Scheme & Syllabi

for

B.Sc. (Hons) Computer (Data Science)

under Choice Based Credit System (w.e.f. 2019-2020)

Semester-I

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Ability Enhancement Compulsory Course-I	BDS-101	English	2	2	70	30	100
Core Course-I	BDS-102	Fundamentals of Computers & Programming in C	4	4	70	30	100
Core Course-II	BDS-103	Introduction to Databases	4	4	70	30	100
Generic Elective-I	BDS-104	Statistics I	4	4	70	30	100
Generic Elective-II	BDS-105	Discrete Mathematics-I	4	4	70	30	100
Generic Elective-III	BDS-106	Mathematics-I	4	4	70	30	100
Core Course Practical-I	BDS-107 P	Practical LAB of BDS-102	2	2x2=4	70	30	100
Core Course Practical-II	BDS-108 P	Practical LAB of BDS-103	2	2x2=4	70	30	100
		Total	**26**	**30**	**560**	**240**	**800**

Semester-II

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Core Course-I	BDS-201	Optimization (Linear Programming)	4	4	70	30	100
Core Course - II	BDS-202	Data Structures and Algorithms-I	4	4	70	30	100
Generic Elective -I	BDS-203	Statistics-II	4	4	70	30	100
Generic Elective-II	BDS-204	Introduction to Data Science	4	4	70	30	100
Skill Enhancement Course -I	BDS-205	Linear Statistical Modelling & R	4	4	70	30	100
Core Course Practical-I	BDS-206 P	Practical Based on BDS-202	2	2x2=4	70	30	100
Generic Elective Practical-I	BDS-207 P	Practical Based on BDS-205	2	2x2=4	70	30	100
Ability Enhancement Compulsory Course-II	BDS-208	Hindi	2	2	70	30	100
		Total	**26**	**30**	**560**	**240**	**800**

Semester-III

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	**Internal**	**Total**
Ability Enhancement Compulsory Course-I	BDS-301	Environmental Sciences	2	2	70	30	100
Core Course-I	BDS-302	Data Warehousing and Data Mining	4	4	70	30	100
Core Course-II	BDS-303	Python Programming	4	4	70	30	100
Core Course-III	BDS-304	Operating System	4	4	70	30	100
Generic Elective-I	BDS-305	Multivariate Analysis	4	4	70	30	100
Generic Elective-II	BDS-306	Differential Equation and Linear Algebra	4	4	70	30	100
Core Course Practical-I	BDS-307 P	Linux Operating System	2	2x2=4	70	30	100
Core Course Practical-II	BDS-308 P	Python Programming Lab	2	2x2=4	70	30	100
		Total	**26**	**30**	**560**	**240**	**800**

Semester-IV

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	**Internal**	**Total**
Core Course-I	BDS-401	Software Engineering	4	4	70	30	100
Core Course-II	BDS-402	Cloud Computing	4	4	70	30	100
Core Course-III	BDS-403	Object Oriented Programming Using C++	4	4	70	30	100
Generic Elective-I	BDS-404	Time Series, Forecasting and Index Numbers	4	4	70	30	100
Generic Elective-II	BDS-405	Numerical Methods	4	4	70	30	100
Core Course Practical-I	BDS-406 P	Object Oriented Programming Using 'C++'-Lab	2	2x2=4	70	30	100
Generic Elective Practical-II	BDS-407 P	Numerical Methods-Lab	2	2x2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

Semester-V

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	**Internal**	**Total**
Generic Elective-I	BDS-501	Fundamentals of Econometrics	4	4	70	30	100
Core Course-I	BDS-502	Artificial Intelligence	4	4	70	30	100
Core Course-II	BDS-503	Internet and Web Technology	4	4	70	30	100
Core Course-III	BDS-504	Machine Learning	4	4	70	30	100
Core Course-IV	BDS-505	Digital Logic Design and Computer Organization	4	4	70	30	100
Core Course Practical-I	BDS-506P	Practical Lab of Internet and Web Technology	2	2 X 2=4	70	30	100
Core Course Practical-II	BDS-507P	Practical Lab of Machine Learning	2	2 X 2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

