001):An Introduction to Probability and Statistics, John Wiley & Sons.
- Bailey, N. T. J (1995): Statistical Methods in Biology, 3rd Edition, CUP, 272 pages
- Gupta, S. P. (2018) Statistical Methods. 45th Revised Edition, ISBN 978-93-5161-112-7 (506), Sultan Chand & Co.1440 pages
- S. C. Gupta and V. K. Kapoor. (2008). Fundamentals of Applied Statistics. Sultan Chand and Sons, 4th edn.
- G. Casella and R. L Berger. (2002). Statistical Inference. Thomson Duxbury, 2nd

Code : BST4IC04T

EXPERIMENTAL DESIGNS AND STATISTICAL COMPUTING

MODULE 1. Experimental Designs (5 hrs)

Principles of design, randomization-replication-local control, Completely randomized design (CRD), Randomized block design (RBD), Latin square design (LSD). Missing plot technique-comparison of efficiency.

MODULE 2. Data Analysis and Repeated measures Designs (7 hrs)

Analysis of Variance (ANOVA) : One way, Two way and generalization, Analysis of covariance with a single observation per cell. ANCOVA for CRD and RBD. Factorial Designs: Basic concepts of factorial experiments, 2^3 and 3^2 factorial experiments, Duncan's multiple range test.

MODULE 3. Introduction to R (7 hrs)

Data Handling using Excel: Getting started with Using functions - Statistical Functions. Introduction to SPSS and its Applications. R as a calculator, statistical software and a programming language, R preliminaries, getting help, data inputting methods (direct and importing from other spread sheet applications like Excel), data accessing, and indexing, Graphics in R, built in functions, saving, storing and retrieving work.

MODULE 4. Diagrammatic representation of Descriptive statistics (7 hrs)

Computing data and Diagrammatic representation of univariate and bivariate data (box plots, bar plots, pie diagram, scatter plots), measures of central tendency (mean, median and mode), partition values, measures of dispersion (range, standard deviation, mean deviation and inter quartile range), summaries of a numerical data.

MODULE 5. Probability Distributions (5 hrs)

R as a set of statistical tables – cumulative distribution, probability density function, quantile function, and simulate from the distribution, plotting probability curves for standard distributions.

MODULE 6. Computing Statistical Inference (5 hrs)

Computing of classical tests: One- and two-sample tests, z test, t-test, F-test, chi-square test of independence and goodness of fit, interval estimation for mean, difference of mean and variance, Anova (one-way and two way), correlation and regression analysis (bivariate and multivariate data).

REFERENCES

- Michale J. Crawley, THE R BOOK, John Wiley & Sons, England (2009)
- Sudha G. Purohit et.al., Statistics Using R, Narosa Publishing House, India(2008)
- John Verzani, simple R – Using R for Introductory Statistics. (http://www.math.csi.cuny.edu/Statistics/R/SimpleR/Simple.)
- W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R , Notes on R: A Programming Environment for Data Analysis and Graphics, Version 2.15.2 (2012-10-26)

- Das, M.N. and Giri N.C. (2006): Design and Analysis of Experiments Delhi. New Age International (P) Ltd., New, 2nd edition.
- Montgomery D.C (2006): Design and Analysis of Experiments, Wiley India 5 th Edn.
- Zar, J.H. (2007): Biostatistical Analysis, Pearson Education 4 th edition.
- Govindarajulu, Z. (2000): Statistical techniques in Bioassay, Thomson Duxbury, 2nd edn
- Morrison, (1990): Multivariate Statistical Methods, McGraw-Hill, 3 rd edition.

Johnson, R.A. and Wichern, D.W. Applied Multivariate Statistical Analysis, PearsonEducation, Asia 5th edition.

- Agresti, A. (2002): Categorical data analysis, John Wiley & Sons, 3rd edition
- Norman Matloff (2011) The Art of R Programming: A Tour of Statistical Software Design. NoStarch Press.
- Robert Knell (2013) Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R. Amazon Digital South Asia Services Inc,.
- K.V.S Sharma - Statistics made simple - Do it yourself on PC - Prentice Hall of India, New Delhi.
- Sanjay Saxena - A first Course in Computers - Vikas publishing house Pvt. Ltd.
- Edward C. Willett - Microsoft Office 2003 Bible - Wiley Publishing, Inc.
- Guy Hart - Microsoft Office Excel 2003, A Beginners Guide - - dream tech Press.
- Sanjay Saxena - Introduction to Computers & MS Office - Vikas Publishing House Pvt. Ltd.
- Perry R. Hinton, Charlotte Brownlow, Isabella Mc Murray and Bob Cozens - SPSS Explained - Routledge Taylor and Francis Group, London & New York.

INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME
BIOSTATISTICS ALLIED CORE COURSE - PRACTICAL Code :
BST4IC05P
[Practical I*A+ I*B+ I*C+ I*D]

[144 hours] [2 hrs per week] [Spread over first 4 semesters] [4 Credits]

Course Outcomes

- Attain a secure foundation in Statistics to complement the core for their future courses
- Solve basic problems in biostatistics
- Acquire wide range of biostatistical skills, including problem solving, project work and presentation
- Understand and utilize the powerful tools for tackling a wide range of topics in Standard distributions, Sampling distributions, Estimation and Testing of hypotheses
- Familiarize with additional relevant Statistical techniques

FIRST SEMESTER INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME
BIOSTATISTICS ALLIED CORE COURSE PRACTICAL- I*A
BASIC STATISTICS AND INTRODUCTION TO BIOSTATISTICS
[36 hours] [2 hrs per week]

1. Prepare a frequency table using the given data.
2. Measure the size of given leaves / shells / any sample of data and represent it in a

graphical form and interpret it. Represent the data graphically using different graphs like frequency polygon, frequency curve, line diagram, ogive, bar diagram, histogram and pie diagram.

3. Measure the size of given leaves / any sample of data and calculate the mean, median and mode (raw data, discrete series & continuous series).

4. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.
5. Construct a frequency curve with mean ± SD using suitable data. Draw the same in Excel or using any free software and record it.
6. Prepare a frequency polygon with mean ± SD utilizing appropriate data.
7. Draw a bar diagram with mean ± SD employing suitable data.
8. Construct a histogram with mean ± SD utilizing suitable data. Do the same with software.
9. Draw a pie diagram using suitable data. Draw the same in Excel or using any free software.
10. From the given data find out measures of central tendency and measures of dispersion. Find out Pearsons coefficient of skewness.
11. Calculation of moments, measures of skewness and measures of Kurtosis.
12. Find out probability of events from the given data and graph.

SECOND SEMESTER INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME

BIOSTATISTICS ALLIED CORE COURSE PRACTICAL- I*B

ANALYSIS AND STATISTICAL INFERENCE I

[36 hours] [2 hrs per week]

1. Data on abundance of species is given for the 10 years. Predict the abundance for the next year using regression analysis.
2. Prepare a questionnaire using epi- info software and record at least 50 data of a recent epidemic in Kerala.
3. Drawing a simple random sample with the help of table of random numbers.
4. Estimation of population means and variance in simple random sampling.
5. Stratified Random Sampling-Estimation of mean and standard error-proportional allocation, Optimum allocation, Estimation of gain due to stratification.
6. Systematic Sampling
7. Estimation of sampling size in different sampling techniques.
8. Ratio and Regression estimation methods- Estimation mean, total and S.E.
9. Cluster Sampling – Equal and unequal cluster sizes.
10. Find the sample size using cluster sampling, stratified sampling and systematic sampling using excel and manual method (Using the formulae)

THIRD SEMESTER INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME

BIOSTATISTICS ALLIED CORE COURSE PRACTICAL- I*C

ANALYSIS AND STATISTICAL INFERENCE II

[36 hours] [2 hrs per week]

1. Formulate a hypothesis of any scientific observation made by you
2. Fitting of Binomial, Poisson and Normal distributions to observed data and testing of goodness of fit.

3. Census the avian fauna/ Any fauna of two different areas and present the data in a suitable graphical form. Compare by t- test.
4. t – test for (i) $\mu = \mu_0$ (ii) $\mu_1 = \mu_2$
5. F-test for $\sigma_1^2 = \sigma_2^2$
6. Fisher's Z-transformation and its use in testing $\rho_1 = \rho_2$
7. Chi-square analysis : In the garden pea, yellow cotyledon colour is dominant to green and inflated pod shape is dominant to the constricted form. Considering both of these traits jointly in self-fertilized dihybrids, the progeny appeared in the following numbers: 193- green inflated, 184- yellow constricted, 556- yellow inflated, and 61- green constricted. Do these genes assort independently? Support your answer using Chi-square analysis.
8. Non- parametric tests. Kolmogorov-Smirnov test, Median test, Wald run test, Mann Whitney U-test, multiple range test. (any 2 tests)

FOURTH SEMESTER INTEGRATED MSc BIOLOGY FOUNDATION PROGRAMME

BIOSTATISTICS ALLIED CORE COURSE PRACTICAL- I*D

EXPERIMENTAL DESIGNS AND STATISTICAL COMPUTING

[36 hours] [2 hrs per week]

