

## DETAIL OF COURSES

### Statistics-I (Introduction to Statistics)

3(3+0)

#### Learning Objectives:

- To have introduction of statistics as a field of knowledge and its scope and relevance to other disciplines of natural and social sciences.
- To equipped and prepare students for advance courses in the field of statistics.
- To achieve the capability of critical thinking about data and its sources; have idea about variables and their types and scale measures.
- Be able to calculate and interpret descriptive statistics (able to classify, tabulate, describe and display data using software).

#### Learning Outcomes:

- Acquire the basic knowledge of the discipline of Statistics.
- Understand and differentiate between the types of data and variables.
- Evaluate and Interpret basic descriptive statistics. Display and Interpret data graphs.

#### Course Contents:

The nature and scope of the Statistics, Variables and their types, Data and its sources, Scales of measurements, Tabulation and classification of data, Graphs and Charts: Stem-and leaf diagram, Box and Whisker plots and their interpretation. Measures of Central Tendency, Quantiles, Measures of Dispersion: Their properties, usage, limitations and comparison. Moments, Measures of Skewness and Kurtosis and Distribution shapes. Rates and ratios, Standardized scores.

Index numbers: construction and uses of index numbers, un-weighted index numbers (simple aggregative index, average of relative price index numbers), weighted index numbers (Laspayer's, Paasche's and Fisher's ideal index numbers), Consumer price index (CPI) and Sensitive Price Indicators

#### Recommended Books:

1. Clarke, G. M., & Cooke, D. (1978). *A basic course in statistics* (No. 519.5 C53).
2. Chaudhry, S.M. and Kamal, S. (2008), "*Introduction to Statistical Theory*" Parts I & II, 8<sup>th</sup> ed, Ilmi Kitab Khana, Lahore, Pakistan.
3. Mann, P. S. (2010) *Introductory Statistics*. Wiley.
4. Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2000) "*Probability and Statistics*", 2<sup>nd</sup> ed. Schaums Outlines Series. McGraw Hill. NY.

5. Walpole, R.E., Myers, R.H and Myers, S.L. (1998), "*Probability and Statistics for Engineers and Scientist*" 6<sup>th</sup> edition, Prentice Hall, NY.
6. Zaman, A. (2016), "Introduction to Statistics" Online access for book and related data sets.  
<https://sites.google.com/site/introstats4muslims/textbook>  
<https://sites.google.com/site/introstats4muslims/excel>.

## **Statistics-II (Introduction to Probability Distributions) 3(3+0)**

### **Learning Objectives:**

- Understand basic concepts of probability, conditional probability, independence etc.
- Be familiar with some of the more commonly encountered random variables, particularly the Binomial and Normal random variable.
- Be able to calculate first two moments of common random variables i.e. means and variances.
- Be able to apply the concepts of random variables to scientific applications. Computation of uncertainty using probability techniques.

### **Learning Outcomes:**

- Acquire the basic knowledge of probability and probability distribution.
- Understand the concepts of basic techniques of measuring the uncertainty problem.
- Analyze the problem of genetics finance and telecommunications by using probability techniques.

### **Course Contents:**

Set theory and its operations, Probability Concepts, Addition and Multiplication Rules, Bivariate Frequency Tables, Joint and Marginal Probabilities, Conditional Probability and Independence, Bayes' Rule. Random Variables, Discrete Probability Distribution, Mean and Variance of a Discrete Random Variable, Bernoulli Trials, Properties, Applications and Fitting of Binomial, Poisson, Hypergeometric, Negative Binomial and Geometric Distributions. Continuous Random Variable, Probability Density Function and its Properties, Normal Distribution and its Properties, Standard Normal Curve.

### **Recommended Books:**

1. Cacoullos, T. (2012). *Exercises in probability*. Springer Science & Business Media.
2. Mclave, J.T., Benson, P.G. and Snitch, T. (2005) "*Statistics for Business & Economics*" 9<sup>th</sup> Edition. Prentice Hall, New Jersey.
3. Santos, David (David A.) (2011). *Probability : an introduction*. Jones and Bartlett Publishers, Sudbury, Mass

4. Walpole, R.E., Myers, R.H and Myers, S.L. (2007), "*Probability and Statistics for Engineers and Scientist*" 7<sup>th</sup> edition, Prentice Hall, NY.

### **Statistics-III (Basic Statistical Inference)**

**3(3+0)**

#### **Learning Objectives:**

- To understanding of basic techniques of sampling and estimation, their properties and application
- To select a sample from a given population and use it to make inferences about the population and its parameter
- To test, deduce and infer the validity of different types of hypotheses and models built on the basis of the raw data collected in diverse problem-situations.

#### **Learning Outcomes:**

- Acquire the knowledge of the sampling distributions and their properties.
- Derive the appropriate estimators for parameters using best estimation procedure.
- Use appropriate sampling distributions for interval estimation and hypotheses testing.
- Apply appropriate inferential procedures to handle the practical situations.