Semester-VI

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Core Course-I	BDS-601	Big Data Analytics	4	4	70	30	100
Core Course-II	BDS-602	Computer Networks	4	4	70	30	100
Core Course-III	BDS-603	Neural Network and Deep Learning	4	4	70	30	100
Elective Course-I	BDS-604	Elective I	4	4	70	30	100
Elective Course-II	BDS-605	Elective II	4	4	70	30	100
Core Course Practical-I	BDS-606P	Practical Lab of Big Data Analytics	2	2 X 2=4	70	30	100
Core Course Practical-II	BDS-607P	Practical Lab of Computer Networks	2	2 X 2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

Elective-I

Paper Code	Nomenclature
BDS-604-i	Data Visualization
BDS-604-ii	Internet of Things
BDS-604-iii	Natural language Processing

Elective-II

Paper Code	Nomenclature
BDS-605-i	Statistical Simulation and Data Analysis
BDS-605-ii	Social Network Analysis
BDS-605-iii	Cryptography and Network Security

BDS-101: English

Total Credit =2 Duration of External exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70 Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objective: To introduce students for the efficient writing skill to present work in the effective way.
Course Outcomes: The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Unit-I

Syntax **7Hrs**

Sentence structures, Verb patterns and their usage

Unit-II

Phonetics **8Hrs**

Basic Concepts – Vowels, Consonants, Phonemes, Syllables; Articulation of Speech Sounds-Place and Manner of Articulation; Transcription of words and simple sentences, using International Phonetic Alphabet.

Unit-III

Comprehension **7Hrs**

Listening and Reading comprehension – Note taking, Reviewing, Summarizing, Interpreting, Paraphrasing and Précis Writing.

Unit-IV

Composition **8Hrs**

Descriptive, Explanatory, Analytical and Argumentative Writing - description of simple objects like instruments, appliances, places, persons, principles; description and explanation of processes and operations; analysis and arguments in the form of debate and group discussion.

BOOKS SUGGESTED:

1. Roy A. & Sharma P.L. English for Students of Science, Orient Longman.
2. Spoken English for India by R.K. Bansal and J.B. Harrison, Orient Longman.
3.Tickoo M.L. & Subramanian A.E. Intermediate Grammar, Usage and Composition, Orient Longman.
4. Pink M.A. & Thomas S.E. English Grammar, Composition and Correspondence, S. Chand and Sons Pvt.Ltd.,Delhi.
5. Thomson & Martinet A Practical English Grammar, OUP, Delhi.
6. Hornby A.S Guide to Patterns and Usage in English, OUP, Delhi.
7. Balasubramanian T. A Textbook of English Phonetics for Indian Students, MacMillan, Chennai.
8. O"Connor J.D. Better English Pronunciation, Cambridge Univ. Press, London.
9. McCarthy English Vocabulary in Use, Foundation Books (Cambridge University Press), Delhi.
10. Buck,Assessing Listening, Foundation Books (Cambridge University Press), Delhi.

BDS-102 Fundamentals of Computers & Programming in C

Total Credit =4 Duration of External exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70 Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objective: To introduce students for the fundamental of computers, Operating System Basics, Internet basics, Programming Languages, Programming fundamentals, C Programming language, Pre-processor, etc**.**
Course Outcomes : After completing this module students will be expected to be able to understand the computer hardware and employ the C programming language for the data analytics.

Unit-1

An Overview of Computer System: Anatomy of a digital Computer, Memory Units, Main and Auxiliary Storage Devices, Classification of Computers. **Radix number system**: Decimal, Binary, Octal, Hexadecimal numbers and their inter-conversions; Representation of information inside the computers. **Operating System Basics**: The user Interface, Running Programmes, Managing files, **Introduction to PC operating Systems**: Unix/Linux , DOS, Windows. **Internet basics:** Introduction to the basic concepts of Networks and Data Communications, How Internet works, Major features of internet, Emails, FTP, Using the internet.

Unit-2

Programming Languages: Machine language, assembly language, high level language, assembler, compiler, interpreter, debuggers. **Programming fundamentals**: problem definition, algorithms, flow charts and their symbols, introduction to compiler, interpreter, assembler, linker and loader and their inter relationship. **Low level programming**: Bitwise operators, Bit fields in structures, other low level techniques.

Unit-3

C Programming language: C fundamentals: Formatted input/ output, expressions, selection statements, loops and their applications; Basic types, arrays, functions, including recursive functions. **Program organization**: local and external variables and scope; pointers & arrays. **Strings:** strings literals, string variables, I/O of strings, arrays of strings; applications. **Standard library**: Input / output; streams, file operations, formatted I/O, character I/O, line I/O, block, string I/O, Library support for numbers and character data, error handling.

