CHRIST
(DEEMED TO BE UNIVERSITY)
PUNE LAVASA CAMPUS
The Hub of Analytics

# Department of Data Science

## Pune Lavasa Campus

# Syllabus

## BSc (Data Science)

Academic Year 2020-21

Batch 2020-2023

## DEPARTMENT OVERVIEW

The Department of Data Science at CHRIST (Deemed to be University), Pune Lavasa Campus was established to shape students into outstanding Data Scientists and Analytics professionals with ethical and human values. The department offers various undergraduate and postgraduate programmes viz., Bachelor of Science in Data Science, Master of Science in Data Science, Bachelor of Science in Economics & Analytics, and Doctor of Philosophy in the area of Computer Science and Engineering. The department has rich expertise in faculty resources who are trained in various fields like Data Science, Data Security, Data Analytics, Artificial Intelligence, Machine Learning, Networking, Data Mining, Big Data, Text Mining, Knowledge Representation, Soft Computing, and Cloud Computing. The department has a wide variety of labs set up, namely the Machine Learning Lab, Data Analytics Lab, Open Source Lab, etc., which are exclusively for students' hands-on training for their lab-oriented courses and research.

The department intermittently organizes hands-on workshops on recent technologies like Machine Learning, Cloud Computing, Hadoop, etc. for the students to make them ready for the industry. The department aims to equip students with a holistic education to make them better citizens.

## VISION

“Enrich Ethical Scientific Excellence”

## MISSION

“To develop Data Science professionals with ethical and social values.”

”To divulge state-of-the-art knowledge in the area of Data Science and Analytics.”

“To encourage research and innovation.”

“To accustom the students with current industry practices, teamwork, and entrepreneurship.”

## INTRODUCTION TO THE PROGRAMME

### BSc (Data Science)

The Bachelor of Science (Data Science) is a 3-year course designed to prepare graduates who can conduct data-driven investigations and conduct visual and advanced analytics by acquiring and managing data of all types. The graduates will develop an in-depth understanding of data science and the techniques for analysis of quantitative and qualitative data to arrive at solutions. They will be able to identify patterns, predict trends, and analyze data from various sectors such as manufacturing, banking and finance, retail, and healthcare. The academic track of the program is a blend of core and advanced specialist subjects. Our curriculum is built on the principle that the topics get more specialized as you progress through the program.

### Programme Objectives:

- To acquire an in-depth understanding of theoretical concepts in statistics, data analysis, data mining, machine learning, and other advanced data science techniques.
- To gain practical experience in programming tools for data sciences, database systems, machine learning, and big data tools.
- To strengthen analytical and problem-solving skills by developing real-time applications.
- To empower students with tools and techniques for handling, managing, analyzing, and interpreting data.

### Ethics and Human Values

1. Only proprietary or open-source software would be used for academic teaching and learning purposes.

2. Copying of programs from the internet, friends or other sources is strictly discouraged as it impairs the development of programming skills.

3. Unique Practical (Domain-based) exercises are given to ensure that the students don't involve in code plagiarism.

4. Projects undertaken by students during the course are done in teams to improve collaborative work and synergy between team members.

5. Projects involve modularization which initiates students to take individual responsibility for common goals.

6. Passion for excellence is promoted among the students, be it in software development or project documentation.

7. Giving due credit to sources during the seminar and research assignment is promoted among the students

8. The course is designed in such a way that it enforces the practice of proper referencing techniques to improve the sense of integrity.

9. The course involves group discussions and debates on ethical practices and human values, which sensitize the students in dealing with customers and members within the organization.

**Programme Eligibility**

- Basic eligibility for the programme is a pass at the +2 level (Maharashtra HSC / ISC / CBSE / NIOS / State Boards) from any recognized examination in India.
- Candidates writing the +2 examinations in March-May may apply with their class X and XI marks.
- It is compulsory to have studied (Mathematics) at the Class XII level.

**Programme Outcomes**

On successful completion of the BSc Programme, the students will be able to:

PO1. Understand and apply fundamental principles, concepts and methods in critical areas of science and multidisciplinary fields.

PO2. Demonstrate problem-solving, analytical and logical skills to provide solutions for scientific requirements.

PO3. Develop critical thinking with scientific temper.

PO4. Communicate the subject effectively.

PO5. Understand the importance and judicious use of technology for the sustainable growth of humanity in synergy with nature.

PO6. Understand professional, ethical, and social responsibilities.

PO7. Enhance research culture and uphold scientific integrity and objectivity.

PO8. Engage in continuous reflective learning in the context of technological and scientific advancements.

**Programme Specific Outcomes (PSO)**

PSO1: Abstract Thinking: To develop the ability to understand abstract concepts that lead to various data science theories in Mathematics, Statistics, and Computer Science.

PSO2: Problem Analysis and Design Ability: To identify, analyze and design solutions for problems using the fundamental principles of Mathematics, Statistics, Computing Sciences, and relevant domain disciplines.

PSO3: Modern Software Tool Usage: To acquire the skill of handling data science programming tools for problem-solving and solution analysis for domain-specific problems.

PSO4: Professional Ethics: To understand and commit to professional ethics, cyber regulations, responsibilities, and norms of professional computing practices.

PSO5: Conduct investigations of complex computing problems: Use research-based knowledge and research methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.

PSO6: Individual and Teamwork: To function effectively as an individual, as a member or as a leader in diverse teams and multidisciplinary environments.

PSO7: Applications in Multidisciplinary domains: To understand the role of statistical approaches and apply the same to solve real-life problems in the fields of data science.

PSO8: Project Management: To apply research-based knowledge to analyze and solve advanced problems in data science.

**EVALUATION PATTERN**

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|---|
| **CIA - 70%** |
| **ESE - 30%** |

# Curriculum Structure for BSc (Data Science) 2020-2023

| SEM | SUBCODE | SUBJECT NAME | Hrs./WEEK | CREDIT | MAX MARKS | TYPE |
|---|---|---|---|---|---|---|
| I | BDS131 | Discrete Mathematics | 4 | 4 | 100 | CORE |
| | BDS132 | Statistical Methods | 4 | 4 | 100 | CORE |
| | BDS133 | Digital Computer Fundamentals | 4 | 4 | 100 | CORE |
| | BDS171 | Programming in Python | 6 | 5 | 150 | DSEP |
| | BDS121 | English -I | 3 | 3 | 50 | AECC |
| | BDS122 | Additional English – I | 3 | 3 | 50 | AECC |
| | HOL111 | Holistic Education | 1 | 2 | Grade | SEC |
| | EVS123 | Environmental Studies | - | 2 | 50 | AECC |
| | | | **25** | **27** | **600** | |
| **SEM** | **SUBCODE** | **SUBJECT NAME** | **Hrs./WEEK** | **CREDIT** | **MAX MARKS** | **TYPE** |
| II | BDS231 | Calculus | 4 | 4 | 100 | CORE |
| | BDS232 | Probability and Distribution Theory | 4 | 4 | 100 | CORE |
| | BDS233 | Introduction to Data Science | 4 | 4 | 100 | CORE |
| | BDS271 | Advanced Python for Data Science | 6 | 5 | 100 | DSEP |
| | BDS272 | R for Analytics | 5 | 4 | 100 | DSEP |
| | BDS221 | English-II | 3 | 3 | 50 | AECC |
| | BDS222 | Additional English – II | 3 | 3 | 50 | AECC |
| | HOL211 | Holistic Education | 1 | 2 | Grade | SEC |
| | BDS281I | Summer Internship | - | 1 | 50 | |
| | | | **30** | **30** | **650** | |
| **SEM** | **SUBCODE** | **SUBJECT NAME** | **Hrs./WEEK** | **CREDIT** | **MAX MARKS** | **TYPE** |
| III | BDS331 | Software Engineering | 3 | 3 | 100 | CORE |
| | BDS332 | Professional Ethics in Computing | 2 | 2 | 50 | CORE |
| | BDS371 | Inferential Statistics | 5 | 4 | 100 | DSEP |
| | BDS372 | Database Management System | 6 | 5 | 150 | DSEP |
| | BDS373 | Data Structures using Python | 6 | 5 | 150 | DSEP |
| | BDS321-A | French | 2 | 2 | 50 | AECC |
| | BDS321-B | German | 2 | 2 | 50 | AECC |
| | HOL311 | Holistic Education | 1 | 2 | Grade | SEC |
| | | | **25** | **23** | **600** | |

| SEM | SUBCODE | SUBJECT NAME | Hrs./WEEK | CREDIT | MAX MARKS | TYPE |
|---|---|---|---|---|---|---|
| IV | BDS431 | Sampling Techniques | 4 | 4 | 100 | CORE |
| | BDS432 | Data Warehousing and Mining | 4 | 4 | 100 | CORE |
| | BDS433 | Data Communication and Networking | 4 | 4 | 100 | CORE |
| | BDS434 | Operating System | 4 | 4 | 100 | CORE |
| | BDS471 | Linear Algebra | 6 | 5 | 150 | DSEP |
| | BDS412 | Applied Excel | 2 | 1 | 50 | SEC |
| | HOL411 | Holistic Education | 1 | 2 | Grade | SEC |
| | BDS481I | Summer Internship | - | 1 | 50 | |
| | | | **25** | **25** | **650** | |
| **SEM** | **SUBCODE** | **SUBJECT NAME** | **Hrs./WEEK** | **CREDIT** | **MAX MARKS** | **TYPE** |
| V | BDS531 | Applied Regression | 4 | 4 | 100 | CORE |
| | BDS571 | Machine Learning | 6 | 5 | 150 | DSEP |
| | BDS572 | NoSQL Databases and Best Practices | 6 | 5 | 150 | DSEP |
| | BDS541-A | Software Quality Management | 3 | 3 | 100 | DSE |
| | BDS541-B | Project Management | 3 | 3 | 100 | DSE |
| | BDS541-C | Operations Research | 3 | 3 | 100 | DSE |
| | BDS573-A | Web Programming | 6 | 5 | 150 | DSEP |
| | BDS573-B | Mobile Application Development | 6 | 5 | 150 | DSEP |
| | BDS573-C | Digital Image Processing | 6 | 5 | 150 | DSEP |
| | BDS561 | Econometrics for Data Science | 2 | 2 | 50 | GE |
| | | | **27** | **24** | **700** | |
| **SEM** | **SUBCODE** | **SUBJECT NAME** | **Hrs./WEEK** | **CREDIT** | **MAX MARKS** | **TYPE** |
| VI | BDS671 | Big Data Analytics | 6 | 5 | 150 | DSEP |
| | BDS641-A | Stochastic Analysis | 3 | 3 | 100 | DSE |
| | BDS641-B | Introduction to Multivariate Analysis | 3 | 3 | 100 | DSE |
| | BDS641-C | Actuarial Mathematics and Statistics | 3 | 3 | 100 | DSE |
| | BDS672-A | Introduction to TensorFlow | 6 | 5 | 150 | DSEP |
| | BDS672-B | Data Visualization Techniques | 6 | 5 | 150 | DSEP |
| | BDS672-C | Time Series and Forecasting | 6 | 5 | 150 | DSEP |
| | BDS661 | Human Resource Management | 2 | 2 | 50 | GE |
| | BDS681P | Project | 10 | 5 | 300 | |
| | | | **27** | **20** | **750** | |

# SEMESTER I

## BDS 131 DISCRETE MATHEMATICS

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

- Formulate and interpret statements by applying the rules and methods of propositional logic
- Demonstrate a working knowledge of set notation and elementary set theory, recognize the connection between set operations and logic
- Prove elementary results involving sets
- Apply the different properties of injections, surjections, bijections, compositions, and inverse functions
- Demonstrate the use of mathematical reasoning by justifying and generalizing patterns and relations
- Determine when a relation is reflexive, symmetric, antisymmetric, or transitive, apply the properties of equivalence relations and partial orderings, and explain the connection between equivalence relations
- Gain enhanced understanding on Boolean algebra and it uses in Circuits

**Course Outcomes**

- Understand the notion of mathematical thinking, mathematical proofs, and algorithmic thinking, and be able to apply them in problem solving.
- Understand the basics of combinatorics, and be able to apply the methods from these subjects in problem solving.
- Be able to use effectively algebraic techniques to analyse basic discrete structures and algorithms.

**Unit 1** **Hours: 15**

**Foundations of Mathematical Logic-**

**Propositional Logic:** Propositions, Conditional Statements, Truth tables of Compound Statements, Precedence of Logical Operators, Logic and bit operations - **Applications of Propositional Logic**: Translating English sentences, System specifications, Boolean Searches, Logic Puzzles, Logic Circuits - **Propositional Equivalences:** Compound proposition, Logical Equivalences, Using De Morgan's Laws, Constructing new logical equivalences, Propositional Satisfiability, Applications of Satisfiability: A Sudoku Puzzle,

**Predicates and Quantifier** : Predicates, Quantifiers, Quantifiers with Restricted Domains, Precedence of Quantifiers.

**Unit 2** **Hours: 15**

**Permutations, Combinations and Functions-**

**Permutations:** permutation, r-permutations, circular r-permutations, permutations with repetitions, permutations with indistinguishable objects, **Combinations:** r-combinations, combinations with repetitions, **Functions:** Definition of a Function, functions in programming languages, One-to-One and Onto functions, One to one correspondence, Inverse functions and compositions of functions, Graphs of functions, Floor, ceiling, greatest Integer and Factorial functions,, partial functions.

**Unit 3** **Hours: 15**

**Matrices:** Matrix, Matrix Arithmetic, Transposes and Powers of Matrices, Zero-One Matrices: Boolean Product, Diagonal Matrix, Inverse of Matrix, System of Linear equations and Matrices **- Relations:**

Relations and Products, Functions as Relations, Relations on a Set, Properties of Relations: reflexive, irreflexive, symmetric, asymmetric, antisymmetric, transitive, inverse and complementary relations, Combining Relations, **n-ary Relations and their applications:** n-ary Relations, Databases and Relations, Operations on n-ary Relations, SQL.

**Unit 4** **Hours: 15**

**Boolean Algebra-**

**Boolean Functions:** Boolean Expressions and Boolean Functions, Identities of Boolean Algebra, Duality, The Abstract definition of a boolean algebra, **Representing Boolean Functions:** Sum-of-Products expansions, Product-of-Sums expansions, Functional Completeness, **Logic Gates:** Combinations of Gates, Half Adder, Full Adder, **Minimization of Circuits:** Karnaugh Maps, Don't Care Conditions, The Quine-McCluskey Method.

**Text Books**

1. K. H. Rosen, Discrete Mathematics and its Applications, 7th ed., McGraw – Hill, 2012.

**Reference Books**

1. R.P. Grimaldi and B.V. Ramana, Discrete and Combinatorial Mathematics, An applied introduction, 5th ed., Pearson Education, 2007.
2. D. S. Chandrasekharaiah, Discrete Mathematical Structures, 4th ed., India: PRISM Book Pvt. Ltd., 2012.
3. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Application to Computer Science, Reprint, India: Tata McGraw Hill Education, , 2008.

# BDS132 STATISTICAL METHODS

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

- To introduce the historical development of statistics, presentation of data, descriptive measures and fitting mathematical curves for the data.
- To introduce measurement of the relationship of quantitative and qualitative data and the concept of probability.
- To enable the students to understand and apply the descriptive measures and probability for data analysis.

**Course Outcomes**

After Successful completion of the course students will be able to

- Demonstrate the history of statistics and present the data in various forms.
- Infer the concept of correlation and regression for relating two or more related variables.
- Demonstrate the probabilities for various events.

**Unit 1** **Hours: 10**

**Organization and Presentation of data:** Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods).

**Unit 2** **Hours: 15**

**Descriptive Statistics** Measures of location or central tendency: Arithmetic Mean, Median, Mode, Geometric mean, Harmonic mean. Partition values: Quartiles, Deciles and percentiles. Measures of dispersion: Mean deviation, Quartile deviation, Standard deviation, Coefficient of variation. Moments: measures of skewness, Kurtosis.

**Unit 3** **Hours: 10**

**Correlation and Regression:** Correlation: Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only). Regression: Concept of errors, Principles of Least Square, Simple linear regression and its properties.

**Unit 4** **Hours: 10**

**Association of Attributes:** Relation between class frequencies, consistency of data, independence of attributes, criterion of independence, association of attributes: Yule's coefficient of association, Yule'coefficient of colligation

**Hours: 15**

**Unit 5**

**Basics of Probability :** Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye's theorem and its applications.

**Textbooks**


1. Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.