1. Regression analysis and correlation analysis of a data of heights and weights of a group of students.
2. Data analysis by SPSS
3. Designing an experiment for the comparison of efficacy few diets using ANOVA with the help of R software.
4. Graphical representation of data using R software (boxplot, stem and leaf diagram, q-plot, bar plot)
5. Analyse the data using R software (measures of central tendency and measures of dispersion)

Practical work should be done on statistical packages or using high level languages. The purpose of this part is to use a statistical package such as MS- Excel /SPSS /S+/ R/ MINITAB/ etc. to carry out statistical procedures already known to students based on theory paper taught in semester IV. No new statistical methods should be presented but interesting data can be analyzed using known methods on the package.

References

- Rohtagi,V.K. and Saleh, A.K.(2001):An Introduction to Probability and Statistics, John Wiley & Sons.
- Bailey, N. T. J (1995): Statistical Methods in Biology, 3rd Edition, CUP, 272 pages
- Gupta, S. P. (2018) Statistical Methods. 45th Revised Edition, ISBN 978-93-5161-112-7 (506), Sultan Chand & Co.1440 pages
- S. C. Gupta and V. K. Kapoor. (2008). Fundamentals of Applied Statistics. Sultan Chand and Sons, 4th edn.

- G. Casella and R. L Berger. (2002). Statistical Inference. Thomson Duxbury, 2nd edn.
- Norman Matloff (2011) The Art of R Programming: A Tour of Statistical SoftwareDesign. NoStarch Press.
- Robert Knell (2013) Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R. Amazon Digital South Asia Services Inc,.
- K.V.S Sharma - Statistics made simple - Do it yourself on PC - Prentice Hall of India,New Delhi.
- Sanjay Saxena - A first Course in Computers - Vikas publishing house Pvt. Ltd.
- Guy Hart - Microsoft Office Excel 2003, A Beginners Guide - - dream tech Press.
- Sanjay Saxena - Introduction to Computers & MS Office - Vikas Publishing House Pvt.Ltd.
- Perry R. Hinton, Charlotte Brownlow, Isabella Mc Murray and Bob Cozens - SPSSExplained - Routledge Taylor and Francis Group, London & New York.

Semester III

Course Category	**Core Course 3**
Course Title and Code	**Quantitative Methods for Economic Analysis - I ECO3 B03**
No. of Credits	**4**
No. of Contact Hours	**5 Hours per week**

QUANTITATIVE METHODS FOR ECONOMIC ANALYSIS – I

Preamble: Students of economics should have sound quantitative skills to collect, analyse and interpret empirical data. They also require these skills for advanced studies in quantitative economics. Quantitative skills have become an essential toolkit for most branches of economics. This course is intended to provide students an introduction to quantities methods and tools that are used in the study of economics at the undergraduate level. The aim of this course is to develop skill in statistical and mathematical techniques that are required for a meaningful study of applied economics and for carrying out empirical their further study in most branches of economics.

Module I –Basic Concepts

Exponents and logarithms-Equations –Linear, quadratic and simultaneous equations up to three un knows- Functions –types and their applications in economics –Introduction to co-ordinate geometry, Graphs, Slope and Intercepts, Equations of Straight Lines.

Module II - Basic Matrix Algebra:

Matrix -Meaning and types, Matrix operations, Addition, Subtraction and Multiplication- Properties of Matrix multiplication, Transpose of matrix, Determinant and their properties (Up to 3 x 3) – Minor and Cofactors – Rank of a Matrix- Solving linear equations using Matrix Inverse- - Cramer's rule

Module III – Univariate Analysis

Univariate Analysis: -Frequency Tables, Representation of data-Frequency Polygon, Ogives and Pie diagram. Measures of Central tendency - Arithmetic Mean, Median, Mode, Geometric Mean and Harmonic Mean -. Measures of Dispersion: Absolute and Relative measures of Dispersion – Range, Quartile Deviation, Mean Deviation and Standard Deviation, Coefficient of variation - Lorenz Curve - Gini Coefficient - Skewness and Kurtosis.

Data management using Spread Sheet : Mean, Median, Mode, Dispersion, Coefficient of Variation -Graphical Presentation of Data: Line, bar, pie diagrams.

Module IV: Correlation and Regression Analysis

Correlation-Meaning, Types- Methods of Measuring Correlation-Graphical: Scatter Diagram and correlation Graph; Algebraic Methods: Karl Pearson‘s Coefficient of Correlation and Rank Correlation Coefficient -Simple linear regression - Meaning, Principle of Ordinary Least Squares and Regression Lines-Correlation and Regression using spread sheet.