#### **Course Contents:**

Sampling and sampling distribution of sample mean, proportion, difference between means and difference between proportions; Point and interval estimate properties of good point estimator; Testing of hypothesis for population mean, difference between population means and population proportion and difference between two population proportions, difference between means for paired data; Single population variance, ratio of two variances; Non-parametric methods: The sign test, Wilcoxon's signed rank test, Mann-Whitney U test, Median test, Run test, Kolmogorov-Smirnov test, Kruskal-Wallis test, Median test for k-samples, Friedman test.

### **Recommended Books:**

1. Ross, S. (2017). *A first course in Probability*. 9<sup>th</sup> edition. Pearson Education Limited.
2. DeGroot, M. Schervish, M. (2017). *Probability and Statistics*. 4<sup>th</sup> edition. Pearson Education Limited.
3. Srivastava, M.K., Khan, A.H. and Srivastava, N. (2014). *Statistical Inference: Theory of Estimation*. Prentice-Hall of India Pvt. Ltd
4. Clark, G.M. and Cooke, D. (1998). *A Basic Course in Statistics*. 4<sup>th</sup> ed, Arnold, London.
5. Mclave, J.T., Benson P.G. and Sincich, T. (2014). *Statistics for Business and Economics*. 12<sup>th</sup> Edition. Pearson Education Ltd, U.K.
6. Spiegel, M.R., Schiller, J.L. and Sirinivasan, R.L. (2015). *Probability and Statistics*. 3<sup>rd</sup> edition. Schaums Outlines Series. McGraw-Hill. NY.

## Statistics-IV (Exploratory Data Analysis and Visualization)

3(3+0)

### Learning Objectives:

- to provide solid understanding of the process of Exploratory Data Analysis
- to educate students in data exploration, analysis, and visualization
- to train students in industry standard tools for data analysis and visualization

### Learning outcomes:

- describe exploratory data analysis and visualization concepts
- describe data analysis and visualization models and algorithms
- describe applicability of different data analysis and visualization models techniques to solve real-world problems
- acquire and pre-process data
- apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization

### Course Contents:

Exploratory Data Analysis: Explore, Visualize, Analyze, Repeat. Selective data collective and data exploration. Data visualization and Data analysis (using Excel/Tableau/R/STATA/SPSS etc).

### Recommended Books:

1. Peng R. (2015) Exploratory Data Analysis with R <http://leanpub.com/exdata>
2. Tukey, J. (1977) Exploratory Data Analysis
3. Chang, W. (2013). R Graphics Cookbook. O'Reilly. <http://www.cookbook-r.com/>
4. Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis (2<sup>nd</sup> Springer. <http://ggplot2.org/book/>; <http://hadley.nz/>

## Statistics-V (Introduction to Regression and Analysis of Variance)

3(3+0)

### Course Objectives:

- To provide foundations of regression analysis.
- To provide basic knowledge and art of statistical data analysis
- To predict and draw inference about the parameters of the parameters of population.

### Learning Outcomes:

- Explore more adequately the connection between theory of regression.
- Analysis of real world problems.
- Prediction of dependent variable.

### Course Contents:

Relationship between variables, Simple linear regression model, Estimation of parameters by method of least squares and corresponding variance estimates, Testing and confidence intervals for least squares estimators, mean prediction and individual prediction. Multiple linear regression with two regressors, coefficient of multiple determination, Partial and multiple correlation up to three variables. Inference of simple, partial and multiple correlation coefficients, Analysis of variance for one-way classification and two-way classification. Decomposition of total sum of squares, Multiple comparison tests; least significant difference and Duncans multiple range test, Tukey test and Least significant difference test.

### Recommended Books:

1. Montgomery, D. C., Peck, E. A., and Vining, G. G. (2012). Introduction to linear regression analysis (Vol. 821). John Wiley and Sons.
2. Dielman, T. E. (2001). Applied regression analysis for business and economics. Pacific Grove, CA: Duxbury/Thomson Learning.
3. Rawlings, J. O., Pantula, S. G., and Dickey, D. A. (2001). Applied regression analysis: a research tool. Springer Science and Business Media.

## **Calculus-I**

**Credit Hours: 3+0**

### **Specific Objectives of the Course:**

Calculus is serving as the foundation of advanced subjects in all areas of mathematics. The course, equally, emphasizes the basic concepts and skills needed for mathematical manipulation. This Calculus focus on the study of functions of a single variable.

### **Course Outline:**

Functions, upper and lower bounds of variables and functions, inverses of exponential, circular, hyperbolic and logarithmic functions, one sided and two sided limits of functions, continuity of functions and their graphical representations, properties of continuous function on closed bounded intervals, discontinuity of function and its types. Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions, Inverse functions and their derivatives. The chain rule. Implicit differentiation. Rates of change in natural and social sciences. Related rates. Linear approximations and differentials. Higher derivatives, Leibnitz's theorem. Applications of derivatives: Increasing and decreasing functions. Relative extrema and optimization. First derivative test for relative extrema. Convexity and point of inflection. The second derivative test for extrema. Indeterminate forms and L'Hopitals rule. Anti-derivatives and integrals. Riemann sums and the definite integral. Properties of Integral.

