## COURSE STRUCTURE

<table>
<thead>
<tr>
<th>Year</th>
<th>Semester</th>
<th>Course</th>
<th>Title of the Course</th>
<th>No. of Hrs /Week</th>
<th>No. of Credits</th>
</tr>
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<tbody>
<tr>
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<td>II</td>
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<td>II</td>
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<td>Statistical Methods</td>
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<td>IV</td>
<td>3</td>
<td>Design and Analysis of Experiments</td>
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<td>III</td>
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<td>Computational Statistics and R Programming</td>
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<td>Computational Statistics and R Programming Practical Course</td>
<td>2</td>
<td>1</td>
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</tbody>
</table>
I. Learning Outcomes
After successful completion of the course students will be able to:
1. To acquaint with the role of statistics in different fields with special reference to business and economics.
2. To review good practice in presentation and the format most applicable to their own data.
3. To learn the measures of central tendency or averages reduce the data to a single value which is highly useful for making comparative studies.
4. To familiar with the measures of dispersion throw light on reliability of average and control of variability.
5. To deal with the situation where there is uncertainty and to measure that uncertainty by using the probability, which is essential in all research areas.

II. Syllabus

Unit – 1: Statistical Description of Data

Unit – 2:
Measurement Scales – Nominal, Ordinal, Ratio and Interval. Frequency distribution and types of frequency distributions, forming a frequency distribution. Diagrammatic representation of data – Histriogram, Bar, Multiple bar and Pie with simple problems. Graphical representation of data: Histogram, frequency polygon and Ogives with simple problems.

Unit – 3: Measures of Central Tendency (MCT)

Unit – 4: Measures of Dispersion

Unit – 5: Elementary Probability
Basic Concepts of Probability, random experiments, trial, outcome, sample space, event, mutually exclusive and exhaustive events, equally likely and favourable outcomes. Mathematical, Statistical, axiomatic definitions of probability. Conditional Probability and independence of events, Addition and multiplication theorems of probability for 2 and for n events and simple problems. Boole's inequality, Bayes theorem and its applications in real life problems.
SEMESTER-II
COURSE 1: DESCRIPTIVE STATISTICS
Practical Credits: 1 2 hrs/week

Syllabus

1. Writing a Questionnaire in different situations.
2. Forming a grouped and ungrouped frequency distribution table.
3. Diagrammatic presentation of data – Bar, multiple Bar and Pie.
5. Computation of measures of central tendency – Mean, Median and Mode.
7. Computation of non-central, central moments, $\beta_1$ and $\beta_2$ for ungrouped data.
8. Computation of non-central, central moments, $\beta_1$ and $\beta_2$ and Sheppard’s corrections for grouped data.
9. Computation of Karl Pearson’s and Bowley’s Coefficients of Skewness.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

III. References

IV. Suggested Co-curricular Activities:
1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc. on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.
I. Learning Outcomes

After successful completion of the course students will be able to:
1. To get the knowledge of estimating future values by using curve fitting.
2. To calculate the relationship between bivariate data.
3. To find the relationship about the multivariate data.
4. To acquaint about the forecasting of the data by using regression techniques.
5. To find the association of the categorical data by using attributes.

II. Syllabus

Unit – 1: Curve fitting
Bivariate data, Principle of least squares, fitting of $k^{th}$ degree polynomial. Fitting of straight line, Fitting of Second degree polynomial or parabola, fitting of family of exponential curves and power curve.

Unit – 2: Correlation
Meaning, Types of Correlation, Measures of Correlation – Scatter diagram, Karl Pearson’s Coefficient of Correlation, Rank Correlation Coefficient (with and without ties), Properties. Bivariate frequency distribution, correlation coefficient for bivariate data and problems. Lag and Lead in correlation.

Unit – 3:
Coefficient of concurrent deviation, probable error and its properties, coefficient of determination, Concept of multiple and partial correlation coefficients (three variables only), properties and problems, intra-class correlation and correlation ratio.