**Reference Books**


1. Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.
2. Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.
3. Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.
4. Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 2

# BDS133 DIGITAL COMPUTER FUNDAMENTALS

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- Understand the digital fundamentals of computer.
- Possess the concept and importance of the number systems, logic gates and flips flops.
- Analyse the working of devices like encoders and decoders, multiplexers and demultiplexers

**Course Outcomes**

- After Successful completion of the course students will be able to
- Understand math and Boolean algebra in performing computations in various number systems.
- Demonstrate Simplification of Boolean algebraic expressions.
- Design efficient combinational and sequential logic circuit implementations from functional description of digital systems.

**Unit 1** **Hours: 5**

Fundamentals of computers – Characteristics of computers – Computer Language – Operating Systems – Generation of Computers.

**Unit 2** **Hours: 15**

Number systems: Decimal numbers , Binary numbers : Counting in binary, The weighted structure of binary numbers, Octal numbers, hexadecimal numbers and their mutual conversions ,Binary arithmetic : Addition, subtraction, multiplication and division of binary numbers, 1‘s and 2‘s complement, signed numbers, arithmetic operations: addition, subtraction with signed numbers, 9‘s and 10‘s complement, BCD numbers, BCD addition, BCD subtraction, Gray code: Binary to Gray code conversion, Gray to Binary conversion, Weighted code : 8421 code and Non weighted codes : ASCII and EBCDIC.

**Unit 3** **Hours: 10**

**Boolean Algebra**

Boolean operations and expressions, Laws and rules of boolean algebra, Demorgan‘s Theorem,

Boolean expressions, Simplification of Boolean expression.

**Logic Gates**

AND gate, OR gate, NOT gate , NAND gate , NOR gate , X-OR gate , X-NOR gate, The universal property of NAND gate and NOR gate, Realization of basic gates. Boolean expression for logic circuits, Karnaugh map SOP with examples.
Self-Learning:
Universal property of NOR gate

**Unit 4** **Hours: 10**

**Combinational Logic**

Basic Adders : Half adder, Full adder, 4-bit Parallel adders, Subtractor : Half subtractor, Full subtractor Implementation using logic gates, Decoders: 4 bit decoder, BCD to decimal decoder, Encoder : Decimal to BCD encoder, Multiplexer : 4 to 1 multiplexer, Demultiplexer : 1 to 4 demultiplexer .

**Unit 5** **Hours: 10**

**Flip-flops**

Latches : SR latch, Clocked flip-flops :SR flip-flop, D flip-flop, JK flip-flop, Positive edge triggered flip flops, Timing diagrams , Master slave JK flip-flop.

**Unit 6** **Hours: 10**

**Flip-flops**

Latches : SR latch, Clocked flip-flops :SR flip-flop, D flip-flop, JK flip-flop, Positive edge triggered flip flops, Timing diagrams , Master slave JK flip-flop.

**Text Books**

1. Floyd, Thomas L: Digital Computer Fundamentals, 11th Edition, Pearson International, 2015.

**Reference Books**

1. Malvino, Paul Albert , Leach, Donald P, Gautam Saha: Digital Principles And Applications, TMH,8th Edition, 2015.
2. Bartee, Thomas C: Digital Computer Fundamentals, 6 Edition, TMH, 2010.

# BDS171 PROGRAMMING IN PYTHON

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week:6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

- Provide comprehensive knowledge of paradigms of python programming language.

**Course Outcomes**

After successful completion of the course students be able to

- Demonstrate the use of built-in objects of Python
- Apply the programming concepts of Python for data science applications.
- Implement GUI and Web based programming concepts.

**Unit 1** **Hours: 7**

Introduction to Python, Underlying mechanism of Module Execution- Whitespace Formatting, Operators, Control Statements, Arithmetic Functions and String functions. Sequences, Mapping and Sets- Dictionaries- Functions - Lists and Mutability- Problem Solving Using Lists and File handling.

**Unit 2** **Hours: 7**

Classes: Classes and Objects, Inheritance—Polymorphism- Abstract classes- Exceptional Handling, Types of exception-Inbuilt, User defined, Regular Expressions using “re” module.

**Unit 3** **Hours: 7**

Introduction-Tkiner module-Root window-Widgets-Button-Label-Message-Text-Menu-ListboxesSpinbox-Creating tables

**Unit 4** **Hours: 8**

Introduction-Web framework-creating model to add database service-python application shell-Django administration application-input-forms and models

**Unit 5** **Hours: 8**

Introduction to Numpy, Computation on NumPy-Aggregations-Computation on Arrays-Comparisons, Masks and Boolean Arrays-Fancy Indexing-Sorting Arrays-Structured Data: NumPy’s Structured Array.

**Unit 5** **Hours: 8**

Introduction to Pandas, Data Series, Data Frames, Data Wrangling, Data indexing and SelectionOperating on Data in Pandas-Handling Missing Data-Hierarchical Indexing.

Visualizing DataMatplotlib, Bar Charts, Line Charts, Scatterplots, Linear Algebra, Vectors, Matrices.

**Text Books**


1. Wesely J.Chun,Core Python Application Programming ,Prentice Hall,third edition 2015. 2. T.R.Padmanabhan, Programming with Python,Springer Publications,2016.


**Reference Books**


1. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372
2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058
3. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014
4. Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365


**Lab Programs** **Hours: 60**

1. Implement the concepts of variables and operators.
2. Implement the concepts of Strings.
3. Demonstrate the concept of Sets using real world scenario.
4. Demonstrate the concept of Lists using real world scenario.
5. Demonstrate the concept of Tuples using real world scenario.
6. Demonstrate the concept of Dictionaries using real world scenario.
7. Demonstrate the concept of File operations.
8. Implement the concept of Inheritance.
9. Implement the concept of Exception handling using predefined and user defined exceptions.
10. Demonstrate usage of basic and advance Regular expressions.
11. Demonstrate the concept of building a GUI using Tkiner.
12. Demonstrate the concept of building a web framework using Django.
13. Implement the concepts of aggregation, Indexing and sorting using Numpy Arrays.
14. Implement the concept of data series and data frames using Pandas.
15. Demonstrate the concept of data visualization using Matplotlib.

# BDS121 ENGLISH - I

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 50** **Credits: 3**

**Course Objectives**

- To help learners understand the relationship between the world around them and the text/literature
- To help improve their communication skills for larger academic purposes and vocational purposes and teach them logical sequencing of content and process information
- To enable learners to be able to speak for various purposes and occasions using context specific language and expressions and to listen to audio content and infer contextual meaning.
- To enable learners to develop the ability to write for various purposes using suitable and precise language.

**Course Outcomes**

- Understand how to engage with texts from various countries, historical, cultural specificities and politics
- Understand and develop the ability to reflect upon and comment on texts with various themes
- Develop the ability to communicate both orally and in writing for various purposes
- Develop an analytical and critical bent of mind to compare and analyze the various literature they read, listen and discuss in class.

**Unit 1** **Hours: 6**

**BEAUTY**

**1.1.** The Happy Prince by Oscar Wilde

**1.2.** Shakespeare Sonnet 18

**Language**

Common Errors- Subject-Verb Agreement, Punctuation, Tense Errors

**Unit 2** **Hours: 6**

**TRAVEL**

**2.1.** Why We Travel by Pico Iyer

**2.2** What Solo Travel Has Taught Me About the World – and Myself by Shivya Nath- Blog post

**Language**

Sentence Fragments, Dangling Modifiers, Faulty Parallelism

**Unit 3** **Hours: 6**

**ENVIRONMENT**

**3.1.** Thinking like a Mountain by Aldo Leopold

**3.2.** Short Text: On Cutting a Tree by Gieve Patel

**Language**

Note Making

**Unit 4** **Hours: 6**

**RELIGION**

**4.1.** Violence in the name of God is Violence against God by Rev Dr Tveit

**4.2.** Leave this Chanting From Gitanjali by Rabindranath Tagore

**Language**

Paragraph writing

**Unit 5** **Hours: 6**

**CRIME**

**5.1.** The Story of B24 by Sir Arthur Conan Doyle

**5.2.** Short Text: Aarushi Murder Case

**Language**

Newspaper report

**Unit 6** **Hours: 6**

**HEALTH**

**6.1.** Long text: My Story by Nicole DeFreece

**6.2.** Short text: Why You Should Never Aim for Six Packs

**Unit-6**

**Language**

Essay Writing

**Unit 7** **Hours:6**

**SPORTS**

**7.1.** Long Text: Sir Ranjth Singh Essay by Sourav Ganguly

**7.2.** Short text: Casey at the Bat by Ernest Lawrence Thayer

**Unit-7**

**Language**

Paraphrasing and interpretation skills

**Unit 8** **Hours:3**

**8.1 Visual Text**

Visual text- Before the Flood

**Text Books**

- Englogue – I : A textbook for First Year Undergraduate Students

**Reference Books**

- Wren and Martin's English Grammar and Composition
- English Grammar and Composition by NK Narayan
- Master your English Grammar by I. Jayakaran

## BDS122 ADDITIONAL ENGLISH - I

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 50** **Credits: 3**

**Course Objectives**

- To expose students to the rich literary and cultural diversity of Indian literatures
- To sensitise students on the social, political, historical and cultural ethos that has shaped the nation- INDIA
- To enable to grasp and appreciate the variety and abundance of Indian writing, of which this compilation is just a passing glance
- To learn and appreciate India through association of ideas in the texts and the external contexts (BhashaUtsav will be an intrinsic help in this endeavour)

**Course Outcomes**

- The students will become sensitive to cultural, social, religious and ethnic diversities and help them engage with their peers and all around them in a more understanding and 'educated' manner.
- It will also enable them through the activities conducted to become more proactive citizens/participants in society.
- Awareness of the dynamics of gender, identity, communalism and politics of this vast nation through its literature.

**Unit 1** **Hours: 10**

**Poetry**

1. Keki N Daruwala "Migrations"

2. Kamala Das "Forest Fire"
3. Agha Shahid Ali "Snow on the Desert"
4. Eunice D Souza "Marriages are Made"

**Unit 2** **Hours: 15**

**Short Stories**

1. Rabindranath Tagore "Babus of Nayanjore"
2. Ruskin Bond "He said it with Arsenic"
3. Bhisham Sahni "The Boss Came to Dinner"
4. N. Kunjamohan Singh "The Taste of Hilsa"
5. Mohan Thakuri "Post Script"

**Unit 3** **Hours: 20**

**Essays**

1. Mahatma Gandhi "What is True Civilization?" (Excerpts from *Hind Swaraj)*
2. Ela Bhatt "Organizing for Change"
3. Sitakant Mahapatra "Beyond the Ego: New Values for a Global Neighbourhood
4. B. R Ambedkar "Waiting for A Visa"

**Text Books**

1. Reading Diversity –Additional English Textbook

**Reference Books**

1. Hind Swaraj-Mahatma Gandhi
2. Annihilation of Caste- B.R Ambedkar
3. My Story- Kamala Das
4. Lone Fox Dancing- Ruskin Bond
5. The Day India Burned- BBC Documentary

# SEMESTER II

## BDS231 CALCULUS

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

This course will help the learner to,

- Gain familiarity with the concepts of limit, continuity and differentiability.
- Analyse and interpret the different versions of mean value theorems.
- Learn successive differentiation and $n_{th}$ derivative of product of two functions.
- Find derivative of functions of more than one variable.
- Be familiar with curve tracing

**Course Outcomes**

- Understand and use the notion of Derivative of the function of one variable
- Demonstrate a working knowledge of vectors and vector functions
- Determine partial derivatives of the functions of two or more variables and illustrate the computational skills in finding the directional derivatives, Gradient vectors and differentials

**Unit 1** **Hours: 20**

**Limits, Continuity, Differentiability and Mean Value Theorems**

Definition of the limit of a function (ε-δ) form – Continuity, Uniform Continuity – Types of discontinuities – Properties of continuous functions on a closed interval – Differentiability – Mean Value Theorems: Rolle's theorem – Lagrange's and Cauchy's First Mean Value Theorems – Taylor's theorem (Lagrange's form and Cauchy's forms of remainder) –

Maclaurin's theorem and expansions - Indeterminate forms. Maxima and Minima

**Unit 2** **Hours: 20**

**Successive and Partial Differentiation**

– First and higher order derivatives – Differentiation of homogeneous functions – Euler's theorem – Taylor's theorem for two variables (only statements and problems)- Maxima and Minima of functions of two variables.

**Unit 3** **Hours: 20**

**Curve Tracing**

Tangents and Normals, Curvature, Asymptotes, Singular points, Tracing of curves (Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates).

**Text Books**


1. G.B. Thomas, M. D. Weir and J. Hass, *Thomas Calculus*, 12th ed., Pearson Education India, 2015


**Reference Books**


1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons Inc., 2002.
   F. Ayres and E. Mendelson, *Schaum's Outline of Calculus*, 6th ed. USA: Mc. Graw Hill., 2013.
2. J. Stewart, *Single Variable Essential Calculus: Early Transcendentals*, 2nd ed.: Belmont, USA: Brooks/Cole Cengage Learning., 2013.
3. S. Narayanan & T. K. M. Pillay, *Calculus*, Reprint, India: S. Viswanathan Pvt. Ltd., 2009. (Vol. I & II)
4. M. Spivak, *Calculus*, 3rd ed., Cambridge University Press, 2006.
5. T.M. Apostol, *Calculus, Vol-II*, Wiley India Pvt. Ltd., 2011.
6. J. Edwards, *An elementary treatise on the differential calculus: with applications and numerous examples*, Reprint, Charleston, USA: BiblioBazaar, 2010.
7. N. P. Bali, *Differential Calculus*, New ed. New Delhi, India: Laxmi Publications (P) Ltd., 2012.


## BDS232 PROBABILITY AND DISTRIBUTION THEORY

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- To teach the basic concepts of random variables and its generation functions.
- To give a brief idea about standard probability distributions and how they are applied in real time situations.
- To enable the students to understand the properties and applications of various probability functions.

**Course Outcomes**

After Successful completion of the course students will be able to

- Demonstrate the random variables and its functions
- Infer the expectations for random variable functions and generating functions.
- Demonstrate various discrete and continuous distributions and their usage.
- Hypothesis will useful to take decision and Research

**Unit 1** **Hours: 10**

**Random variables:** Definition, Discrete and continuous random variables, Probability Mass function and Probability density function, Distribution function and its properties. Two dimension random variables: Discrete and continuous type, Joint Density function, Marginal and conditional Probability Mass function and Probability Density function, independence of variables with illustration.

**Unit 2** **Hours: 10**

**Mathematical Expectation and Generating functions:** Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications, Conditional expectations

**Unit 3** **Hours: 10**

**Discrete Probability distributions:** Discrete distributions, Mathematical Expectation, Binomial, Poisson, geometric, negative binomial, Hypergeometric distributions along with their properties, limiting/approximation cases and applications.

**Unit 4** **Hours: 15**

**Continuous Probability distributions:** Continuous distributions: Uniform, normal, exponential, Cauchy, beta and gamma distributions along with their properties, limiting/approximation cases and applications.

**Unit 5** **Hours: 15**

**Continuous Distribution:** Univariate continuous distribution Uniform, Normal, Exponential, Cauchy, Gamma, and Beta distributions Mean and Variance and their properties Sampling distributions t, F and Chi-square distribution Derivation and its properties Relationship between t, F and Chi-square distribution.

**Text Books**


1. Rohatgi V.K and Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 2014.


**Reference Books**

1 .Mukhopadhyay P, Mathematical Statistics, Books and Allied (P) Ltd, Kolkata, 2015.
2 Walpole R.E, Myers R.H, and Myers S.L, Probability and Statistics for Engineers and Scientists, Pearson, New Delhi, 2017.
3 Montgomery D.C and Runger G.C, Applied Statistics and Probability for Engineers, Wiley India, New Delhi, 2013.
4 Mood A.M, Graybill F.A and Boes D.C, Introduction to the Theory of Statistics, McGraw Hill, New Delhi, 200

## BDS233 INTRODUCTION TO DATA SCIENCE

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- Provide a strong foundation for data science and application areas related to it.
- Understand the underlying core concepts and emerging technologies in data science.
- Learn the process of working with data on large scale.
- Explore the concepts of Data Processing.
- Learn basic concepts of Machine Learning.
- Prepare students for advanced courses in Data Science.