### **Recommended Books:**

- J. Stewart, Calculus (5th edition or latest edition), 2002, Brooks/Cole
- H. Anton, I. Bevens, S. Davis, Calculus: A New Horizen (8th edition or latest), 2005, John Wiley, New York
- G. B. Thomas, A. R. Finney, Calculus (11th edition or latest edition), 2005, Addison-Wesley, Reading, Ma, USA

## **Calculus-II**

**Credit Hours: 3+0**

### **Specific Objectives of the Course:**

Analytical geometry is serving as the foundation of advanced subjects in all areas of mathematical analysis. The sequence, equally, emphasizes the basic concepts and skills needed for mathematical manipulation. As continuation of Calculus, it focuses on the study of foundation of plane and one, two dimensional geometry.

### **Course Outline:**

Curves and their representation in cartesian, polar and parametric forms, tangents and normal, maxima, minima and points of inflection, convexity and concavity, asymptotes and curve tracing, translation and rotation of axes in one dimension, general equation of the second degree and the classification of conic sections, conic in polar coordinates, tangents and normal, rectangular coordinate system, translation and rotation of axes in two dimension, direction cosines, ratios and angles between two lines, standard forms of equations of planes and lines, intersection of planes and lines, distance between points, lines and planes, shortest distance between lines, symmetry, intercepts and sections of a surface, spherical, polar and cylindrical coordinate systems, standard form of the equations of sphere, cylinder, cone, ellipsoid, paraboloid and hyperboloid.

### **Recommended Books:**

- J. Stewart, Calculus (5th edition or latest edition), 2002, Brooks/Cole
- H. Anton, I. Bevens, S. Davis, Calculus: A New Horizen (8th edition or latest), 2005, John Wiley, New York
- G. B. Thomas, AR Finney, Calculus (11th edition or latest), 2005, Addison-Wesley, Reading, Ma, USA

**Specific Objectives of the Course:**

This is a course in abstract linear algebra. The majority of follow up courses in both pure and applied mathematics assume the material covered in this course.

**Course Outline:**

Algebra of matrices, determinants, matrix of a linear transformation, row and column operations, rank, inverse of matrices, solution of homogeneous and non-homogeneous equations, orthogonal transformation. Vector spaces, subspaces, linear dependence and independence, linear span of a subset of a vector space, bases and dimensions of a vector space, sums and direct sums of subspaces of a finite dimensional vector space, dimension theorem, linear transformation, null space, image space of linear transformation, rank and nullity of a linear transformation, relation between rank, nullity and dimension of the domain of a linear transformation, matrix of linear transformation, change of basis, inner product spaces, orthogonal and orthonormal basis, similar matrices and diagonalization of a matrix,  $\text{Home}(V, W)$ , dimension and basis of  $\text{Home}(V, W)$ , dual space and dual basis, annihilators, Eigen values and Eigen vectors and minimal polynomials.

**Recommended Books:**

- S. J. Axle, Linear Algebra Done Right, Undergraduate Texts in Mathematics, 1996, Springer, New York, Schaum's outlines series
- G. Birkhoff, S. Maclane, A Survey of Modern Algebra (4th edition), AKP
- W. L. C. Perry, Elementary Linear Algebra, 1988, McGraw-Hill, New York



## **Ordinary Differential Equations**

**Credit Hours: 3+0**

### **Specific Objectives of the Course:**

This course will provide the foundation for all advanced subjects in Mathematics. Strong foundation and applications of Ordinary Differential Equations is the goal of the course.

### **Course Outline:**

Basic definition of differential equations, formation of differential equations, initial and boundary value problems, differential equations of the first order and first degree, equations with separable variable, homogeneous differential equations, equations reducible to homogeneous form, exact differential equations, integrating factors, rules for determinations of integrating factors, linear equations of the first order, Non-linear equations of the first order, linear differential equations of high order, solution of homogeneous linear equations, principle of superposition and Wronksian, determination of particular integral, short methods for finding particular integral, orthogonal trajectories, Cauchy-Euler equations, 2nd order linear differential equations, reduction of order method, undetermined Coefficient method, variations of parameters method.

### **Recommended Books:**

- D.G. Zill, M.R, Cullen, Differential Equations with Boundary-Value Problems, (latest Edition), PWS Publishing Company
- D.G. Zill, Advanced Engineering Mathematics, Jones and Bartlett Publishers, 2005
- Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons (9th edition)
- G.E. Andrews, R. Askey, and R. Roy, Special Functions, Cambridge University Press