Unit-4

Pre-processor: Pre-processor directives, macro definition, conditional compilation. **Structures, Unions and Enumerations**: Structure variables and operations on structures; Structured types, nested array structures; unions; enumeration as integers, tags and types. **Declaration:** Declaration syntax, storage classes, types qualifiers, declarators, initializers. **Program Design**: modules, information hiding, abstract data types, difference between C & C++.

Books:

1. Using Information Technology, 5th Edi, Brian K Williams & Stacey C. Sawyer, 2003, TMH
2. The C Programming Language by Dennis M Ritchie, Brian W. Kernigham, 1988, PHI.
3. C Programming – A modern approach by K.N. King, 1996, WW Norton & Co.
4. Theory and problem of programming with C, Byron C Gottfried, TMH
5. Teach yourself all about computers by Barry Press and Marcia Press, 2000, IDG Books India.
6. Using Computers and Information by Jack B. Rochester, 1996, Que Education & Training.

BDS-103 Introduction to Databases

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objective: To introduce students for the efficient organisation and retrieval of large amounts of data some standard notations of SQL that implement important parts of relational algebra.
Course Outcomes : After completing this module students will be expected to be able to employ the notions of relation key and normal forms in a relational database design may create a relational database schema in SQL and retrieve information from a database using the SQL SELECT Statement.

Unit-I

Database Concepts: Introducing the database and the DBMS, database systems, the database system environment, DBMS functions. data models: Data modeling and data models , the importance of data models, data model basic building blocks. **Evolution of Data Models**: the hierarchical model, the network model, the relational model, the entity relationship model, the object-oriented (OO) model, the convergence of data models, database models and the internet.

Unit-II

The relational database model: Fundamentals of relational database systems, **Relationships within the Relational Database:** The (1:M; 1:1 and M:N) relationship. **The Entity Relationship Model (ERM)**: Entities, attributes, connectivity and cardinality, existence dependence, relationship strength, weak entities, relationship participation, relationship degree, recursive relationships, associative (composite) entities. **Normalization of Database Tables:** Database tables and normalization , the normalization process, conversion to first normal form, conversion to second normal form, conversion to third normal form, improving the design, surrogate key considerations. **Higher-level normal forms**: the Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF).

Unit-III

Introduction to Structured Query Language (SQL): Introduction to SQL, Data Definition Commands, Data Manipulation Commands, **Advanced Data Definition Commands:** Changing a Column's Data Type, Changing a Column's Data Characteristics, Adding a Column, Dropping a Column, Advanced Data Updates, Adding Primary and Foreign Key Designations, Deleting a Table from the Database.

Unit-IV

SELECT Queries: Selecting Rows with Conditional Restrictions, Arithmetic Operators: The Rule of Precedence , Logical Operators: AND, OR, and NOT, Special Operators. **Advanced SELECT Queries**: Ordering a Listing, Listing Unique Values, Aggregate Functions, Grouping Data. Joining Database Tables, Relational Set Operators, **SQL Join Operators:** Cross Join, Natural Join, Join USING Clause, JOIN ON Clause, Outer Joins.

Books:

1. R. Elmasri and S.B. Navathe, "Database Systems: Models, Languages, Design and Application Programming", Pearson, 2011 (6th ed.).
2. Elmasri & Navathe, Fundamentals of Database systems, Addison Wesley, 3rd Edition, New Delhi, 2010.
3. An Introduction to Database System, Bipin C.Desai, Galgotia Publication, New Delhi, 1990.
4. T. Connolly and C. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Pearson, 2010 (5th ed.).
5. Peter Rob and Carlos Coronel. "Database Systems: Design, Implementation, and Management", Eighth Edition, Thomson Course Technology.
6. Database Management Systems, R.Pannerselvam, PHI Learning Pvt Ltd, New Delhi , Second Edition, 2011.
7. Database Management Systems, Ramon a.Mato-Toledo, Pauline K.Cushman, Schaums'Outline series, TMH, New Delhi Special Indian Edition 2007.