**Course Outcomes**

After Successful completion of the course, students will be able to

- Understand the fundamental concepts of data science.
- Evaluate the data analysis techniques for applications handling large data and Demonstrate the data science process.
- Understand concept of machine learning used in the data science process.
- Visualize and present the inference using various tools.
- Learn to think through the ethics surrounding privacy, data sharing.

**Unit 1 Data Evolution** **Hours: 12**

**Data Evolution:** Data to Data Science – Understanding data: Introduction – Type of Data, Data Evolution – Data Sources.

Preparing and gathering data and knowledge - Philosophies of data science - data all around us: the virtual wilderness - Data wrangling: from capture to domestication - Data science in a big data world - Benefits and uses of data science and big data - facets of data.

**Unit 2** **Hours: 12**

**Digital Data-An Imprint:** Introduction to Big Data: - Evolution of Big Data - What is Big Data – Sources of Big Data. Characteristics of Big Data 6Vs – Big Data-Challenges of Conventional Systems- -– Data Processing Models – Limitation of Conventional Data Processing Approaches – Big Data. Big Data Exploration - The Big data Ecosystem and Data science.

Overview of the data science process - retrieving data - Cleansing, integrating, and transforming data.

**Unit 3** **Hours: 12**

**Machine learning** – Modelling Process – Training model – Validating model – Predicting new observations –Supervised learning, Unsupervised learning, Semi-supervised learning. Exploratory data analysis.

**Unit 4** **Hours: 12**

**First steps in big data** - Distributing data storage and processing with frameworks - Case study: Assessing risk when loaning money - Join the NoSQL movement - Introduction to NoSQL - Case Study. The rise of graph databases - Introducing connected data and graph databases.

**Unit 5** **Hours: 12**

**Ethics and Data Science-** Doing Good Data Science, Data Ownership, The Five Cs, Implementing the Five Cs, Ethics and Security Training, Developing Guiding Principles, Building Ethics into a Data-Driven Culture, Regulation, Building Our Future, Case Study.

**Text Books**


1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Manning Publications, 2016.
2. Think Like a Data Scientist, Brian Godsey, Manning Publications, 2017.

3. Ethics and Data Science, Mike Loukides, Hilary Mason and D J Patil, O'Reilly, 1st edition, 2018.

**Reference Books**

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.
2. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013.
3. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014.
4. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013.

## BDS271 ADVANCED PYTHON FOR DATA SCIENCE

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week:6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The enables students to

- Recognize the effective coding techniques.
- Understand the importance of Threads also know how network programs can be written
- Identify the techniques involved in extracting data from web.
- Know the importance of libraries associated with Data

**Course Outcomes**

After successful completion of the course students be able to

- Apply the best coding techniques.
- Apply Multithreading and Networking concepts in the required area.
- Analyze the techniques used in processing XML and JSON format data.
- Formulate the results from data using various Data Processing and Visualization Libraries.

**Unit 1** **Hours: 10**

**Generators, Iterator, Decorator**: Working with yield keyword, Difference between yield and return, Decorating a function with another function

**Lambda Functions:** Difference between def and lambda functions, Working with filter functions, Working with map functions, Working with reduce functions,

List Comprehensions, Serialization, Partial Functions, Code Introspection, Closures

**Unit 2** **Hours: 12**

**Multithreading:** Multithreading Introduction-Multithreading methods N Deamon Thread- Inter Thread Communication by Using Event N Condition-Inter Thread Communication By Using Queue

**Networking:** Socket, Simple Server, Simple Client, Retrieving web pages using urllib, Parsing HTML using regular Expression and Beautiful Soup, Sending Email,

**Unit 3** **Hours: 10**

Web Services: Parsing XML, JSON, Application Programming Interfaces

**Unit 4** **Hours: 14**

NumPy Libraries for Arrays, Pandas Library for Data Processing

**Unit 5** **Hours: 14**

Matplotlib for Visualization, Seaborn Library for Visualization, SciPy Library for Statistics

**Text Books**


1. Wesley J Chun, Core Python Applications Programming, 3rd Edition. Pearson
2. Michael Bowles, Machine Leaning in Python, Essential techniques for predictive analysis, Wiley
3. Al Sweigart,"Automate the Boring Stuff with Python",1st Edition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)


**Reference Books**


1. Mark Pilgrim, Dive into Python: Python Novice to pro (source: http://diveintopython.org/.)
2. Alex Martelli, Python Cookbook, O'REILLY
3. Luke Sneeringer, Professional Python, WROX
4. Laura Cassell, Python Projects, WROX
5. Shai Vaingast,Beginning Python Visualization , Crafting Visual Transformation Scripts, Apress


**Lab Programs** **Hours: 30**

1. Write a program using generator function.
2. How to call same function with decorator and without decorator.
3. Create Thread using Threading Module.

4. Multi-Threading Priority Queue
5. Implement a program using Socket.
6. Implement a program using Urllib
7. Sending Email
8. Construct an XML formatted data and Write Python Program to Parse that XML data.
9. Construct an JSON formatted data and Write Python Program to Parse that XML data.
10. Accessing Array index using NumPy
11. Aggregation function using NumPy.
12. Implement
    a) Matplotlib
    b) Seaborn
    c) SciPy

## BDS272 R FOR ANALYTICS

**Total Teaching Hours for Semester: 75** **No of Lecture Hours/Week: 5**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- Understand the environment R and the R preliminaries.
- Apply the R objects for statistical computations.
- Analyze and model data using various statistical packages.

**Course Outcomes**

After Successful completion of the course students will be able to

- Handle data using statistical tool
- Perform graphical representation of data using R
- Use R packages for introductory statistics.

**Unit 1** **Hours: 9**

**Introduction**

Introduction and preliminaries-The R environment, R and statistics, R commands, Data permanency and removing objects, Simple manipulations, Numbers and Vectors, Objects- modes and attributes, Ordered and unordered Factors, Arrays and Matrices

**Unit 2** **Hours: 9**

**Lists and Data Frames**

Constructing and modifying lists, Making Data frames, attach( ) and detach( ), Working with data frame, Reading data from files using read.table( ), scan( ), Grouping, Conditional execution: if statements, Repetitive execution: for loops, repeat and while loops, Functions.

**Unit 3** **Hours: 9**

**Data Exploration for Univariate and Bivariate Data**

Univariate Data - Handling categorical data and numerical data using R, Bivariate Data -Handling bivariate categorical data using R, Categorical vs. Numerical, Numerical vs. Numerical

**Unit 4** **Hours: 9**

**Data Exploration for Multivariate Data**

Multivariate Data **-**Storing multivariate data in R data frames, Accessing and manipulating data in R data frames, view multivariate data, apply( ) family functions - apply( ), sapply(), lapply( ), tapply( ), *dplyr* package- select( ), filter( ), arrange( ), rename( ), mutate( ), group_by( ), %>%, summarize( ).

**Unit 5** **Hours: 9**

**Correlation and Data Visualization**

Pearson correlation, Spearman rank correlation
*lattice* package in R - 1D, 2D, 3D plots using lattice
*ggplot2* package in R- 1D, 2D, 3D plots using ggplot2

**Lab Programs** **Hours:30**

1. Demonstrate the usage of Numbers and Vectors in R
2. Simple manipulations on Numbers and Vectors, Objects- modes and attributes, Ordered and unordered Factors
3. Implement the concepts of Arrays and Matrices
4. Demonstrate the usage of Data Frames and Lists and its attributes -attach, detach, scan and importing a file
5. Implement the concept of grouping and conditional execution on Data Frames and Lists
6. Demonstrate repetitive executions on Data Frames
7. Use a Dataset to handle the Categorical and numerical data
8. Use a Dataset to handle the Bi-variate categorical data
9. Use a Dataset to handle the Multivariate categorical data
10. Demonstrate the usage of apply() functions.
11. Implement the usage of dplyr package
12. Utilize a lattice package to plot 1D, 2D and 3D plots for a given dataset.

13. Utilize ggplot2 package to plot 1D, 2D and 3D plots for a given dataset.
14. Demonstrate Pearson correlation and Spearman rank correlation.

**Text Books**


1. W. N. Venables, D. M. Smith, *An Introduction to R*, R Core Team, 2018.
2. John Verzani, *simpleR – Using R for Introductory Statistics*, CRC Press, Taylor & Francis Group, 2005.


**Reference Books**


1. Seema Acharya, *Data Analytics Using R*, CRC Press, Taylor & Francis Group, 2018.
2. Michael Lavine, *Introduction To Statistical Thought*, Orange Grove Books, 2009.
3. Paul Teetor, *R Cookbook,* O'Reilly, 2011


## BDS221 ENGLISH - II

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 50** **Credits: 3**

**Course Objectives**

- To help learners understand the relationship between the world around them and the text/literature
- To help improve their communication skills for larger academic purposes and vocational purposes and teach them logical sequencing of content and process information
- To enable learners to be able to speak for various purposes and occasions using context specific language and expressions and to listen to audio content and infer contextual meaning.
- To enable learners to develop the ability to write for various purposes using suitable and precise language.

**Course Outcomes**

- Understand how to engage with texts from various countries, historical, cultural specificities and politics.
- Understand and develop the ability to reflect upon and comment on texts with various themes.
- Develop the ability to communicate both orally and in writing for various purposes.

- Develop an analytical and critical bent of mind to compare and analyze the various literature they read, listen and discuss in class.

**Unit 1** **Hours: 9**

**FOOD**

**1.1.** Long text: Witches' Loaves by O Henry

**1.2.** Short text: Portion size is the trick!!! by Ranjani Raman

**Language**

**1.1.1.** Presentation Skills

**1.1.2.** Listening skills

**Unit 2** **Hours: 7**

**FASHION**

**2.1.** Long text: In the Height of Fashion by Henry Lawson

**2.2.** Short text: Crazy for Fashion by Babatunde Aremu

**Language**

**2.1.1.** Report Writing

**2.1.2.** Listening skills

**Unit 3** **Hours: 8**

**MANAGEMENT**

**3.1.** Long Text: The Amazing Dabbawalas of Mumbai by Shivani Pandita

**3.2.** Short Text: If by Rudyard Kupling

**Language**

3.1.1. Interview Skills and CV Writing

3.1.2. Listening skills

**Unit 4** **Hours: 9**

**HISTORY**

**4.1.** Long text: Whose Ambedkar is he anyway? by KanchaIlaiah

**4.2.** Short text: Dhauli by Jayanta Mahapatra

**Language**

**4.1.1.** Developing Arguments- Debating

**4.1.2.** Listening skills

**Unit 5** **Hours:8**

**WAR**

**5.1.** Long text: An Occurrence at Owl Creek Bridge by Ambrose Bierce

**5.2.** Short text: Strange meeting by Wilfred Owen

**Language**

**5.1.1.** Letter Writing

**5.1.2.** Listening skills

**Unit 6** **Hours: 4**

**VISUAL TEXT**

**6.1** BBC Documentary- Dabbawalas

**Text Books**

1. Englogue – I : A textbook for First Year Undergraduate Students

**Reference Books**


1. Shivani Pandita, *The story of Mumbai Dabbawalas,* BBC Documentary,2008.
2. I.Jayakaran, *Master your English Grammar*, 2M Publishing International,2004.
3. Wren & Martin, *English and Grammar Composition*, Blackie ELT Books,2016.
4. https://www.youtube.com/watch?v=M7hOpT0lPGI, TED Talk, 2018.
5. https://www.youtube.com/watch?v=lmyZMtPVodo, TED Talk, 2014.
6. Rudyard Kipling, *Something of myself*, Macmillan and Co Limited ,1937


## BDS222 ADDITIONAL ENGLISH - II

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 50** **Credits: 3**

**Course Objectives**

- To expose students to the rich literary and cultural diversity of Indian literatures
- To sensitise students on the social, political, historical and cultural ethos that has shaped the nation- INDIA
- To enable students to express and appreciate the variety and abundance of Indian writing, of which this compilation is just a passing glance
- To analyse and learn about India through association of ideas in the texts and the external contexts.

**Course Outcomes**

- The students will be able to identify the cultural, ethical, social and political situations that exists in India
- The course will sensitize students towards cultural, social, religious and ethnic diversities and help them engage with their peers and all around them in a more understanding and 'educated' manner.

- It will enable students to critically analyse the Indian culture and societal structure through the activities conducted to become more proactive citizens/participants in society.
- Students will be able to explain the dynamics of gender, identity, communalism and politics of the nation through its literature.

**Unit 1** **Hours: 10**

**Poetry**

1. Jayanta Mahapatra "Grandfather"
2. Meena Alexander "Rites of Sense"
3. K.Satchidanandan "Cactus"
4. Jean Arasanayagam "Nallur"

**Unit 2** **Hours: 15**

**Short Stories**

6. Temsula Ao "The Journey"
7. A. K Ramanujan "Annaya's Anthropology"
8. Sundara Ramswamy "Waves"
9. Ashfaq Ahmed "Mohsin Mohalla"
10. T.S Pillai "In the Floods"

**Unit 3** **Hours: 20**

**Essays**

5. Salman Rushdie "Gandhi Now"
6. Amartya Sen "Sharing the World"
7. Suketu Mehta "Country of the No"
8. Rahul Bhattacharya "Pundits From Pakistan" (An Excerpt)

**Text Books**

- Reading Diversity –Additional English Textbook

**Reference Books**


- A.K Ramanujan, *Is there an Indian way of Thinking*?, Oxford University Press, 2004.
- *A. Roy, The Doctor and the Saint*, Penguin Books, 2017.
- A. Sen*, The Argumentative Indian*, Penguin Books, 2006.
- C. Macrae*, Sri Lanka's Killing Fields*, BBC Documentary, 2011.
- M.K. Gandhi*, Hind Swaraj,* 13ed, Cambridge texts in Modern Politics, 2009.

# SEMESTER III

## BDS331 SOFTWARE ENGINEERING

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The course is designed to

- Introduce to the concepts and best practices for Agile and Scrum.
- Know different life cycle models.
- Be an expert in Scrum, thus enhancing the ability to develop and deliver high-quality products, and apply Scrum concepts to the organization.
- Provide practical exposure of Agile methodologies through hands-on projects on JIRA, also maximize business value while mitigating potential risks.

**Course Outcomes**

After Successful completion of the course students will be able to

- Gain knowledge of difference software development lifecycle and tradeoff among them.
- Become proficient in requirement gathering, estimation, and testing techniques
- Develop understanding of Agile methodologies and its various implementations
- Attain applied knowledge of Scrum methodology using JIRA cloud
- Capable of producing different scrum artifacts, including product backlog, sprint backlog, definition of ready, and definition of done.
- Facilitate different Scrum ceremonies, including product backlog grooming, sprint planning, daily stand-up, sprint reviews, and sprint retrospective.

**Unit 1** **Hours: 12**

**Software Process**

Introduction –S/W Engineering Paradigm – life cycle models (water fall, incremental, spiral, WINWIN spiral, evolutionary, prototyping, object oriented) - system engineering – computer based system – verification – validation – life cycle process – development process –system engineering hierarchy - Requirements and Estimation – Testing Basis.

**Unit 2** **Hours: 10**

**Agile Project Management**

Why Agile - Agile Manifesto - Principles behind Agile Manifesto - History of Agile – Agile Methods and Examples - Project Engineering: Then & Now - Traditional Approach & Agile Approach - Some Agile Facts and Figures

**Unit 3** **Hours: 8**

**Overview of SCRUM**

What is SCRUM - Overview of SCRUM - Key Aspects of SCRUM – Product Owner, Planning Poker, the Team, The Sprint, Scrum Master, Manager in Scrum and Product Backlog - Scrum Pre-Planning meeting – Roadmap – Estimation - Backlog

**Unit 4** **Hours: 7**

**Sprint in Agile**

Scrum Pre-Planning Meeting - Sprint Planning meeting - A typical Sprint Calender - Defining DONE - Getting to DONE – Definition of Ready - Good and BAD Ways.