Unit – 4: Regression

Unit – 5: Attributes
Notations, Class, Order of class frequencies, Ultimate class frequencies, Consistency of data, Conditions for consistency of data for 2 and 3 attributes only, Independence of attributes, Association of attributes and its measures, Relationship between association and colligation of attributes, Contingency table: Square contingency, Mean square contingency, Coefficient of mean square contingency, Tschuprow’s coefficient of contingency.
Practical Syllabus
1. Fitting of straight line by the method of least squares
2. Fitting of parabola by the method of least squares
3. Fitting of exponential curve of two types by the method of least squares.
4. Fitting of power curve of the type by the method of least squares.
5. Computation of correlation coefficient and regression lines for ungrouped data.
6. Computation of correlation coefficient for bivariate frequency distribution.
7. Computation of correlation coefficient, forming regression lines for grouped data.
10. Computation of Pearson's, Tschuprow’s coefficient of contingency.

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I. Learning Outcomes

After successful completion of the course students will be able to:
1. To acquaint with the role of statistics in different fields with special reference to agriculture.
2. Learn to apply the one of the design of experiment to agricultural fields.
3. Learn to apply the randomization to the blocks of various fields in agriculture.
4. To get the familiarity about applications of three principles.
5. Learn to deal the agricultural fields with different factors and levels.
6. To use appropriate experimental designs to analyze the experimental data.

II. Syllabus

Unit – 1: Analysis of variance (ANOVA)
Concept, Definition and assumptions. ANOVA one way classification – mathematical model, analysis – with equal and unequal classification. ANOVA two way classification – mathematical model, analysis and problems.

Unit – 2: Completely Randomised Design (CRD)
Definition, terminology, Principles of design of experiments, CRD – Concept, advantages and disadvantages, applications, Layout, Statistical analysis. Critical Differences when hypothesis is significant.

Unit – 3: Randomised Block Design (RBD)
Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of RBD relative to CRD. RBD with one missing value and its analysis, problems.

Unit – 4: Latin Square Design
Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of LSD over RBD and CRD. Estimation of one missing value in LSD and its analysis, problems.

Unit – 5: Factorial experiments
Main effects and interaction effects of $2^2$ and $2^3$ factorial experiments and their Statistical analysis. Yates procedure to find factorial effect totals.
Practical Syllabus

1. ANOVA - one - way classification with equal number of observations.
2. ANOVA - one - way classification with unequal number of observations.
3. ANOVA Two-way classification.
4. Analysis of CRD and critical differences.
5. Analysis of RBD and critical differences. Relative efficiency of CRD with RBD.
7. Analysis of LSD and efficiency of LSD over CRD and RBD.
8. Estimation of single missing observation in LSD and its analysis.
10. Analysis of $2^3$ with RBD layout.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

I. References
2. K.V.S. Sarma: Statistics Made Simple: Do it yourself on PC. PHI.

II. Suggested Co-curricular Activities:
1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
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7. Visits/field trips of firms, research organizations etc.
I. Learning Outcomes
   After learning this course the student will be able
   1. Learn the different difference operators and applications.
   2. Accustom with the interpolation techniques with equal and unequal intervals.
   3. Able to use numerical differentiation tools.
   4. Familiar to use numerical integration methods.

II. Syllabus

Unit 1
Definitions of Forward difference operator (Δ), Backward difference operator, Shift or Extension (displacement) operator (E), Central Differences operator(µ), Differentiation operator(D), Mean value operator Symbolic relations between operators, properties of difference and shift operators, fundamental theorem on finite differences and simple problems.

Unit 2
Interpolation with equal intervals: Concept of interpolation and extrapolation, assumptions and uses of interpolation, difference tables, methods of interpolation with equal intervals - Newton’s formula for forward and backward interpolation, Central differences, Gauss forward and backward, Sterling, Bessel’s and Laplace - Everett’s Formulae.

Unit 3
Interpolation with unequal intervals: Divided differences and their properties. Methods of interpolation with unequal intervals – Newton’s Divided difference formula and Lagrange’s formula. Inverse interpolation - Lagrange’s formula.

Unit 4
Numerical Differentiation: Introduction to Numerical differentiation. Determination of First and Second order derivatives for the given data using Newton’s forward and backward, Gauss forward and backward, Sterling, Bessel’s and Newton’s Divided difference formula.