BDS-104 Statistics-I

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30 0

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objective: To introduce students about descriptive statistics, measures of central tendency and dispersion, measures of dispersion, probability and its rules, total probability theorem, Bayes' theorem, discrete probability distributions, Bernoulli distribution, Poisson distribution and their applications.
Course outcomes: On successful completion of it the students should be able to understand the ways of calculations and interpretation of statistical data. Understand basic rules of probability and application of the total probability theorem and Bayes' theorem. Understand and recognise situations appropriate for Binomial and Poisson models, Understand to calculate expectations and variances for discrete and continuous random variables.

Unit-I

Descriptive statistics: Variables: Qualitative and quantitative variables, discrete and continuous variables, scales, grouped data, data collection and summary. **Graphical Representation of a Variable**: bar chart, pie chart, histogram, kernel density plots, Stem/leaf plots and histograms. Displaying Bivariate Numerical Data, Describing the Center of a Data Set, Describing Variability in a Data Set.

Unit-II

Measures of Central Tendency and Dispersion: Measures of Central Tendency, Arithmetic Mean, Median and Quantiles, Quantile–Quantile Plots (QQ-Plots), Mode, Geometric Mean, Harmonic Mean, **Measures of Dispersion**: Range and Interquartile Range, Absolute Deviation, Variance, and Standard Deviation, Coefficient of Variation, Box Plots, Measures of Concentration, Lorenz Curve, Gini Coefficient.

Unit-III

Probability: Relative frequency. Probability as a limit. Events. Union and intersection. Addition rule. Exclusive events. Independent events. Multiplication rule. Permutations and combinations. Conditional probability. Total probability theorem, Bayes' theorem.

Unit-IV

Discrete probability distributions: Discrete random variables. Probability distributions. Expectation. Algebra of expectations. Variance. Bernoulli distribution. Binomial distribution (sampling with replacement). Mean and variance of Bernoulli and Binomial. Poisson distribution (and applications). Derivation of the Poisson. Approximation to the Binomial.

Books:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.
2. Murray R. Spiegel, John J. Schiller and R. Alu Srinivasan, Schaum's Outline of Probability and Statistics, 2012.
3. Allan Bluman, Elementary Statistics: A Step By Step Approach, McGraw-Hill Higher Education, 2014.
4. Christian Heumann and Michael Schomaker Shalabh Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R. Springer, 2016.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2001.

BDS-105 Discrete Mathematics-I

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: Students are to make familiar with the components of discrete mathematics and their applications in the computer science. The topics of set theory, logic and Propositional Calculus, Techniques of Counting, Recursion and Graph Theory are included in this module for making familiar with the use of these as tools in other areas of the course curriculum**.**
Course outcomes: On successful completion of it the students should be able to understand logic and Propositional Calculus, Techniques of Counting, Recursion and Graph Theory and their applications.

Unit-I

Set Theory: Sets and elements, subsets, Venn diagrams, algebra of sets, duality, finite sets, counting principle, classes of sets, power sets, partitions, mathematical induction. **Relations:** Product sets, relations, pictorial representatives of relations, composition of relations, types of relations, closure properties, equivalence relations, partial ordering relations. **Functions and Algorithms**: One-to-One, Onto, and invertible functions, mathematical functions, exponential and logarithmic functions, sequences, indexed classes of sets, recursively defined functions, cardinality, algorithms and functions, complexity of algorithms.

Unit-II

Logic and Propositional Calculus: Propositions and compound statements, basic logical operations, propositions and truth tables, tautologies and contradictions, logical equivalence, algebra of propositions, conditional and biconditional statements, arguments, propositional functions, quantifiers, negation of quantified statements. **Techniques of Counting**: Basic counting principles, mathematical functions, permutations, combinations, the pigeonhole principle, the inclusion–exclusion principle, tree diagrams.

Unit-III

Advanced Counting Techniques, Recursion: Combinations with repetitions, ordered and unordered partitions, inclusion–exclusion principle revisited, pigeonhole principle revisited, recurrence relations, linear recurrence relations with constant coefficients, solving second-order homogeneous linear recurrence relations, solving general homogeneous linear recurrence relations.

Unit-IV

Graph Theory : Data structures, graphs and multigraphs, subgraphs, isomorphic and homeomorphic graphs, paths, connectivity, traversable and Eulerian graphs, bridges of Königsberg, labelled and weighted graphs, complete, regular, and bipartite graphs, tree graphs, planar graphs, graph colourings, representing graphs in computer memory, graph algorithms, traveling-salesman problem.