**How Sprint Works:** Daily Scrum Meeting - Updating Sprint Backlog - Burndown Chart – TaskBoard - Sprint Review - Sprint Retrospective

**Unit 5** **Hours: 8**

**Scrum and Metrics**

Principles of Agile metrics – Reflections: – Reflection of each iteration - Business value Delivered – Velocity – BurnDown - Code Coverage – Pairing - Defects Caried Over. Release Planning and Estimation in Scrum: Velocity – Based on historical Data - How to plan a release in Scrum - Scrum dis-advantages

**Text Books**

1. The Scrum Essential Scrum: A Practical Guide to the Most Popular Agile Process (Addison-Wesley Signature Series (Cohn)) - Free downloadable pdf link
2. Essential Scrum: A Practical Guide to the Most Popular Agile Process (Addison-Wesley Signature Series (Cohn)) : Link
3. Agile Methodologies - free ebook : Link

**Reference Books**


1. Roger S. Pressman, *Software engineering- A Practitioner's Approach*, McGraw-Hill International Edition, 9th Edition 2020.
2. Ian Sommerville, *Software engineering,* Pearson education Asia, 10th Edition 2016.

# BDS332 PROFESSIONALS ETHICS IN COMPUTING

**Total Teaching Hours for Semester: 30** **No of Lecture Hours/Week: 2**

**Max Marks: 50** **Credits: 2**

**Course Objectives**

The Course enables Students

- To create an awareness on Engineering Ethics
- To instil Moral and Social Values and Loyalty.
- To appreciate the rights of Others

**Course Outcomes**

After Successful completion of the course students will be able to

- Apply the Ethical values in their professional life
- Implement the moral and social values pertaining to the personal and social life
- Understand how to tackle the rights issue in their professional life.

**Unit 1** **Hours: 7**

**Engineering Ethics**

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

**Unit 2** **Hours: 7**

**Engineering as Social Experimentation**

Engineering as experimentation - engineers as responsible experimenters - codes of ethics – a balanced outlook on law - the challenger case study

**Unit 3** **Hours: 8**

**Safety, Responsibilities and Rights**

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the Three Mile Island and Chernobyl case studies.

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

**Unit 4** **Hours: 8**

**Global Issues**

Multinational corporations - Environmental ethics - computer ethics – weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE,

Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

**Text Books**


1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.
2. 2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.


**Reference Books**


1. Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, NewJersey, 2004 (Indian Reprint)
2. 2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics –Concepts and Cases", Wadsworth Thompson Learning, United States, 2000 (Indian Reprintnow available)
3. 3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi,2003.
4. 4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.


## BDS371 INFERENTIAL STATISTICS

**Total Teaching Hours for Semester: 75** **No of Lecture Hours/Week: 5**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- To introduce the concepts of theory of estimation and testing of hypothesis
- To enable the students to give inference about the population based on sample statistics.
- To deal with the concept of parametric tests for large and small samples.
- To provide knowledge about non-parametric tests and its applications.

**Course Outcomes**

After Successful completion of the course students will be able to

- Demonstrate the concepts of point and interval estimation of unknown parameters and their significance using large and small samples.
- Apply the idea of sampling distributions of difference statistics in testing of hypotheses.
- Infer the concept of nonparametric tests for single samples and two samples.

- Solving the Industrial and real world problems

**Unit 1** **Hours: 10**

**Introduction:** Introduction of Inferential statistics, Population and sample, Finite and Infinite Population, Parameter and statistic, difference between population and sample, sampling distribution, standard error, overview of inferential statistics, Estimation, type of estimates, Criteria of a good estimator, Unbiasedness, Consistency, Efficiency, Sufficiency.

**Unit 2** **Hours: 15**

**Estimation Theory-I:** Practical questions to proof, Consistent estimator, Some Important remarks about consistency, sufficient condition for consistency.

**Unit 3** **Hours: 10**

**Estimation Theory II:** Efficient Estimator, Minimum Variance Unbiased Estimator (MVUE), Practical questions, Cramer Rao Inequality and their conditions, sufficient estimator, Fisher-Nyman Factorization theorem and their application, Black Rao Theorem, Method of Maximum Likelihood, properties of Maximum likelihood estimators, Method of moment, Method of Moment, Properties of Moment of estimators, drawback of Moment of estimators. Method of least square

**Unit 4** **Hours: 10**

**Hypothesis I:** Introduction of hypothesis and their types, Critical and acceptance region, Types of error, Level of significance, Power function of a test, p value and it use, procedure of testing a hypothesis, unbiased test, Neyman-Pearson lemma.

**Unit 5** **Hours: 15**

**Hypothesis II:** Test of significance, test static and critical value, test of significance of large sample, and small sample, Test of significance for attributes (large samples), test of significance for difference in proportions, test of significance in single mean, test of significance of difference of mean, test of significance based on chi square distribution, test of significance based on t- distribution, test for difference of two population mean, Paired t test for difference of mean, Test of Significance based on F- Distribution.

**Lab Programs**

1. Introduction to R: How to download Cran and R studio their commands
2. Basics of R: Small operations of R software
3. Probability: existence of probabilities like binomial, Poisson etc.
4. Foundations for inference: Sampling distributions etc.

5. Foundations for inference: Confidence intervals
6. Inference for numerical data and their applications
7. Hypothesis: applications and analysis.

**Text Books**


1. Rohatgi V.K an Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.
2. Gupta S.C and Kapoor V.K, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, New Delhi, 2014.


**Reference Books**


1. Walpole R.E, Myers R.H and Myers S.L, *Probability and Statistics for Engineers and Scientists*, 9th edition, Pearson, New Delhi, 2017.
2. Mukhopahyay P, *Mathematical Statistics*, Books and Allied (P) Ltd, Kolkata, 2015
3. Rajagopalan M and Dhanavanthan P, *Statistical Inference*, PHI Learning (P) Ltd, New Delhi, 2012.
4. Conover W.J, *Practical Nonparametric Statistics*, 3rd edition, Wiley International, 1999.


## BDS372 DATABASE MANAGEMENT SYSTEM

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- To learn the fundamentals of data models and to conceptualize and depict a database system using ER diagram
- To make a study of SQL and relational database design
- To implement the design of the tables in DBMS
- To construct queries to get optimized outputs
- To gather an introductory knowledge about the emerging trends in the area of distributed database

**Course Outcomes**

After Successful completion of the course students will be able to

- Apply the fundamental concepts of databases and Entity-Relationship (E-R)

model.

- Apply E-R Model and Normalization principles to create relational databases for the given problems.
- Compare and contrast different file organization concepts for data storage in Relational databases.
- Apply the transaction management principles on relational databases.
- Apply the current trends such as object-oriented databases, distributed data storage in database technology.

**Unit 1** **Hours: 12**

**Introduction & DBMS Architecture**

Introduction- Data, Database, Database management system, Characteristics of the database approach, Role of Database administrators, Role of Database Designers, End Users, Advantages of Using a DBMS and When not to use a DBMS.

DBMS Architecture – Data Models – Categories of Data models, Schemas, Instance, and Database states, DBMS Architecture and Data Independence – The Three schema architecture, Data Independence. DBMS language and interface, Classifications of Database Management Systems.

**Unit 2** **Hours: 12**

**Data Modelling Using Entity-Relationship Model**

Using high level conceptual Data models for Database Design, Example Database Applications. Entity types, Entity Sets, Attributes and Keys. Relationships, Relationship types, Roles and Structural constraints. Weak Entity Types and Drawing E- R Diagrams. measures

**Unit 3** **Hours: 12**

**Database Design**

Functional dependencies and Normalization for Relational Databases - Normalization on concepts, first, second, third normal forms. Introduction to SQL.

**Unit 4** **Hours: 12**

**SQL**

SQL data definition and data types, specifying constraints in SQL, schema change statements, Basic queries, Views – Concept of a view in SQL.

The Relational Algebra and Relational Calculus

Relational Algebra: Unary relational operations; Binary relational operations; Examples of queries in relational algebra, Relational calculus: The Tuple relational calculus; The Domain relational calculus

**Unit 5** **Hours: 12**

**Transaction Processing Concepts and Concurrency Control**

Transaction and System concepts – Desirable properties of Transactions – Schedules and Recoverability. Lock-Based Protocols – Locks, Granting of Locks, and Two- phase locking protocol.

**Distributed Databases**

Distributed database concepts, Data fragmentation, Replication, and Allocation Techniques for Distributed database design, Types of Distributed database systems.

**Lab Programs** **Hours: 30**

Data Definition Language (DDL)
- Create, Drop Alter
- Tables
- Column
- Views
- Alter table

Data Manipulation Language (DML)
- Insert,
- Update
- Delete

SQL Functions
- The Concatenation Operator
- Column Aliases
- String Functions
- Arithmetic Functions
- Date Function

Advanced SQL Functions
- Select with Minus, Union and Intersect
- Handling NULL

Filtering Data Using Where
- Where Operators
- Where with Keywords and Logical Operators

Group by and Group by having
- Group Function Examples
- Group Function with Having

Integrity Constraints
- Types of constraint
- Referential Integrity

Defining Constraints

**Text Books**

1. Elmasri Ramez and Navathe Shamkant B, Fundamentals of Database Systems, Addison- Wesley, 6th Edition, 2010

**Reference Books**

1. Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.
2. O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.
3. Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 2003

## BDS373 DATA STRUCTURES USING PYTHON

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

- This course will introduce the concepts of Abstract data type (ADTs), linear data structures which includes lists, stacks, and queues. The course covers various sorting, searching and hashing algorithms and applications of linear data structures.

**Course Outcomes**

After Successful completion of the course students will be able to

- Understand the need for Data Structures when building applications.
- Appreciate the need for an optimized algorithm.
- Able to understand the concepts of data types, data structures and linear structures.
- Able to apply data structures to solve various problems.
- Able to understand non-linear data structures.
- Able to apply different Sorting Techniques
- Improve programming skills

**Unit 1** **Hours: 12**

**LINEAR DATA STRUCTURES – LIST**

**Linear Lists:** Abstract Data Types (ADTs) – List ADT – array-based implementation linked list implementation –– singly linked lists- circularly linked lists- doubly-linked lists – applications of lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal).

**Unit 2** **Hours: 12**

**LINEAR DATA STRUCTURES – STACKS, QUEUES**

Stack ADT – Operations – Applications – Evaluating arithmetic expressions- Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue- Priority Queue – deQueue – applications of queues.

**Unit 3** **Hours: 12**

**SEARCHING, SORTING AND HASHING TECHNIQUES**

Searching- Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Radix sort. Hashing- Hash Functions – Separate Chaining- Open Addressing – Rehashing – Extendible Hashing.

**Unit 4** **Hours: 12**

**NON-LINEAR DATA STRUCTURES -GRAPHS**

Definition – Representation of Graph – Types of graph – Breadth-first traversal – Depth-first traversal – Topological Sort – Bi-connectivity – Cut vertex – Euler circuits- Applications of graphs.

**Unit 5** **Hours: 12**

**NON-LINEAR DATA STRUCTURES – TREES**

Tree ADT – tree traversals – Binary Tree ADT – expression trees – applications of trees- binary search tree ADT –Threaded Binary Trees- AVL Trees – B-Tree -B+ Tree – Heap – Applications of heap.

**Lab Programs** **Hours:30**

1. **ARRAY IMPLEMENTATION OF**

   a.Stack b. Queue ADTs c. List ADTs

2. **IMPLEMENTATION OF SINGLE LINKED LIST**

   Write Python programs for the following operations on Single Linked List.

(i) Creation (ii) insertion (iii) deletion (iv) traversal

3. **IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST**

Write Python programs for the following operations on Circular Linked List.

(i) Creation (ii) insertion (iii) deletion (iv) traversal

4. **IMPLEMENTATION OF DOUBLE LINKED LIST**

Write Python programs for the following: Uses functions to perform the following operations on Double Linked List.

(i)Creation (ii) insertion (iii) deletion (iv) traversal in both ways

5. **IMPLEMENTATION OF STACK USING LINKED LIST**

Write a Python program to implement Stack using linked list.

6. **IMPLEMENTATION OF QUEUE USING LINKED LIST**

Write a Python program to implement Linear Queue using linked list

7. **IMPLEMENTATION OF SEARCHING TECHNIQUES**

a. Linear search, b. Binary search

8. **IMPLEMENTATION OF SORTING ALGORITHM**

a. Merge sort, b. Quick sort

9. **IMPLEMENTATION OF SORTING ALGORITHM**

Separate chaining and Open Addressing Hashing Technique

10. **GRAPH TRAVERSAL TECHNIQUES**

Write Python programs to create a tree and implement the following graph traversal algorithms

a. Depth first search. b. Breadth first search.

11. **IMPLEMENTATION OF BINARY SEARCH TREE**

a. Create a binary search tree.

b. Traverse the above binary search tree recursively in pre-order, post-order and in- order

c. Count the number of nodes in the binary search tree. LIST

12. **IMPLEMENTATION OF AVL TREE**

Write Python programs to implement AVL Tree

**Text Books**

1. Rance D. Necaise. “Data Structures and Algorithms Using Python”, Hamilton Printing Company,2011

**Reference Books**

1. Mark Summerfield, Programming in Python 3 “A Complete Introduction to the Python Language”, Addison-Wesely Reprint 2011.

# SEMESTER IV

## BDS 431 SAMPLING TECHNIQUES

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

This course is designed to introduce students about official statistical system in India and to understand basic concepts of Sampling and surveys. Through the course student will be able

- To enable the students to understand various sampling techniques and their application in various research studies.
- To Identify the circumstances the make sampling unnecessary and the reason they re rare.
- To Describe the concept of sampling error and explain how its size is affected by the number of cases sampled, the heterogeneity of the population, and the fraction of population included in the sample.

**Course Outcomes**

After Successful completion of the course students will be able to

- Demonstrate the official Statistical System in India.
- Demonstrate various sampling techniques and their application
- Infer various sampling error and non-sampling error.
- solving the Industrial and real world problems

**Unit 1** **Hours: 10**

Sampling Method : Concept of population, sample, parameter and statistic, sampling versus census, advantages of sampling methods, role of sampling theory, sampling and non-sampling errors, bias and its effects, probability sampling.

**Unit 2** **Hours: 15**

Simple Random sampling with and without replacement, use of random number tables in selection of simple random sample, estimation of population mean and proportion. Derivation of expression for variance of these estimates. Estimates of variance. Sample size determination.

**Unit 3** **Hours: 10**

Stratified random sampling. Problem of allocation, proportional allocation, optimum allocation. Derivation of the expression for the standard errors of the usual estimators

when these allocation are used. Gain in precision due to stratification.

**Unit 4** **Hours: 10**

Systematic sampling : estimation of population mean and population total, standard errors of these estimators

**Unit 5** **Hours: 15**

Cluster sampling with equal clusters. Estimation of population mean and their mean square error.

**Text Books**


1. Cochran, W.G., Sampling Techniques, Wiley Eastern Ltd. ,New Delhi
2. Sukhatma P.v., Sampling Theory of Survey with Applications, Piyush Publications, New Delhi


**Reference Books**


1. Murthy M.N. Sampling Theory and Methods- Statistical Publishing Society, Calcutta.
2. Raj D. , Sampling Survey Theory, Narasa Publication House, New Delhi
3. Daroga Singh and F.S. Chaudhary, Sampling Survey Design, Wiley Eastern Ltd. New Delhi.


## BDS432 DATA WAREHOUSING AND MINING

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- Explore the concepts of Data Warehousing.
- Posses in depth understanding of data mining tasks like constructing Decision trees, finding Association Rules, Classification and Clustering.
- Provide broad understanding of data mining algorithms.

**Course Outcomes**

After Successful completion of the course students will be able to

- Design a Data Warehouse system and perform business analysis with OLAP tools
- Apply data pre-processing techniques for data analysis.

- Apply the different association algorithms or classification techniques for data analysis.
- Apply the different clustering algorithms based on their accuracy for solving the real world problems

**Unit 1** **Hours: 12**

**Data Warehouse-** The Need for an Operational Data Store, Operational Data Store, Data Warehouse, Data Marts, Data Warehouse versus OLTP, Data **Warehouse Schema**- Introduction to Data Warehouse Schema, Star Schema, Snow flake schema, Fact Constellation Schema, Online Analytical Processing- Introduction, Data Cube, Type of OLAP Servers, OLAP Operations

**Unit 2** **Hours: 12**

**Introduction to Data Mining:** What is Data mining? Data Mining Tasks, Data Preprocessing- Types of data, Data Quality, Data Preprocessing, Similarity & Dissimilarity measures

**Unit 3** **Hours: 12**

**Classification:** Introduction, Applications Decision Tree based Algorithms, Model Overfitting, Performance Evaluation of a classifier, Comparison Classifiers. **Classification Alternative Techniques-**Rule Based Classifier, Nearest Neighbor Classifier, Bayesian Classification.