Unit 5
Numerical Integration: Introduction to numerical integration, General Quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson’s 1/3rd, Simpson’s 3/8th rule and Weddle’s rule.
Practical Syllabus

1. Interpolation by using Newton-Gregory forward and backward difference formulae.
2. Interpolation by using Gauss forward and backward difference formulae.
3. Interpolation by using Sterling and Bessel’s formulae.
4. Interpolation by using Laplace-Everett’s Formula.
5. Interpolation by using Newton’s divided difference and Lagrange’s formulae.
6. Inverse interpolation by using Lagrange’s formula.
7. Determination of first and second order derivatives by using Newton-Gregory forward and backward difference formulae.
8. Determination of first and second order derivatives by using Gauss forward and backward difference formulae.
9. Determination of first and second order derivatives by using Newton’s divided difference formula.

III. References

IV. Suggested Co-curricular Activities:
1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photos of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.
I. Learning Outcomes
After learning this course, the student will be able to know about
1. Forecasting Techniques and its applications.
2. Interpret and use a range of index numbers commonly used in the business sector.
3. Perform calculations involving simple and weighted index numbers.
4. Understand the basic structure of the Consumer price index and perform calculations involving its use.
5. Various data collection methods enabling to have a better insight in policy making, planning and systematic implementation,
6. Construction and implementation of life tables.
7. Population growth curves, population estimates and projections,
8. Real data implementation of various demographic concepts as outlined above through practical assignments.

II. Syllabus

Unit – 1: Time Series

Unit – 2: Seasonal Component
Determination of seasonal indices by Simple Averages method, Ratio to Moving Average, Ratio to Trend and Link Relative methods, Deseasonalization.

Unit – 3: Index numbers
Concept, construction, problems involved in the construction of index numbers, uses and limitations. Simple and Weighted index numbers – Various Weighted Aggregate Index numbers, Criterion of a good index number, Fisher’s ideal index number. Cost of living index number and Wholesale price index number.

Unit – 4: Vital Statistics
Introduction, definition, and uses of vital statistics, sources of vital statistics. Measures of Mortality Rates – Crude Death Rate, Specific Death Rate, Standardised Death Rate with different populations and problems.

Unit – 5:
Life table – Columns, Construction and Uses of Life table, Proofs of life table functions. Measures of Fertility Rates – Crude Birth Rate, General Fertility Rate, Specific Fertility Rate, Total Fertility Rate. Measures of population growth – Pearls, Gross Reproduction Rate, Net Reproduction Rate and its problems.
Practical Syllabus

1. Measurement of trend by method of moving averages (odd and even period)
2. Measurement of trend by method of Least squares (linear and parabola)
3. Determination of seasonal indices by method simple averages
4. Determination of seasonal indices by method of Ratio to Moving Averages
5. Determination of seasonal indices by method of Ratio to Trend
6. Determination of seasonal indices by method of Link relatives
7. Computation of simple index numbers.
8. Computation of all weighted index numbers.
9. Computation of reversal tests.
10. Computation of various Mortality rates
11. Computation of various Fertility rates
13. Construction of Life Table.

III. References

IV. Suggested Co-curricular Activities:
1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photos of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.
I. Learning Outcomes

After learning this course the student will be able
1. Be comfortable using commercial and open source tools such as the R language and its associated libraries for
data analytics and visualization.
2. Learn skills to analyze real time problems using R
3. Able to use basic R data structures in loading, cleaning the data and preprocessing the data.
4. Able to do the exploratory data analysis on real time datasets
5. Able to understand and implement Linear Regression
6. Able to understand and use - lists, vectors, matrices, data frames, etc

II. Syllabus

Unit – 1: Computer basics
Basic applications of computer, components of computer system, Central Processing Unit (CPU), input
and output units, computer memory and mass storage devices. Programming languages and their
applications. Concept of files and folders. Software and types of software. Operating System like
Windows and Linux.