Books:

1. Seymour Lipschutz, Marc Laras Lipson and Varsha H. Patil, Discrete Mathematics (Schaum's Outlines) (SIE), 2017.
2. Kenneth H. Rosen, Discrete Mathematics and its applications, TMH, New Delhi, 2001 (4^{th} ed.).
3. Norman L. Biggs. Discrete Mathematics. Oxford University Press, second edition, 2002.
4. Kevin Ferland. Discrete Mathematics. Cengage Learning, 2008.
5. Ronald L. Graham, Donald E. Knuth, and Oren Patashnik. Concrete Mathematics: A Foundation for Computer Science. Addison Wesley Longman Publishing Co., Inc., Boston, MA, USA, 2nd edition, 1994.

BDS-106 Mathematics-I

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: Students are to make familiar with the quantification of the notion of limit and precise formulation of intuitive notions of infinite sums, functions, continuity and the calculus, notion of sequences and series in one variable, continuity and differentiability of functions in one and two variables, evaluation of integrals. Matrix algebra and applications.
Course outcomes: On successful completion of it the students should be able to understand what it means for a sequence to converge or diverge, computation of simple limits, the notions of continuity and differentiability with various properties of continuous and differentiable functions. It enable the student to state when a function can be represented by a power series. Solution of system of equations in matrix form.

Unit-I

Decimal expressions and real numbers: The geometric series and conversion of recurring decimals into fractions, convergence of a nonrecurring decimal and the completeness axiom in the form that an increasing sequence which is bounded above converges to a real number. The completeness axiom as the main distinguishing feature between the rationals and the reals; approximation of irrationals by rationals and vice-versa, Inequalities.

Unit-II

Sequence: Formal definition of sequence and subsequence, limit of a sequence of real numbers; Cauchy sequences and the Cauchy criterion of convergence of a sequence. **Series:** series with positive terms, alternating series, the number e both as limit. **Test of Convergence**: Comparison test, ratio test, root test, Leibnitz test. **Sets:** Boundedness of the set of real numbers; least upper bound, greatest lower bound of a set, neighbourhoods, interior points, isolated points, limit points, open sets, closed set, interior of a set, closure of a set in real numbers and their properties.

Unit-III

Functions of real variable: Continuity of function, properties of continuous functions, continuous limits, differentiability, properties of differentiable functions, higher order derivatives, Power series, Taylor's theorem, the classical functions of analysis, upper and lower limits. Limit and continuity of real valued functions of two variables. Partial differentiation. Total Differentials; Composite functions & implicit functions. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two variables.

Unit-IV

Matrices: Types of matrices. Elementary operations on matrices. Rank of a matrices. Inverse of a matrix. Linear dependence and independence of rows and columns of matrices. Eigenvalues, eigenvectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley Hamilton theorem(without proof) and its use in finding the inverse of a matrix. Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations.

Books:

1. Murray, R. Spiegel, Theory and Problems of Advanced Calculus, Schaum's Publishing Co., New York.
2. Schaum's Outline of Linear Algebra, 2007.
3. S.C. Malik, Mathematical Analysis, Wiley Eastern Ltd., Allahabad.
4. Shanti Narayan, A Course in Mathematical Analysis, S.Chand and Company, New Delhi.
5. D. Stirling, Mathematical Analysis and Proof, 1997.
6. M. Hart, *Guide to Analysis*, Macmillan.
7. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985

BDS-107 P Practical Lab of BDS-102

Total Credit =2 **Marks(Total) : 100**

Marks (Practical) : 70

Marks (Internal Assessment) : 30

Syllabus:

Practical based on the theory paper "Fundamentals of Computers & Programming in C (BDS-102)"

BDS-108 P Practical Lab of BDS-103

Total Credit =2 **Marks (Total) : 100**

Marks (Practical) : 70

Marks (Internal Assessment) : 30

Syllabus:

Practical based on the theory paper "Introduction to Databases (BDS-103)"

Semester-II

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Core Course-I	BDS-201	Optimization (Linear Programming)	4	4	70	30	100
Core Course - II	BDS-202	Data Structures and Algorithms-I	4	4	70	30	100
Generic Elective -I	BDS-203	Statistics-II	4	4	70	30	100
Generic Elective-II	BDS-204	Introduction to Data Science	4	4	70	30	100
Skill Enhancement Course -I	BDS-205	Linear Statistical Modelling & R	4	4	70	30	100
Core Course Practical-I	BDS-206 P	Practical Based on BDS-202	2	2x2=4	70	30	100
Generic Elective Practical-I	BDS-207 P	Practical Based on BDS-205	2	2x2=4	70	30	100
Ability Enhancement Compulsory Course-II	BDS-208	Hindi	2	2	70	30	100
		Total	**26**	**30**	**560**	**240**	**800**