**Unit 4** **Hours: 12**

**Association Rule Mining:** Introduction, Applications, Market-Basket Analysis, Frequent Itemsets, Apriori Algorithm, Alternative Methods.

**Unit 5** **Hours: 12**

**Clustering:** Introduction, Applications, Partitioning Algorithms, Hierarchical Algorithms, Density based Algorithms, Cluster Evaluation.

**Text Books**

1. Tan P. N., Steinbach M & Kumar V. "Introduction to Data Mining" Pearson Education, 2006.
2. Prateek Bhatia, "Data Mining and Data warehousing", Cambridge University Press, 2019.

**Reference Books**

1. Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Second Edition, 2006
2. Dunhum M.H. & Sridhar S. "Data Mining-Introductory and Advanced Topics", Pearson Education, 2006.

# BDS433 DATA COMMUNICATION AND NETWORKING

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students to

- Illustrate basic computer network technology.
- List and explain the layers of the OSI model and TCP/IP model.
- Demonstrate subnetting and routing mechanisms.
- Classify routers, IP and Routing Algorithms in network layer.

**Course Outcomes**

After Successful completion of the course students will be able to

- Understand and describe the layered protocol model.
- Describe, analyse and evaluate a number of data link layer protocols.
- Describe, analyse and evaluate a number of network layer protocols.
- Describe, analyse and evaluate a number of transport layer protocols.
- Program network communication services for client/server and other application layouts.
- Describe the current architecture of internet and the entities involved in running several applications.

**Unit 1** **Hours: 12**

Data Communications, Networks, Network Types, Protocol Layering, The OSI Model, Layers in the OSI model, TCP/IP Protocol suite.

**Physical layer**: Transmission impairment, Date Rate Limits, Performance.

**Connecting Device and Virtual LANs**: Connecting Device, Virtual LANs

**Unit 2** **Hours: 12**

**Data Link Layer**-Introduction, Link Layer Addressing, Detection and Correction-Introduction, Block Coding, Cyclic Codes- CRC, Polynomials, Checksum.

**Data Link Layer**– Data Link Control Framing, Flow and error control, Protocols, HDLC, Point-to-Point Protocol- Framing.

**Unit 3** **Hours: 12**

Network Services and Internal Network Operation, Packet Network Topology, Datagrams and Virtual Circuits, Routing in Packet Networks, Shortest Path Routing, ATM Networks, Traffic Management at the Packet Level, Traffic Management at Flow Aggregate Level

**Unit 4** **Hours: 12**

**TCP/IP** :The TCP/IP Architecture, The Internet Protocol, IPV6,User Datagram Protocol, Transmission Control Protocol, Internet Routing Protocol, Multicast Routing, DHCP, NAT and Mobile IP.

**Unit 5** **Hours: 12**

Client Server Programming, Iterative Programming in JAVA, WWW and HTTP, FTP, Electronic Mail, Telnet, SSH.

Dynamic Multipoint VPN, Cisco ASA, EIGRP, MPLS

**Text Books**


1. Behrouz A. Forouzan "Data Communications and Networking" Tata McGraw-Hill, 5th Edition, 2013.
2. Alberto Leon-Garcia and Indra Widjaja, "Communication Networks - Fundamental Concepts and Key architectures", Tata McGraw-Hill, 2nd Edition, 2004.


**Reference Books**


1. William Stalling, "Data and Computer Communication,", Pearson Education, 8th Edition,2007.
2. Larry L. Peterson and Bruce S. Davie. "Computer Networks – A Systems Approach", Elsevier, 4t Edition,2007
3. Nader F. Mir "Computer and Communication Networks", Pearson Education, 2007.


## BDS434 OPERATING SYSTEM

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

The Course enables Students

- To have an overview of different types of operating systems
- To know the components of an operating system.
- To have a thorough knowledge of process management
- To have a thorough knowledge of storage management
- To know the concepts of I/O and file systems.

**Course Outcomes**

After Successful completion of the course students will be able to

- Understanding the concepts of Process Management
- Understanding the concepts of Memory Management
- Understanding the concepts of File & I/O Management
- Ability to implement the different CPU scheduling algorithms.
- Ability to implement various memory management techniques.
- Demonstrate the working of an OS, explain the structure of operating systems, applications, and the relationship between them.
- Able to implement/ simulate some process/ memory management function of OS.

**Unit 1** **Hours: 12**

**Introduction:** Categories of Operating Systems, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations.

**System Structures:** Operating-System Services, User Operating-System Interface, System Calls, Types of System Calls, System Programs.

**Process Management:** Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Inter-process Communication.

**Unit 2** **Hours: 12**

**Multithreaded Programming:** Overview, Multithreading models, threading issues.

**Process Scheduling:** CPU Scheduling, Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling. **Synchronization:** The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic problems of Synchronization, Monitors.

**Unit 3** **Hours: 12**

**Deadlocks:** System Model, Deadlock Characterization, Methods for handling Deadlocks -Deadlock Prevention, Deadlock avoidance, Deadlock detection, Recovery from Deadlocks.

**Memory Management Strategies:** Swapping, Contiguous Memory allocation, Paging, Structure of the Page Table, Segmentation.

**Unit 4** **Hours: 12**

**Virtual Memory Management:** Demand Paging, Copy-on-Write, Page Replacement, Allocation of frames, Thrashing.

**File System**: File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File Sharing, Protection.

**Unit 5** **Hours: 12**

**Implementing File Systems:** File System Structure, File System Implementation, Directory Implementation, allocation Methods, Free-space Management.

**Secondary Storage Structure**: Disk Structure, Disk Attachment, Disk Scheduling, Disk Management and Swap-Space Management. Case study.

**Text Books**

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", Ninth Edition, John Wiley & Sons (ASIA) Pvt. Ltd, 2013.

**Reference Books**

1. Harvey M. Deitel, "Operating Systems", Third Edition, Pearson Education Pvt. Ltd, 2007.
2. Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall of India Pvt. Ltd, 2009.
3. William Stallings, "Operating System", Pearson Education 2009.
4. Pramod Chandra P. Bhatt – "An Introduction to Operating Systems, Concepts and Practice", PHI, 2010.

## BDS471 LINEAR ALGEBRA

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

This course will help the learner to

- Understand the algebra of matrices, concepts in vector spaces and Linear Transformations
- How to Analyze and solve a linear system of equations
- Gain problems solving skills in solving systems of equations using matrices, finding eigenvalues and eigenvectors, vector spaces and linear transformations.

**Course Outcomes**

After the completion of the course students will be able to

- Use properties of matrices, especially invertibility, and matrix algebra.

- Understand concepts of vector space, subspace of a vector space, linear span, linear dependence, linear independence, dimension, basis and formally prove standard results related to these concepts.
- Be familiar with Linear transformations and their corresponding matrices and understand the Rank and nullity concepts

**Unit 1** **Hours: 12**

**Matrices and System of linear equations**

Elementary row operations - Rank - Gaussian elimination, elementary matrices – Inversion of a matrix using row operations - Echelon Forms - Normal Forms - System of Homogeneous and non-homogeneous equations - Cayley Hamilton Theorem - Eigenvalues - Eigenvectors - and diagonalization.

**Unit 2** **Hours: 12**

**Vector Spaces**

Vector space-Examples and Properties, Subspaces-criterion for a subset to be a subspace, linear span of a set, linear combination, linear independent and dependent subsets, Basis and dimensions, Standard properties, Examples illustrating concepts and results.

**Unit 3** **Hours: 12**

**Linear Transformations**

Linear transformations, properties - matrix of a linear transformation, change of basis - range and kernel, rank and nullity, Rank-Nullity theorem.

**Unit 4** **Hours: 12**

**Norms and Inner Product Spaces**

Introduction - Inequalities on Linear Spaces - Norms on Linear Spaces - Inner products-Orthogonality - Unitary and Orthogonal Matrices - norms for matrices

**Unit 5** **Hours: 12**

**Linear Algebra Application to Data Science**

Linear Algebra in Machine Learning - Loss functions - Regularization-covariance Matrix-Support Vector Machine Classification. Linear Algebra in dimensionality Reduction - Principal Component Analysis (PCA) - Singular Value Decomposition (SVD). Linear Algebra in Natural Language Processing - Word Embeddings - Latent Semantic Analysis. Linear Algebra in Computer Vision - Image Representation as Tensors- Convolution and Image Processing.

**Lab Programs** **Hours:30**

Operations on Matrices

1. Echelon form
2. Inverse of a matrix by Gauss Elimination method

3. Solving system of Equations using various method
4. Eigenvalues and Eigenvectors
5. Expressing a vector as a linear combination of given set of vectors
6. Linear Span, Linear Independence and Linear dependence
7. Linear Transformations and Rank
8. Plotting of Linear transformations

**Text Books**


1. Amit Saha, *Doing Math with Python: Use Programming to Explore Algebra, Statistics, Calculus, and More!*, no starch press:San Fransisco, 2015.
2. H P Langtangen, *A Primer on Scientific Programming with Python,* 2nd ed., *Springer*, 2016


**Reference Books**


1. B E Shapiro, *Scientific Computation: Python Hacking for Math Junkies*, Sherwood Forest Books, 2015.
2. C Hill, Learning Scientific Programming with Python, Cambridge University Press, 2016.


## BDS412 APPLIED EXCEL

**Total Teaching Hours for Semester: 30** **No of Lecture Hours/Week: 2**

**Max Marks: 50** **Credits: 1**

**Course Objectives**

The Course enables Students to

- Provide students with the fundamental knowledge of the use of computers in business
- Provide exposure to the students on MS Office Excel.
- Apply MS, excel functions in business.

**Course Outcomes**

After Successful completion of the course students will be able to

- Apply their knowledge in excel for creating useful spreadsheets
- Create their own spreadsheet containing formulas that helps in calculations

- Create spreadsheet that contains data visualization using various charts
- Create spreadsheets that contain useful functionalities like lookups and pivot charts.

**Unit 1** **Hours: 6**

**Introduction to Excel**

**Basic Excel functions**: Structure of an excel function, functions such as SUM (), MIN (), MAX (), AVERAGE (), COUNT (), AUTOSUM, AUTOFILL. **Working with an Excel List:** Understanding Excel List Structure, Sorting a List Using Single Level Sort, Sorting a List Using Multi-Level Sorts, Using Custom Sorts in an Excel List, Filter an Excel List Using the AutoFilter, Creating Subtotals in a List, Format a List as a Table, Using Conditional Formatting to Find Duplicates, Removing Duplicates. **Excel Data Validation:** Understanding the Need for Data Validation, Creating a Validation List, Adding a Custom Validation Error, Dynamic Formulas by Using Validation Techniques

**Unit 2** **Hours: 6**

**Conditional Functions and Working with Large Excel Data Sets**

**Conditional Functions:** Working with Excel Name Ranges, Using Excel's IF () Function, Nesting Functions, Using Excel's COUNTIF () Function, Using Excel's SUMIF () Function, Using Excel's IFERROR () Function.

**Working with Large Sets of Excel Data:** Using the Freeze Panes Tool, Grouping Data (Columns and/or Rows), Consolidating Data from Multiple Worksheets.

**Unit 3** **Hours: 6**

**LookUp and Text Based Function**

**Excel's Lookup Functions:** Using Excel's VLOOKUP() Function, Using Excel's HLOOKUP() Function, Using Excel's INDEX() and MATCH() Functions. **Excel's Text Based Functions:** Using Excel's functions such as LEFT(), RIGHT() and MID(), LEN(), SEARCH(), CONCATENATE().

**Unit 4** **Hours: 12**

**Excel PivotTables**:

Understanding Excel PivotTables, Creating an Excel PivotTable, Modifying Excel PivotTable Calculations, Grouping PivotTable Data, Formatting PivotTable Data, Drilling Down into PivotTable Data, Creating Pivot Charts, Filtering PivotTable Data, Filtering with the Slicer Tool.

**Unit 5** **Hours: 12**

**Visualization using Pivot Charts**

Column Chart, Combo Chart, Scatter Plot chart, Heatmap, Stacked area chart & animating chart over time, Building an interactive dashboard in excel using a combination of techniques learn

**Reference Books**


2. Alexander, Kusleika, & Walkerbach ; Excel 2019 Bible;Wiley,2018
3. John Walkenbach; Excel Charts, Wiley,2016

# SEMESTER V

## BDS531 APPLIED REGRESSION

**Total Teaching Hours for Semester: 60** **No of Lecture Hours/Week: 4**

**Max Marks: 100** **Credits: 4**

**Course Objectives**

- This course aims to provide the grounding knowledge about the regression model building of simple and multiple regression.

**Course Outcomes**

After Successful completion of the course students will be able to

- Develop a deeper understanding of the linear regression model
- Understand the forward, backward and stepwise methods for selecting the variables
- Understand the importance of multicollinearity in regression modelling
- Ability to use and understand generalizations of the linear model to binary and count data
- solving the Industrial and real world problems

**Unit 1** **Hours: 10**

**SIMPLE LINEAR REGRESSION:** Introduction to regression analysis: Modelling a response, overview and applications of regression analysis, major steps in regression analysis. Simple linear regression (Two variables): assumptions, estimation and properties of regression coefficients, significance and confidence intervals of regression coefficients, measuring the quality of the fit.

**Unit 2** **Hours: 15**

**MULTIPLE LINEAR REGRESSION:** Multiple linear regression model: assumptions, ordinary least square estimation of regression coefficients, interpretation and properties of regression coefficient, significance and confidence intervals of regression coefficients.

**Unit 3** **Hours: 10**

**CRITERIA FOR MODEL SELECTION:** Mean Square error criteria, R2 and R 2 criteria for model selection; Need of the transformation of variables; Box-Cox transformation; Forward, Backward and Stepwise procedures.

**Unit 4** **Hours: 10**

**RESIDUAL ANALYSIS:** Residual analysis, Departures from underlying assumptions, Effect of outliers, Collinearity, Non-constant variance and serial correlation, Departures from normality, Diagnostics and remedies

**Unit 5** **Hours: 15**

**NON LINEAR REGRESSION:** Introduction to nonlinear regression, Least squares in the nonlinear case and estimation of parameters, Models for binary response variables, estimation and diagnosis methods for logistic and Poisson regressions. Prediction and residual analysis.

**Text Books**


1. D.C Montgomery, E.A Peck and G.G Vining, Introduction to Linear Regression Analysis, John Wiley and Sons,Inc.NY, 2003.
2. S. Chatterjee and AHadi, Regression Analysis by Example, 4th Edition, John Wiley and Sons, Inc, 2006.
3. Seber, A.F. and Lee, A.J., Linear Regression Analysis, John Wiley, 2013

[Relevant sections from chapters [3, 4, 5, 6, 7, 9, 10].


**Reference Books**


1. Iain Pardoe, Applied Regression Modeling, John Wiley and Sons, Inc, 2012.
2. P. McCullagh, J.A. Nelder, Generalized Linear Models, Chapman & Hall, 1989.


## BDS571 MACHINE LEARNING

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- To understand basic concepts of machine learning
- Understand how to evaluate models generated from data
- Discover how to build machine learning algorithms, prepare data, and use different techniques using Python

**Course Outcomes**

After Successful completion of the course students will be able to

- Implement different machine learning algorithm techniques .

- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
- Apply appropriate data sets to the Machine Learning algorithms.
- Identify and apply Machine Learning algorithms to solve real world problems.

**Unit 1** **Hours: 12**

**INTRODUCTION TO MACHINE LEARNING :**Definition of Machine Learning - Understanding Objectives of Machine Learning - Various Components of Machine Learning – Data Storage – Data Processing – Deriving Variables – Transformation – Generalization - Sampling – Features of Machine Learning - Types of Machine Learning – Supervised – Unsupervised – Reinforcement Learning - Techniques and Predictive Models – Deployment of Solution – Strategic Solution

**Unit 2** **Hours: 12**

**SUPERVISED LEARNING**-Classification and Regression, **Generalization, Overfitting, and Underfitting** : Relation of Model Complexity to Dataset Size . **Supervised Machine Learning Algorithms** : Some Sample Datasets, k-Nearest Neighbours, Linear Models Naive Bayes Classifiers, Decision Trees , Support Vector Machines , **Uncertainty Estimates from Classifiers** :The Decision Function , Predicting Probabilities , Uncertainty in Multiclass Classification.