Unit – 2: Data processing
Data processing using spreadsheets – Data entry and editing features in Excel, copy, paste, paste special
options, sort and filter options, auto sum, steps of finding average and standard deviation of data using
statistical functions. Matrix operations like transpose, multiply and inverse using Excel functions.
Simple graphs like bar chart, line chart and pie chart in Excel. Exporting Excel output to word processers
like MS-Word and slide presentations like Power Point.

Unit – 3:
Scatter diagram, fitting of straight line, polynomial and power curves using Excel – Reading R-square
value and equation from the graph. Predicting future values using ‘forecast’ and ‘trend’ functions. Data
Analysis Pak and its features. Performing Student’s t-test and one- way Analysis of Variance using Data
Analysis Pak. P-value and its interpretation.

Unit – 4: R Programming
- special numbers - Logical values - Basic Functions - R help functions - R Data Structures - Control
Structures. Vectors: Definition- Declaration - Generating - Indexing - Naming - Adding & Removing
elements - Operations on Vectors - Recycling - Special Operators - Vectorized if- then else-Vector
Equality – Functions for vectors - Missing values - NULL values - Filtering & Subsetting.

Unit – 5:
Matrices - Creating Matrices, Adding or Removing rows/columns, Operations. Creating Data Frames,
Naming, Accessing, Adding, and Removing, Applying Special functions to Data Frames, Merging Data
Frames Factors and Tables.
Exploratory Data Analysis – Descriptive Statistics – Central Tendency - Variability - Mean - Median -
Range - Variance - Summary - Handling Missing values and Outliers - Normalization Data Visualization
in R : Types of visualizations - packages for visualizations - Basic Visualizations, Advanced
Visualizations and Creating 3D plots.
Practical Syllabus

1. Installing R and R studio
2. Create a folder DS_R and make it a working directory. Display the current working directory
3. installing the "ggplot2", "caTools", "CART" packages
4. load the packages "ggplot2", "caTools".
5. Basic operations in r
6. Working with Vectors:
   a) Create a vector v1 with elements 1 to 20.
   b) Add 2 to every element of the vector v1.
   c) Divide every element in v1 by 5.
   d) Create a vector v2 with elements from 21 to 30. Now add v1 to v2.
7. Using the data present in the table given below, create a Matrix "M"

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
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<tr>
<td>C1</td>
<td>0</td>
<td>12</td>
<td>13</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>C2</td>
<td>12</td>
<td>0</td>
<td>15</td>
<td>28</td>
<td>88</td>
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<tr>
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<td>9</td>
</tr>
<tr>
<td>C4</td>
<td>8</td>
<td>28</td>
<td>6</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>C5</td>
<td>20</td>
<td>88</td>
<td>9</td>
<td>33</td>
<td>0</td>
</tr>
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</table>

Find the pairs of cities with shortest distance.
8. Consider the following marks scored by the 6 students

<table>
<thead>
<tr>
<th>Section</th>
<th>Student</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>46</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>34</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>56</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>43</td>
<td>44</td>
<td>45</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>67</td>
<td>76</td>
<td>78</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>76</td>
<td>68</td>
<td>37</td>
</tr>
</tbody>
</table>

   a) create a data structure for the above data and store in proper positions with proper names
   b) display the marks and totals for all students
   c) Display the highest total marks in each section.
   d) Add a new subject and fill it with marks for 2 sections.
9. Three people denoted by P1, P2, P3 intend to buy some rolls, buns, cakes and bread. Each of them needs these commodities in differing amounts and can buy them in two shops S1, S2. The individual prices and desired quantities of the commodities are given in the following table

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
<th>Demand.quantity</th>
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<tr>
<td></td>
<td>S1</td>
<td>S2</td>
</tr>
<tr>
<td>Roll</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Bun</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Cake</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>Bread</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

   a) Create matrices for above information with row names and col names.
   b) Display the demand, quantity and price matrices
   c) Find the total amount to be spent by each person for their requirements in each shop
   d) Suggest a shop for each person to buy the products which is minimal.
10. Applying summary() to find the mean, median, standard deviation, etc
11. Implementation of Visualizations - Bar, Histogram, Box, Line, scatter plot, etc.

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