References:

1. Allen , R.J.D. Mathematical Analysis for Economics ,Macmillan Press, London
2. Dowling Edward T, Mathematical Methods for Business and Economics, SchaumsOutlineSeries, McGraw Hill, 1993
3. Dowling Edaward.T, Introduction to Mathematical Economics, 2_{nd}/3rd Edition, Schaum's Outline Series, McGraw-Hill, New York, 2003
4. Taro Yamane, Mathematics for Economists: An Elementary Survey, Prentice Hall of India
5. Sydsaeter K and Hammond P, Essential Mathematics for Economic Analysis, Prentice Hall
6. Haeussler Earnest F, Paul Richard S and Wood Richard, Introductory Mathematical Analysis Peason Eduction ISBN 0131276298
7. Bressler Barry, A Unified Introduction to Mathematical Economics, harper and Row Publishers, ISBN0060409525
8. Anderson, Sweeney and Williams, Statistics for Business and Economics, Thomson Education
9. Lind D.A., W.G. Marchal and S.A Wathen., Statistical Techniques in Business and Economics, Tata McGraw Hill, New Delhi
10. Gupta S. P, Statistical Methods, Sultan Chand and Sons, New Delhi
11. Aczel D Amir and Sounderpandian Jayavel, Complete Business Statistics, Tata McGraw Hill Publishers, Newdelhi ISBN 0070620164
12. Richard I Levin et.al. *Statistics for management*. India: Pearson Education.
13. John Walkenbach, MS Excel 2007, Wiley India Publishers, 2008

Semester IV

Course Category	**Core Course 5**
Course Title and Code	**Quantitative Methods for Economic Analysis II ECO4 B05**
No. of Credits	**4**
No. of Contact Hours	**5 Hours per week**

QUANTITATIVE METHODS FOR ECONOMIC ANALYSIS – II

Module I: Differential Calculus

Limits and Continuity – Differentiation - Rules, Derivative of single variable and multi variable Functions (except Trigonometric and logarithmic Function), Higher Order Derivatives –Partial differentiation- Optimization - Maxima and Minima of Functions. – Economic Application of Derivatives – Marginal Concepts (MU, MR,MP, Elasticity etc)

Module II: Index Numbers and Time Series Analysis

Index Numbers: Meaning and Uses- Unweighted and Weighted Index Numbers: Laspeyre‘s, Paasche‘s, Fisher‘s, Dorbish-Bowley, Marshall-Edgeworth and Kelley‘s Methods - Tests of IndexNumbers: Time Reversal and Factor Reversal tests - Base Shifting, Splicing and Deflating -CPI and WPI - Stock Price Indices: BSE-SENSEX and NSE-NIFTY.Time Series Analysis - Components of Time Series - Measurement of Trend by Moving Average and the Method of Least Squares.

Module III: Vital Statistics

Vital Statistics: Meaning and Uses- Fertility Rates: Crude Birth Rate, General Fertility Rate, Specific Fertility Rate, Gross Reproduction Rate and Net Reproduction Rate - Mortality Rates: Crude Death Rate, Specific Death Rate, Infant Mortality Rate andMaternal Mortality Rate - Sex Ratio and Couple Protection Ratio.

Module IV- Fundamentals of probability

Basic probability concepts: – Mutually exclusive and collectively exhaustive events – statistically independent events, sample space, events. Types of probability –*A Priori* Classical probability – Empirical Classical Probability – Subjective Probability.

References

1. Allen , R.J.D. Mathematical Analysis for Economics ,Macmillan Press, London
2. Dowling Edward T, Mathematical Methods for Business and Economics, Schaums Outline Series, McGraw Hill, 1993
3. Bressler Barry, A Unified Introduction to Mathematical Economics, harper and Row Publishers, ISBN0060409525
4. Sydsaeter K and Hammond P, Essential Mathematics for Economic Analysis, Prentice Hall
5. Dowling Edaward.T, Introduction to Mathematical Economics, 2_{nd}/3rd Edition, Schaum's
6. Outline Series, McGraw-Hill, New York, 2003
7. Anderson, Sweeney and Williams, Statistics for Business and Economics, Thomson Education
8. Lind D.A., W.G. Marchal and S.A Wathen., Statistical Techniques in Business and Economics, Tata McGraw Hill, New Delhi
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10. Richard I Levin et.al. *Statistics for management*. India: Pearson Education.
11. Aczel D Amir and Sounderpandian Jayavel, Complete Business Statistics, Tata McGraw Hill Publishers, New delhi ISBN 0070620164
12. William G. Cochran, Sampling Techniques, John Wiley, 2007