**Unit 3** **Hours: 12**

**UNSUPERVISED LEARNING AND PREPROCESSING:** Types of Unsupervised Learning, Challenges in Unsupervised Learning**. Reprocessing and Scaling**: Different Kinds of pre-processing , Applying Data Transformations, Scaling Training and Test Data the Same Way, The Effect of Reprocessing on Supervised Learning,

**Unit 4** **Hours: 12**

**DIMENSIONALITY REDUCTION, FEATURE EXTRACTION, AND MANIFOLD LEARNING**: Principal Component Analysis (PCA) , Non-Negative Matrix Factorization (NMF) , Manifold Learning with t-SNE , **Clustering:** k-Means Clustering, Agglomerative Clustering , DBSCAN, Comparing and Evaluating Clustering Algorithms, Summary of Clustering Methods

**Unit 5** **Hours: 12**

**REPRESENTING DATA AND ENGINEERING FEATURES**: **Categorical Variables**: One-Hot-Encoding (Dummy Variables), Numbers Can Encode Categorical, Binning, Discretization, Linear Models, and Trees , **Automatic Feature Selection** : Univariate Statistics , Model-Based Feature Selection , Iterative Feature Selection, Utilizing Expert Knowledge .

**Lab Programs** **Hours:30**

1. Loading the **data** from a given csv file into a data frame and print the shape of the data, type of the data, number of rows-columns, feature names and the description.
2. Get the number of observations, **missing values** and nan values for the given data set.
3. Linear regression
4. K Nearest Neighbour
5. ID3 algorithm.
6. Naïve Bayesian classifier
7. Support vector machine
8. Bayesian network
9. PCA
10. k-Means algorithm.

**Text Books**


1. Andreas C. Müller & Sarah Guido, "Introduction to Machine Learning with Python A Guide For Data Scientists" O'Reilly book, 2017
2. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005.


**Reference Books**


1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008.
3. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009.


## BDS572 NOSQL DATABASE AND BEST PRACTISES

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables students

- To teach the students the installation and operation of NOSQL

- To give students an overview of software like MongoDb, Cassandra, HBASE, Neo4j
- To give students knowledge about replication and shardng
- To give details about HBASE and Riak Operations
- To introduce students to graph NOSQL databases

**Course Outcomes**

After successful completion of the course the students will be able to

- Install NoSQL in their computers
- Apply replication and sharding methods
- Implement databases using Apache HBASE, Riak and Neo4

**Unit 1** **Hours: 12**

**Introduction**

Overview, and History of NoSQL Databases Definition of the Four Types of NoSQL Database, the Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, the Emergence of NoSQL, Key Points comparison of relational databases to new NoSQL stores, MongoDB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, Aggregate-Oriented Databases.

**Unit 2** **Hours: 12**

**Replication and Sharding**

Replication and sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication. NoSQL Key/Value databases using MongoDB, Document Databases, What Is a Document Database? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.

**Unit 3** **Hours: 12**

**Column- oriented NoSQL databases using Apache HBASE**

Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, What Is a Column-Family Data Store? Features, Consistency, Transactions, Availability, Query Features, Scaling,

Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage, When Not to Use.

**Unit 4** **Hours: 12**

**NoSQL Key/Value databases using Riak**

NoSQL Key/Value databases using Riak, Key-Value Databases, What Is a Key-Value Store, Key- Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preferences, Shopping Cart Data, When Not to Use, Relationships among Data, Multi- operation Transactions, Query by Data, Operations by Sets.

**Unit 5** **Hours: 12**

**Graph NoSQL databases using Neo4**

Graph NoSQL databases using Neo4, NoSQL database development tools and programming languages, Graph Databases, What Is a Graph Database? Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data,Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

**LAB** **Hours: 30**

- Introduction to MongoDB and its Installation
- Description of mongo Shell
- Create database and show database
- Basic queries in MongoDB– Insert, Query, Update, Delete and Projection
- Where Clause equivalent in MongoDB
- To study operations in MongoDB – AND in MongoDB, OR in MongoDB, Limit Records and Sort Records.
- To study operations in MongoDB – Indexing, Advanced Indexing, Aggregation and Map Reduce.
- Practice with ' macdonalds ' collection data for document- oriented database.
- Import operation on database.
- Column oriented databases study, queries and practices

**Text Books**

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence , Pearson Education

**Reference Books**

1. Redmond, E. & Wilson, Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement ,1st Edition.
2. Gaurav Vaish, Getting started with NoSQL, Packt publishing, 2013

## BDS541-A SOFTWARE QUALITY MANAGEMENT

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- To provide students an understanding about the integrated approach to software development incorporating quality management methodologies.
- To train the students in Software quality models, Quality measurement and metrics, Quality plan, implementation and documentation, Quality tools including CASE tools,
- To enable the students to handle complexity metrics and International quality standards like ISO and CMM

**Course Outcomes**

After Successful completion of the course students will be able to

- Properly understand software quality models
- Design measurement and metrics
- Design Quality plan, implementation and documentation.
- Apply tools including CASE tools.
- Apply processes of International quality standards – ISO, CMM
- Apply the different clustering algorithms based on their accuracy for solving the real world problems

**Unit 1** **Hours: 9**

**INTRODUCTION TO SOFTWARE QUALITY**

Software Quality – Hierarchical models of Boehm and McCall – Quality measurement – Metrics measurement and analysis – Gilb's approach – GQM Model

**Unit 2** **Hours: 9**

**SOFTWARE QUALITY ASSURANCE**

Quality tasks – SQA plan – Teams – Characteristics – Implementation – Documentation – Reviews and Audits

**Unit 3** **Hours: 9**

**QUALITY CONTROL AND RELIABILITY**

Tools for Quality – Ishikawa's basic tools – CASE tools – Defect prevention and removal –Reliability models – Rayleigh model – Reliability growth models for quality assessment

**Unit 4** **Hours: 9**

**QUALITY MANAGEMENT SYSTEM**

Elements of QMS – Rayleigh model framework – Reliability Growth models for QMS – Complexity metrics and models – Customer satisfaction analysis.

**Unit 5** **Hours: 9**

**QUALITY STANDARDS**

Need for standards – ISO 9000 Series – ISO 9000-3 for software development – CMM and CMMI – Six Sigma concepts.

**Text Books**

1. Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003. (UI : Ch 1-4 ; UV : Ch 7-8)
2. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison-Wesley Professional, 2003.

**Reference Books**

1. Orman E. Fenton and Shari Lawrence Pfleeger, "Software Metrics" Thomson, 2003
2. Mordechai Ben – Menachem and Garry S.Marliss, "Software Quality", Thomson Asia Pte Ltd, 2003.
3. Mary Beth Chrissis, Mike Konrad and Sandy Shrum, "CMMI", Pearson Education (Singapore) Pte Ltd, 2003.
4. ISO 9000-3 "Notes for the application of the ISO 9001 Standard to software development".

# BDS541-B PROJECT MANAGEMENT

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- Give the students a proper understanding of the concepts of project definition, life cycle, and systems approach
- Develop competency in project scoping, work definition, and work breakdown structure (WBS)
- Handle the complex tasks of time estimation and project scheduling, including PERT and CPM
- Develop competencies in project costing, budgeting, and financial appraisal.

**Course Outcomes**

After Successful completion of the course students will be able to

- Apply the concept of project management in engineering field through project management life cycle.
- Analyse the quality management and project activity in the engineering field through work breakdown structure.
- Analyse the fundamentals of project and network diagram in engineering and management domain through PDM techniques.
- Evaluate the concept of network analysis through PERT and CPM techniques
- Apply the concept of scheduler based on resource availability in engineering and management field through project proposals.

**Unit 1** **Hours: 9**

**Introduction to Project and Project Management**

Introduction to Project: Definition of a Project, Sequence of Activities, Unique activities, Complex Activities, Connected Activities, One Goal, Specified Time, Within Budget, According to Specification. Defining a Program, Project parameters: Scope, Quality, Cost, Time, Resources; The scope triangle: Time, Cost, and Resource Availability, Project Classification

**Project Management:** Principles of Project Management: Defining, Planning, Executing, Controlling, Closing; Project Management Life Cycle: Phases of Project Management, Levels of Project Management.

**Unit 2** **Hours: 9**

**Quality Management and Project Activities:**

Quality Management: Continuous Quality Management Model, Process Quality Management Model; Risk Management, Risk Analysis; Relationship between Project Management and other Methodologies

**Project Activities:** Work Breakdown Structure, Uses of WBS, Generating the WBS: Top-Down/ Bottom-Up Approach, WBS for Small Projects, Intermediate WBS for large projects; Criteria to Test for Completeness in the WBS: Measurable Status, Bounded, Deliverable, Cost/Time Estimate, Acceptable Duration Limits, Activity Independence; Approaches to Building the WBS: various approaches, Representing WBS.

**Unit 3** **Hours: 9**

**Activity Duration, Resource Requirements, & Cost and Fundamentals of Project Network Diagram**

Activity Duration, Resource Requirements, & Cost: Duration: Resource Loading versus Activity Duration, Variation in Activity Duration, Methods for Estimating Activity Duration, Estimation Precision; Resources; Estimating Cost, JPP Session to Estimate Activity Duration & Resource Requirements, Determining Resource Requirements

**Fundamentals of Project Network Diagram:** Project Network Diagram, Benefits to Network- Based Scheduling, Building the Network Diagram Using the PDM, Analyzing the Initial Project Network Diagram.

**Unit 4** **Hours: 9**

**Network Analysis: PERT and Network Analysis- CPM**

**Network Analysis – PERT:** Introduction to Project Evaluation and Review Technique, Event, Activity, Dummy, Network rules, Graphical guidelines for network, Common partial situations in network, numbering the events, Cycles; Developing the Network, Planning for network construction, modes of network construction, steps in developing network, hierarchies; Time Estimates in PERT, Uncertainties and use of PERT, Time estimates, Frequency distribution, Mean, Variance & standard deviation, Probability distribution, Beta distribution, Expected time; Time Computations in PERT, Earliest expected time, Formulation for TE, Latest allowable occurrence time, Formulation for TL, Combined tabular computations for TE, TL; Slack, Critical Path, Probability of meeting schedule date.

**Network Analysis- CPM:** Introduction to Critical Path Method, Procedure, Networks, Activity time estimate, earliest event time, Latest allowable occurrence time, combined tabular computations for TE and TL, Start & Finish times of activity, Float, Critical activities & Critical path. Crashing of project network, Resource levelling and Resource allocation

**Unit 5** **Hours: 9**

**Schedules Based on Resource Availability and Joint Project Planning Session**

Schedules Based on Resource Availability: Resources, Levelling Resources, Acceptability Levelled Schedule, Resource Levelling Strategies, Work Packages: Purpose of a Work Package, Format of a Work Package

**Joint Project Planning Session:** Planning the Sessions, Attendees, Facilities, Equipment, Complete Planning Agenda, Deliverables, Project Proposal Text Books And Reference Books:

**Text Books**


1. "Effective Project Management", Robert K. Wysocki, Robert Beck. Jr., and David B. Crane; - John Wiley & Sons 2003.
2. "Project Planning and Control with CPM and PERT" Dr. B.C. Punmia & K.K.Khandelwal; - Laxmi Publications, New Delhi 2011.


**Reference Books**


1. "Project Management" S. Choudhury, - TMH Publishing Co. Ltd, New Delhi 1998.
2. "Total Project Management- The Indian Context" P. K. Joy, Macmillan India Ltd., Delhi 2017.
3. "Project Management in Manufacturing and High Technology Operations" Adedeji Bodunde Badiru, - John Wiley and Sons 2008.
4. "Course in PERT & CPM" R.C.Gupta, - DhanpatRai and Sons, New Delhi.
5. "Fundamentals of PERT/ CPM and Project Management" S.K. Bhattacharjee; - Khanna Publishers, New Delhi 2004.


## BDS541-C OPERATIONS RESEARCH

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- To provide knowledge of operation research and optimization through different techniques.
- To enhance the skill of optimisation
- To understand the competitive strategy management

**Course Outcomes**

After Successful completion of the course students will be able to

- Develop a deep understanding of the operation research
- Learn about simplex methods
- Understand application of operation Research
- Understand how to develop mathematical models for future prediction.
- Ability to develop competitive strategies with use of Operation Research
- Solving the Industrial and real world problems

**Unit 1** **Hours: 9**

**Introduction:** Development of operation Research, definition of operation Research, Scientific Methods of operation research, Necessity of operation research, Scope of operation research, operation research and decision making, Models in OR, Character stick of a good model, Advantage and limitation of a model, type of Mathematical Models, Advantages and Limitation of operation Research.

**Unit 2** **Hours: 9**

**Linear Programming:** Application of Linear Programming method, Area of application of linear programming, Advantages and limitations of linear programing, Graphical Method of solution, Theory of simplex method, slack variable, surplus variable, Artificial variable techniques.

**Unit 3** **Hours: 9**

**Cost Analysis:** Introduction to the model, assumptions of transportation model, North west corner method (NWCM), Least cost Method (LCM), Vogel Approximation Method (VAM), Assignment problem, Hungarian Method, travelling salesman problem.

**Unit 4** **Hours: 9**

**Decision Analysis:** Introduction of Game theory, saddle point, pure strategy and mixed strategy, reduce game by dominance, Mixed strategy.

**Unit 5** **Hours: 9**

**Decision Analysis:** Application of queuing models, assumptions of queuing models, classification of queuing models, Model I Single- channel passion arrival, Birth and death model, what is simulation, when to use simulation, advantages and limitations of simulation technique, application of simulations.

**Text Books**

1. Prem Kumar Gupta & D.S. HIRA . OPERATIONS RESEARCH, S.CHAND & COMPANY PVT. LTD.
2. Kanti Swaroop, Operation research, Sultan Chand and Sons.

**Reference Books**

1. H.A Taha, Operation Research an introduction, Pearson Prentice Hall
2. Wayne L. Winston,"Operations Research" Thomson Learning,2003
3. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.

## BDS573-A WEB PROGRAMMING

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

- Design web pages using HTML5 and Cascading Style Sheets (CSS).
- Design Server-Side programs using PHP and connect it to database
- Design Client-Side programs using JavaScript
- Validating the Webpages using jQuery
- Develop ReactJS script at the client side.

**Course Outcomes**

After successful completion of the course students will be able to

- Design web pages using HTML
- Develop Server side programs using PHP
- Apply styling using Cascading Style Sheets
- Develop JavaScript programs to validate and create dynamic Web Pages
- Create web Pages with ReactJS script at the client side

**Unit 1** **Hours: 10**

**HTML5:** Introduction to HTML, What is HTML and Where did it come from?, HTML Syntax, Semantic Markup, Structure of HTML Documents, Quick Tour of HTML Elements, HTML5 Semantic Structure Elements.

**CSS:** Introduction to CSS, What is CSS, CSS Syntax, Location of Styles, Selectors, The Cascade: How Styles Interact, The Box Model, CSS Text Styling. HTML Tables and

Forms, Introducing Tables, Styling Tables, Introducing Forms, Form Control Elements, Table and Form Accessibility, Microformats.

**Unit 2** **Hours: 10**

**PHP Programming:** Introduction to Server-Side Development with PHP, What is Server-Side Development, A Web Server's Responsibilities, Quick Tour of PHP, Program Control, Functions, PHP Arrays and Super globals, Arrays, $_GET and $_POST Super global Arrays, $_SERVER Array, $_Files Array, Reading/Writing Files.

**Unit 3** **Hours: 12**

**JavaScript**: Client-Side Scripting, What is JavaScript and What can it do? JavaScript Design Principles, Where does JavaScript Go?, Syntax, JavaScript Objects, The Document Object Model (DOM), JavaScript Events, Forms.

**Unit 4** **Hours: 14**

**Advanced JavaScript & JQuery**

JavaScript Pseudo-classes- Using Object Literals, Emulate classes through functions, Using Prototypes,

jQuery Foundations-Including jQuery in your page, jQuery Selectors, jQuery Attributes, jQuery Listeners, Modifying the DOM,

AJAX-Making Asynchronous Requests, Complete control over AJAX

**Unit 5** **Hours: 14**

React JS: Introduction, Creating and using Components, Bindings, Props, State and Events, Working with Components, Conditional Rendering, Building forms with Hooks, Getting data from RESTful APIs with Hooks, CRUD with Hooks, Connecting to an API to persist Data

**Lab Programs** **Hours: 30**

1. Write an HTML code to display your education details in a tabular format.
2. Write an HTML code to display your CV on a web page.
3. Design a web page using CSS (Cascading Style Sheets) which includes the following:

   A. Use different font, styles: In the style definition you define how each selector should work (font, color etc.). Then, in the body of your pages, you refer to these selectors to activate the styles.

   B. Set a background image for both the page and single elements on the page.

   C. Control the repetition of the image with the background-repeat property.
4. Write an HTML code to create a Home page having three links: About Us, Our Services and Contact Us. Create separate web pages
5. Write an HTML code to create a login form. On submitting the form, the user should get navigated to a profile page.

6. Write an HTML code to create a Registration Form. On submitting the form, the user should be asked to login with this new credentials.
7. Write an HTML code to illustrate the usage of the following:
   • Ordered List
   • Unordered List
   • Definition List
8. Write an HTML code to create a frameset having header, navigation and content sections.
9. Write an HTML code to demonstrate the usage of inline CSS
10. Write an HTML code to demonstrate the usage of internal CSS
11. Write an HTML code to demonstrate the usage of external CSS.
12. Write a Java script to prompt for users name and display it on the screen.
13. Design HTML form for keeping student record and validate it using Java script
14. Write an HTML program to design an entry form of student details and send it to store at database server like SQL, Oracle or MS
15. To design the scientific calculator and make event for each button using java script
16. Write an HTML page that contains a selection box with a list of 5 countries, when the user selects a country, its capital should be printed next to the list; Add CSS to customize the properties of the font of the capital (color, bold and font size).
17. Write a JSP which insert the details of the 3 or 4 users who register with the web site by using registration form. Authenticate the user when he submits the login form using the user name and password from the database
18. Create web application that takes a name as input and on submit it shows a hello page where is taken from the request. and it shows a start time at the right top corner of the page and provides the logout button on clicking this button it should shoe a logout page with thankyou message with the duration of Usage.
19. Write a Program to create online quiz and display the score.
20. Write a Program to validate the Following fields in the form
    a) Name b)Email-Id c) Mobile Number d) Country e) Gender f) Hobbies
21. Write a Program to Create an Image Gallery.
22. Write a program to check the validity of username using PHP only and using PHP AJAX prove it using browser console window.

**Text Books**


1. Randy Connolly, Ricardo Hoar “Fundamentals of Web Development” Pearson Education, 1st Edition, 2014
2. Grem Lim, “Beginning React Native with Hooks”


**Reference Books**


1. David Sawyer McFarland “JavaScript & jQuery: The Missing Manual” ,
2. O'Reilly Media, 3rd Edition,September 2014

3. M. Deitel, P.J. Deitel, A. B. Goldberg, "Internet & World Wide Web How to Program", Pearson education, India, 3rd Edition,2004
4. Chris Bates "Web Programming Building Internet Applications", Wiley India, 3rd Edition, 2006.

## BDS573-B MOBILE APPLICATION DEVELOPMENT

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- Develop applications for modern Smartphone operating systems.
- Have practical approach to Android mobile application development and theoretical knowledge about windows application.
- Understand, how to develop and deploy an application to the appmarket.

**Course Outcomes**

After Successful completion of the course students will be able to

- Build Android Applications.
- Explain the differences between Android, Windows and other mobile development environments.
- Secure, tune, package and deploy applications.

**Unit 1** **Hours: 10**

Brief History of mobile technologies, Different mobile technologies, Introduction to Android, Get to know the required tools, Creating your first Android application, Anatomy of android Application. Understanding Activities, linking Activities using intents, fragments, calling Built-in Applications using Intents, Displaying Notifications

**Unit 2** **Hours: 12**

**User Interface and Designing with views**

Understanding the components of a screen, adapting to display orientation, managing changes to screen orientation, Utilizing the Action Bar, Creating the user Interface programmatically, Listening for UI Notifications. Using Basic Views, Using Picker views, Using List views to display lists, Understanding specialized fragments.

**Designing User interface**

Designing User interface Designing by declaration, creating the opening screen, using alternate resources, implementing an about box, applying a theme, adding a menu, adding settings, debugging with log messages, debugging with debugger.

**Unit 3** **Hours: 12**

**Displaying with views, Data persistence**

Using Image Views to display pictures, using menus with views, some additional views. Saving and loading user preferences, persisting DataFiles

**Storing local Data**

Reading/writing local data, Accessing the Internal File system, Accessing the SDcard.

**Unit 4** **Hours: 12**

**Content Providers**

Creating and using Databases. Sharing Data in Android, using content provider, creating your own content providers, using content providers.

**Putting SQL to work**

Introducing SQLite, In and Out of SQLite, Hello Database, Data Binding, using content provider, implementing content provider.

**Preparing and Publishing**

Preparing app for publishing, Deploying APK files, uploading in Market

**Unit 5** **Hours: 14**

**Messaging, Location based services and Networking**

SMS Messaging , Sending E-mail, Displaying Maps, Getting Location Data, Monitoring a Location.

**Preparing and Publishing**

Preparing app for publishing, Deploying APK files

**Introduction to Windows Phone Programming**

Vision and architecture - A different kind of phone - Windows phone architecture - Building and delivering apps - Getting started with “Hello World”

**Lab Programs** **Hours:30**

1. Creating “Hello world” Application.
2. Creating an Application that displays message based on the screen orientation.
3. Create an application that displays custom designed Opening Screen.
4. Play an audio, based on the user event.
5. Create an UI with all views.
6. Create menu in Application.
7. Read/ write the Local data.
8. Create / Read / Write data with database (SQLite).
9. Create an application to send SMS.
10. Create an application to send ane-mail.

11. Display Map based on the Current/given location.
12. Learn to deploy android Applications.

**Text Books**


1. Wei-Meng Lee, Beginning android 4 application Development, John Wiley & sons, Inc, 2012.
2. Andrew Whitechapel, Sean McKenna, Windows Phone 8 Development Internals, Microsoft Press2013.


**Reference Books**


1. Grant Allen, Beginning Android 4, Apress,2012.
2. Ed Burnette, Hello, Android: Introducing Google's Mobile Development Platform, Pragmatic. Bookshelf (2009), ISBN-13:978-1934356173.
3. Jerome (J.F) DiMarzio , Android - A programmer's Guide, TataMcgraw Hill ,2010, ISBN:9780071070591.
4. Charles Petzold, Programming Windows Phone, Microsoft Press,2010


## BDS573-C DIGITAL IMAGE PROCESSING

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

- The course enables students to learn the concepts of basic image processing techniques which includes pre-processing, segmentation and object recognition

**Course Outcomes**

After Successful completion of the course students will be able to

- Comprehend the knowledge of image processing techniques.
- Analyze image processing techniques in spatial domain.
- Design algorithms to solve classification and compression techniques

**Unit 1** **Hours: 12**

**Fundamentals of Image Processing**

The origins of Digital Image Processing, Elements of Digital Image Processing System. Image Sampling and Quantization, Basic relationships: Neighbors, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations.

**Unit 2** **Hours: 12**

**Image Enhancement Techniques**

Gray Level Transformations, Histogram Processing, Histogram equalization. Basics of Spatial Filters, Smoothening and Sharpening Spatial Filters.

**Unit 3** **Hours: 12**

**Image Compression and Image restoration techniques**

Huffman coding and Run Length encoding and decoding techniques. A model of the Image Degradation/ Restoration Process, Noise Models, Restoration in the presence of Noise.

**Unit 4** **Hours: 12**

**Image Segmentation**

Region Based Segmentation – Region Growing and Region Splitting and Merging. Representation – Chain codes. Point, Line and Edge detection. Thresholding – Global thresholding

**Unit 5** **Hours: 12**

**Object recognition**

Introduction to Patterns and Pattern Classes. Minimum distance classifier, K-NN classifier and Bayes. Boundary descriptors –Regional and Topological descriptors

**Lab Programs** **Hours:30**

1. Write a program to display frequency of each pixel occurring in a row of an image.
2. Write a program to convert color images to Gray scale Images.
3. Write a program to perform Rotation of images using different methods.
4. Write a program to perform resizing of images using different methods.
5. Write a program to implement Contrasts stretching.
6. Write a program to demonstrate smoothening of an image.
7. Write a program to perform non-linear filtering of an image (Median)
8. Write a program to implement of Edge detection.
9. Write a program to extract the three-color components in the images
10. Write a program to perform bit plane slicing.

**Text Books**


1. R.C.Gonzalez & R.E.Woods, Digital Image Processing, 3rd Edition. Pearson Education, 2009.
2. A.K. Jain, Fundamental of Digital Image Processing, 4th Edition. PHI, 2011.


**Reference Books**


1. M. A. Joshi, Digital Image Processing: An algorithmic approach, 2nd Edition. PHI, 2009.
2. B.Chanda, D.Dutta Majumdar, Digital Image Processing and analysis, 1st Edition, PHI, 2011.

# BDS561 ECONOMETRICS FOR DATA SCIENCE

**Total Teaching Hours for Semester: 30** **No of Lecture Hours/Week: 2**

**Max Marks: 50** **Credits: 2**

**Course Objectives**

The course aims at providing students with:

- Provide a comprehensive introduction to basic econometric concepts and techniques,
- To develop the ability to apply econometric techniques in the investigation of economic relationships and processes,
- To provide the understanding of the specific econometric problems associated with economic statistics

**Course Outcomes**

Undergoing the course, the students will have the knowledge and skills required:

- For the construction and estimation of simple and multiple regression models.
- To perform econometric analysis and estimation, by understanding their application in economics.
- To analyse each economic problem in depth, and
- To do not only the estimation of the model and testing of the hypotheses, but also perform post-estimation diagnostics and see how well the model performs.

**Unit 1** **Hours: 5**

**Introduction**

Definition and scope of econometrics – the methodology of econometric research – the historical origin of the term regression and its modern interpretation – statistical vs deterministic relationship – regression vs causation – regression vs correlation – terminology and notation – the nature and sources of data for econometric analysis.

**Unit 2** **Hours: 5**

**Simple Linear Regression Model**

Two-Variable Case Estimation of model by OLS method – Assumptions – Properties of Least Square Estimators: Gauss-Markov Theorem; Testing of regression coefficient; Test for regression as a whole, Coefficient of determination.

**Unit 3** **Hours: 10**

**Multiple Linear Regression**

Model Multiple Regression Analysis: The problem of estimation – notation and assumptions – meaning of partial regression coefficients the multiple coefficient of determination – R2 and the multiple coefficient of correlation partial correlation

coefficients – interpretation of multiple regression equation. **Relaxing the Assumptions of CLRM:** Introduction to multicollinearity, heteroscedasticity, autocorrelation; the nature of the problem, its detection and corrective measures.

**Unit 4** **Hours: 10**

**Model Specification Errors**

Omitted Variables and test – s – Misspecification of the functional form – Alternative functional forms - Errors of Measurement – Outliers, The Nature of Dummy Variables – Dummy Variable Trap – ANOVA – Use of Dummy variables: Nature of Qualitative response models – Linear Probability Model – Logit Model – Probit Model.

**Text Books**


1. Studenmund, A. H. (2016). Using Econometrics: A Practical Guide. (7th ed.). New Delhi: Pearson.
2. Wooldridge, J. M. (2014). Introductory Econometrics: A Modern Approach (4th ed.). New Delhi: Cengage Learning


**Reference Books**


1. Dougherty, C. (2016). Introduction to Econometrics (5th ed.). Oxford University Press.
2. Gujarati, D. N., Porter, D.C., & Gunasekar, S. (2017). Basic Econometrics. (5th ed.). McGraw-Hill.
3. J. Angrist and J.S. Pischke, Mostly Harmless Econometrics, Princeton University Press, 2009 (MHE).

# SEMESTER VI

## BDS671 BIG DATA ANALYTICS

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- Provide knowledge about big data and big data analytics
- Gain insight on Hadoop and Hadoop file systems
- Understand the applications using Map Reduce Concepts
- Explore about the concepts of NoSQL

**Course Outcomes**

After Successful completion of the course students will be able to

- Design efficient algorithms for mining the data from large volumes
- Apply the concept of storage and clusters in big data file systems.
- Create applications Hadoop
- Operate NoSQL databases
- Understand the fundamentals of various big data analytics techniques.

**Unit 1** **Hours: 12**

Introduction to Big Data: Types of Digital Data-Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data - 3Vs of Big Data - Elements of Big Data, Big data stack - Big data Analytics - Introducing Technologies for handling Big Data: Distributed and Parallel Computing for Big Data - Cloud Computing and Big Data

**Unit 2** **Hours: 12**

Big Data Storage Concepts- Clusters - File Systems and Distributed File Systems- NoSQL – Sharding – Replication – Sharding and Replication – CAP Theorem – ACID – BASE Big Data Processing Concepts- Parallel Data Processing – Distributed Data Processing – Hadoop – Processing in Batch Mode – Processing

**Unit 3** **Hours: 12**

Introduction to Hadoop: Features – Advantages – Versions. Overview of Hadoop Ecosystem - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL

– RDBMS vs. Hadoop - Hadoop Distributed File System-HDFS Architecture - Features of HDFS - Hadoop Yarn - HBase- Hive – Sqoop – ZooKeeper – Flume – Oozie.

**Unit 4** **Hours: 12**

Understanding Map Reduce Fundamentals- Map Reduce Framework- Exploring Features of Map Reduce- Working of Map Reduce- Exploring Map and Reduce Functions- Techniques to optimize Map Reduce- Hardware/ Network Topology Synchronization- File System- Uses of Map Reduce

**Unit 5** **Hours: 12**

Big Data Storage Technology – On-Disk Storage Devices – Distributed File Systems, RDBMS Databases, NoSQL Databases, NewSQL Databases – In-Memory Storage Devices: In-Memory Data Grids, In-Memory Databases.

**Lab Programs** **Hours: 30**

1. Study of Hadoop
2. Study of Hadoop distributed file system (HDFS)
3. Manipulation of data on HDFS
4. Learning Map Reduce Programming
5. Word count problem using Map Reduce Programming
6. Sorting the data using MapReduce.
7. Finding max and min value in Hadoop.
8. NoSQL Database Operations using MongoDB

**Text Books**


1. DreamTech Editorial Services, “Big Data Black Book”, Dreamtech Press, 2015 Edition
2. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
3. Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publication, 2015.


**Reference Books**


1. Chandrakant Naikodi, “Managing Big Data”, Vikas Publishing, 2015
2. Michael Frampton, “Big Data Made Easy: A Working Guide to the Complete Hadoop Toolset”, Apress, 2014
3. Tom White “Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
4. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.
5. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A HandsOn Approach “,VPT, 2016

6. Thomas Erl ,"Big Data Fundamentals Concepts, Drivers and Techniques", Pearson Education First Edition,2016
7. Vijay Srinivas Agneeswaran, "Big Data Analytics beyond HADOOP", Pearson Education(2015)

## BDS641-A STOCHASTIC ANALYSIS

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- A stochastic process is a set of random variables indexed by time or space.
- Student will study the basic concepts of the theory of stochastic processes and explore different types of stochastic processes including Markov chains, Poisson processes and birth-and-death processes.

**Course Outcomes**

After Successful completion of the course students will be able to

- Compute probabilities of transition between states and return to the initial state after long time intervals in Markov chains.
- Identify classes of states in Markov chains and characterize the classes.
- Determine limit probabilities in Markov chains after an infinitely long period.
- Queuing Models help to solve industrial problems.
- solving the Industrial and real world problems

**Unit 1** **Hours: 9**

**Random Variable and Stochastic Processes:**

Generating functions, Introduction, probability generating function, mean and variance, sum of a random variables, sum of a random numbers of discrete random variables, generating function of bivariate distribution, Laplace transform and its properties, Hazards rate function, Mean residual and properties, an introduction of stochastic process.

**Unit 2** **Hours: 9**

**Markov Chains:**

Definition and examples, transition Matrix or matrix of transition probabilities, order of Markov chain, Markov chains and graphs, higher transition probabilities,

generalization of independent Bernoulli Trials, sequence of chain, -dependent trail, Markov Bernoulli chain, correlated random walk, classification of states and chains, communication relation, class property, classification of chains, classification of states, transient and persistent, determination of higher transition probabilities, Aperiodic chain: limiting behavior.

**Unit 3** **Hours: 9**

Stability of a Markov system, computation of the equilibrium probabilities, Graph theoretic approach, Markov chain with denumerable number of states, Reducible chains, Finite reducible chains with a single closed class, chains with one single class of persistent non-Null Aperiodic states, Absorbing Markov chains, Extension: Reducible chains with a single closed class. Statistical Inference for Markov chains, Markov Chain with continuous state space.

**Unit 4** **Hours: 9**

**Markov Processes with discrete state space:**

Poisson Process, Introduction, postulates for Poisson process, properties of Poisson process, Poisson process and related distributions, interarrival time, generalization of Poisson process.

**Unit 5** **Hours: 9**

**Applications in Stochastic Models:**

Queuing system and models, Queuing processes, Steady state distribution, Birth and Death Process in queuing theory, Markovian Models, M/M/I model, M/M/s model, M/G/I model.

**Text Books**


1. J Medhi, Stochastic processes, New Age International Publishers.
2. Sheldon M. Ross, Stochastic Processes, Wiley Publisher.


**Reference Books**


1. Erthan Cinlar, Introduction to Stochastic Processes, (Dover Books on Mathematics)
2. Ming Liao, Applied Stochastic Processes Press.
3. David Stirzaker, Stochastic Processes and Models, Oxford Press.

# BDS 641-B INTRODUCTION TO MULTIVARIATE ANALYSIS

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- To introduce the historical development of statistics, presentation of data, descriptive measures and fitting mathematical curves for the data.
- To introduce measurement of the relationship of quantitative and qualitative data and the concept of probability.
- To enable the students to understand and apply the descriptive measures and probability for data analysis.

**Course Outcomes**

After Successful completion of the course students will be able to

- Demonstrate knowledge and understanding of parametric and nonparametric tests
- Understand discriminant analysis, factor analysis
- Apply Principal component analysis in medical, industrial, engineering, business and many other scientific areas.
- Solve the Industrial and real world problems

**Unit 1** **Hours: 9**

Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

**Unit 2** **Hours: 9**

Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.

**Unit 3** **Hours: 9**

Applications of Multivariate Analysis: Discriminant Analysis, Principal Components Analysis and Factor Analysis.

**Unit 4** **Hours: 9**

Nonparametric Tests: Introduction and Concept, Test for randomness based on total number of runs, Empirical distribution function.

**Unit 5** **Hours: 9**

Kolmogrov Smirnov test for one sample, Sign tests- one sample and two samples, Wilcoxon-Mann-Whitney test, Kruskal-Wallis test.

**Text Books**


1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3rdEdn., John Wiley
2. Muirhead, R.J. (1982): Aspects of Multivariate Statistical Theory, John Wiley.
3. Kshirsagar, A.M. (1972): Multivariate Analysis, 1stEdn. Marcel Dekker.


**Reference Books**


1. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall
2. Mukhopadhyay, P. :Mathematical Statistics. Books and Allied, January 2016
3. Gibbons, J. D. and Chakraborty, S (2003): Nonparametric Statistical Inference. 4th Edition. Marcel Dekker, CRC.


## BDS641-C ACTUARIAL MATHEMATICS AND STATISTICS

**Total Teaching Hours for Semester: 45** **No of Lecture Hours/Week: 3**

**Max Marks: 100** **Credits: 3**

**Course Objectives**

The Course enables Students to

- Analyze the financial consequences of risk.
- Understand uncertain future events, especially those of concern to insurance and pension programs.
- Assess financial risks in the insurance and finance fields, using mathematical and statistical methods.
- Apply the mathematics of probability and statistics to define, analyze, and solve the financial implications of uncertain future events.

**Course Outcomes**

After Successful completion of the course students will be able to

- Have sufficient exposure to actuarial and financial mathematics
- Be familiar with the role of insurance in society, basic economic theory, and the basics of how insurance and financial markets operate.
- Have familiarity with several of the technical tools, computer languages or software packages used by actuaries.

- Develop communication, leadership and teamwork skills, and understand their importance in the actuarial industry.
- Be able to apply this knowledge and these skills in new combinations and to new problems.

**Unit 1** **Hours: 9**

**Introduction:**

Introduction of Actuarial science and how its useful to risk analysis. Basic concepts of Actuarial science. Risk definition and Managing risks.

**Unit 2** **Hours: 9**

**Interest rates and Factors:**

Simple interest, compound interest, accumulated value, Present value , future value, rate of discount, Rule 72, Rate of discount, constant force of interest, varying force of interest, discrete changes in interest rates.

**Unit 3** **Hours: 9**

**Level Annuities:**

Annuity-immediate, Annuity due, Deferred Annuities, Continuously payable annuities, Perpetuities, Equation of value.

**Unit 4** **Hours: 9**

**Varying Annuities:**

Increasing annuities- Immediate, increase annuity due, decreasing Annuity due, continuously payable varying annuities, compound increasing annuities, continuously increasing annuities, continuous decreasing annuities

**Unit 5** **Hours: 9**

**Project Appraisal and Loans:**

Discounted Cash flow analysis, Nominal vs. Real Interest rates, Investment funds, Allocation investment income, Loans: the amortization method, sinking fund method,

**Text Books**


1. CHRIS Ruck Man, Financial Mathematics A practical Guide for Actuaries, Warren center for Actuarial studies and Research.
2. Annamaria Olivieri and Ermanno Pitacco, Introduction to Insurance Mathematics Technical and Financial Feature of Risk Transfer, Springer


**Reference Books**


1. Mario v. Wuthrich and Michael Merz, Financial Modeling Actuarial Valuation and solvency in insurance, Springer.
2. Dale S Borowiak, Arnold Shapiro, Financial and Actuarial Statistics A introduction, CRC Press, A chapman and Hall Book.

3. Marco Corazza Claudio Pizzi Eds. Mathematical and statistical Methods for Actuarial Sciences and Finance, Springer.

## BDS672-A INTRODUCTION TO TENSORFLOW

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- Understand the fundamentals and current usage of the TensorFlow library for deep learning research and the graphical computational model of TensorFlow.
- Explore the functions available in TensorFlow for deep learning.
- Build and structure models best suited for deep learning projects.

**Course Outcomes**

After Successful completion of the course students will be able to

- Understand the overview and operations of TensorFlow.
- Apply regression models on given data in a project
- Structure a model and manage research experiments.

**Unit 1** **Hours: 12**

**Introduction: Overview of Tensorflow:** Why Tensorflow? Graphs and Sessions.

**Operations:** Basic operations, constants, variables, Control dependencies, Data pipeline, TensorBoard.

**Unit 2** **Hours: 12**

**Linear and Logistic Regression** :TensorFlow's Optimizers, tf.data Example: Birth rate - life expectancy, MNIST dataset.

**Eager execution**
Example: word2vec, linear regression

**Unit 3** **Hours: 12**

**Variable sharing and managing experiments** : Interfaces Name scope, variable scope Saver object, checkpoints, Autodiff Example: word2vec. Introduction to ConvNet.

**Unit 4** **Hours: 12**

**Convnet in TensorFlow** : Example: image classification, **GANs** , **Variational Auto-Encoders, Recurrent Neural Networks**: Example: Character-level Language Modelling

**Unit 5** **Hours: 12**

**Seq2seq with Attention**: Example: Neural machine translation, **Beyond RNNs: Transformer, Tensor2Tensor:** Dialogue agents, Reinforcement Learning in Tensorflow, Keras.

**Lab Programs** **Hours:30**

1. Implement concepts of Basic operations, constants and variables.
2. Implement concepts of Control dependencies
3. Implement concepts of Data pipeline, TensorBoard
4. Implement concepts of TensorFlow's Optimizers
5. Implement concepts of word2vec
6. Implement concepts of Linear regression
7. Implement concepts of Interfaces Name scope,Saver object, checkpoints
8. Implement concepts of Autodiff Example: word2vec
9. Implement concepts of Image classification
10. Implement concepts of GANs , Variational Auto-Encoders
11. Implement concepts of CovNet image classification
12. Implement concepts of GANs
13. Implement concepts of Variational Auto-Encoders
14. Implement concepts of Recurrent Neural Networks
15. Implement concepts of Seq2seq with Attention: Neural machine translation
16. Implement concepts of Transformer
17. Implement concepts of Tensor2Tensor: Dialogue agents
18. Implement concepts of Reinforcement Learning in Tensorflow, Keras

**Text Books**

1. Reza Bosagh Zadeh, Bharath Ramsundar, "TensorFlow for Deep Learning", 2018.

**Reference Books**

1. Giancarlo Zaccone,Md.Rezaul Karim, Ahmed Menshawy" Deep Learning with Tensorflow" , 2017
2. Ian Goodfellow, "Deep Learning", 2016.
3. Francois Chollet, "Deep Learning with Python", 2017.

## BDS672-B DATA VISUALISATION TECHNIQUES

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 4**

**Course Objectives**

The Course enables students to

- Analyze and Understand patterns in data
- Visualize data using Tableau to communicate better
- Understand the need to collect and prepare relevant data
- Understand some key case studies in Data Visualization
- Determine the usage of tools for data analysis and visual communication for actionable insights to solve business problems.

**Course Outcomes**

After Successful completion of the course students will be able to

- Visualize Data Using Tableau
- Create Charts
- Appreciate challenges in visualizing data
- Apply Statistical Functions to get insight from data
- Create reports based on given business requirement

**Unit 1** **Hours: 12**

***Data Visualization Philosophy***: Discussion on Envisioning Information: Information in a London Metro Map, Escaping Flatland (Mountain Region Map, 3D visualization), Layering and Separation (Machine Parts), Color and Information (In Charts, Maps), Narratives of Time and Space (Dance Movement). Tableau Introduction, Installation, Connect and Prepare Data

**Unit 2** **Hours: 12**

***Tableau I:*** Build Charts and Analyze Data, Calculated Fields, custom aggregations, chart types and visualizations, Use parameters and input controls to give users control over certain values using filters, highlighters

***Chart Types***: Line chart, Bar chart, Histogram, Scatterplot, Boxplot, Pareto chart, Pie chart, Area chart, Control chart , Run chart, Stem-and-leaf display, Cartogram, Sparkline, Box Whisker Plot, Spider Plot

**Unit 3** **Hours: 12**

***Tableau II:*** Implement advanced geographic mapping techniques and use custom images and geocoding to build spatial visualizations of non-geographic data. Dashboard, Data Story Telling and Animation Techniques.

**Unit 4** **Hours: 12**

**Case Studies:** Minard's Napoleon March; 1854 Cholera Outbreak by John Snow; Causes of Mortality in Crimean War by Florence Nightingale; History Timelines; Human Migration Map; COVID pandemic data analysis; Hans Rosling Story Telling of Global Trends

**Unit 5** **Hours: 12**

**Statistical Applications:** Aggregates and Charts, Correlation and Scatter Plots, Regression and Trend Lines, Descriptive Statistics and Box Whisker Plot.

**Key Performance Indicators:** Revenue Growth, Gross Margins of Software Projects, Employee Attrition, Gartner's Hype Cycle for emerging technologies, Cricketer Ranking Systems

**Text Books**


1. Linda Ryan, "Visual Data Storytelling with Tableau", First Edition, Pearson Paperback – 2018
2. Edward R Tufte, "Envisioning Information"


**Reference Books**


1. "Information Dashboard Design: Displaying Data for At-a-glance Monitoring" by Stephen Few
2. "Beautiful Visualization, Looking at Data Through the Eyes of Experts by Julie Steele, Noah Iliinsky"
3. "The Visual Display of Quantitative Information" by Edward R.Tufte
4. "The Accidental Analyst: Show Your Data Who's Boss" by Eileen and Stephen McDaniel

**Lab Programs** **Hours: 30**

1. Implement Chart Types, Filters, Highlighters. Demonstrate grasp of Tableau Tool. (10 hours) **Individual (Unit 2,3)**
2. Design a map for a Township or Institution (5 hours) **Teamwork**
3. Create a Dashboard for a self-created dataset which includes calculated fields and aggregate bins (5 hours) **(Pair : Team of 2)**
4. Statistical Analysis of existing dataset (8 hours) (Based on Unit 5) **Individual**
5. Create a KPI for an existing dataset, Visualize key aspects(3 hours) (Unit 5) **Teamwork**

## BDS672-C TIME SERIES AND FORECASTING

**Total Teaching Hours for Semester: 90** **No of Lecture Hours/Week: 6**

**Max Marks: 150** **Credits: 5**

**Course Objectives**

The Course enables Students to

- To equip students with various forecasting techniques and knowledge on modern statistical methods for analysing time series data.
- To familiarize students with applications of time series in various fields
- To make the students understand various methods used in time series analysis

**Course Outcomes**

After Successful completion of the course students will be able to

- Understand the fundamental advantage and necessity of forecasting in various situations.
- Choose an appropriate forecasting method in a particular environment
- Apply various forecasting methods, which includes obtaining the relevant data and carrying out the necessary computation (running suitable statistical software, if necessary).
- Improve forecast with better statistical models based on statistical analysis

**Unit 1** **Hours: 12**

Introduction to times series data, application of time series from various fields, Components of a times series, Decomposition of time series. Trend: Estimation of trend

by free hand curve method, method of semi averages, fitting a various mathematical curve, and growth curves.

**Unit 2** **Hours: 12**

Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend

**Unit 3** **Hours: 12**

Seasonal Component cont.: Ratio to Moving Averages and Link Relative method, Depersonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Moving-average (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

**Unit 4** **Hours: 12**

Random Component: Variate component method. Forecasting: Exponential smoothing methods, Short term forecasting methods: Brown's discounted regression

**Unit 5** **Hours: 12**

Box-Jenkins method and Bayesian forecasting. Stationary Time series: Weak stationarity, autocorrelation function and correlogram of moving average.

**Lab Programs** **Hours 30**

1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Calculation of variance of random component by variate difference method
9. Forecasting by exponential smoothing
10. Forecasting by short term forecasting methods.

**Text Books**


1. Kendall M.G. (1976): Time Series, Charles Griffin, Kogan Page Business Books; Tenth edition (May 1, 2006)
2. Chatfield C. (1980): The Analysis of Time Series an Introduction, Chapman & Hall, Chapman and Hall/CRC, 29 July 2003.

**Reference Books**


1. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied,
2. Rohatgi V.K an Saleh E, *An Introduction to Probability and Statistics*, 3rd edition, John Wiley & Sons Inc, New Jersey, 2015.


## BDS 661 HUMAN RESOURCE MANAGEMENT

**Total Teaching Hours for Semester: 30** **No of Lecture Hours/Week: 2**

**Max Marks: 50** **Credits: 2**

**Course Objectives**

The Course enables Students to

- This course providing knowledge how to utilize Human resources for organization growth through different techniques.
- To develop the understanding of the concept of human resource management and to understand its relevance in organizations.
- To develop necessary skill set for application of various HR issues.
- To analyse the strategic issues and strategies required to select and develop manpower resources.

**Course Outcomes**

After Successful completion of the course students will be able to

- Develop a deep understanding of the Human Resource Development with applications
- Define an organizational structure which drives productivity.
- Developing effective coordination and communication within the organization.
- Dedicate time to finding the right staff and developing their skills base.

**Unit 1** **Hours: 8**

Introduction to HRM & HRD Concept of HRM, Objectives, Process, HRM vs. Personnel Management, HRM Vs. HRD, Objectives of HRD, focus of HRD System, Structure of HRD System, role of HRD manpower.

**Unit 2** **Hours: 7**

Human Resource Policies & Strategies Introduction, role of HR in strategic

management, HR policies & Procedures, HR Program, developing HR policies and strategies.

**Unit 3** **Hours: 8**

Human Resource Procurement & Mobility Productivity & improvement job analysis & Job design, work measurement, ergonomics. Human Resource planning-objectives, activities, manpower requirement process

**Unit 4** **Hours: 7**

Recruitment & Selection, Career planning & development, training methods, basic concept of performance appraisal, Promotion & Transfer.

**Text Books**


1. Dipak Kumar Bhattacharya, Human Resource Management, Excel Books (1 January 2006)
2. Arun Monappa, Managing Human Resource, Laxmi Publications (1 January 2015)


**Reference Books**


1. P.SubbaRao, Essential of HRM and Industrial Relations; Himalaya Publishing House, 2010
2. C.B. Memoria, Personnel Management; Himalaya Publishing House, 2014
3. k. Ashwathappa, Human Resource Management; McGraw Hill Education, 2013
4. Michel Armstrong, A Handbook of Human Resource Management Practice, Kogan Page; 13th edition (3 April 2014)