BDS-201 Optimization (Linear Programming)

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: Students are to make familiar with the construction of an appropriate linear programming model for a given description of a problem, implementation of Simplex technique for the solution of a linear programming problem, sensitivity analysis on an optimal solution, use of duality theory to prove basic theorems of linear programming and apply duality theory to recognize optimality, infeasibility or unboundedness in a linear program, implementation of the Transportation Simplex Algorithm.
Course outcomes: Students will be able to construct an appropriate linear programming model for a given description of a problem, recognise the scope and limitations of linear programming modelling, able to implement Simplex technique and Duality Theory for the solution of a linear programming problem, perform sensitivity analysis on an optimal solution.

Unit-I

Formulation of linear programming models: Geometry of LPP and Graphical solution. **Basic feasible solutions:** Algebraic interpretation of extreme point, Relationship between extreme points and corresponding BFS. Adjacent extreme points and corresponding BFS along with examples.

Unit-II

Fundamental theorem of LPP and its illustration through examples. **Solution of LPP** :Simplex Method, Big - M Method, Two-Phase Simplex, Special Cases in Simple Applications.

Unit-III

Introduction to Duality Theory: Dual Simplex Method, Post Optimality Analysis, Complementary Slackness and Dual Simplex Sensitivity Analysis,

Unit-IV

Transportation programming problem: Modelling and unimodular matrix, Initial BFS and optimal solution of balanced TP problem, Assignment problems and permutation matrix.

Books:

1. Introduction to Mathematical Programming, W. Winston and M. Ventataraman, Duxbury, (4th Edition) 2003.
2. Linear Programming, G. Hadley, Addison-Wesley Publishing Company, 1978
3. Model Building in Mathematical Programming, H.P. Williams, Wiley, (5th Edition) 2013.
4. Numerical Optimization with Applications, S. Chandra, Jayadeva, A. Mehra, Narosa Publishing House, 2009
5. Operations Research: An Introduction, H. A. Taha, Pearson/Prentice Hall, 2007
6. Optimization in Operations Research, R. Rardin, Prentice Hall, 1998.

BDS-202 Data Structures and Algorithms-I

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To address the necessity of the Data structures and algorithms which is an integral part of programming and computation. To provide a coherent introduction to techniques for using data structures and some basic algorithms. The course goal is to provide a solid background in algorithms in preparation either for a job in industry or for more advanced courses at the graduate level. Make capable to use **Java's** collections framework as an example implementation of basic algorithms.
Course outcomes: On completion of the module the student will be able to understand a variety of data structures and be able to use them effectively in design and implementation of algorithms. Implement core data types in **Java** and write programs that make efficient use of them

Unit-I

Introduction to Data Structures: Introduction to complexity, introduction to data structures, classification of data structure, abstract data type; data structure operations, applications of data structure. **Arrays :** Definition of array, single and multi-dimensional arrays, representation of single and 2-dimentional arrays and their address calculation, basic operations on single dimensional arrays, algorithm for insertion and deletion operations; Sparse Matrices and its representation. **Linear Data Structures**; **Stacks:** array representation of stack, linked list representation of stack, application of stack, operations and applications.

Unit-II

Introduction to Algorithms: Notation for expressing algorithms, role and notation for comments, example of an algorithm, problems and instances, characteristics of an algorithm, building blocks of algorithms, procedure and recursion – procedure, recursion, outline of algorithms, specification methods for algorithms. **Greedy algorithms**: greedy method strategy, optimistic storage on tapes, knapsack problem, job sequencing with deadlines, optimal merge pattern, single source shortlist paths. **Divide-and-conquer algorithms:** divide and conquer strategy, binary search, max. and min., merge sort, quick sort.

Unit-III

Queues: Introduction of queue, array representation of queue, linked list representation of queue, circular queues**,** operations and applications. **Linked Lists:** Introduction, Array vs Linked list; operation – creations, insertion, deletion, sqrt(n) primality testing, circular lists, doubly linked list, Implementation of Stack and simple Queue as single Linked List.

Unit-IV

Sorting : Preliminaries, insertion sort , a lower bound for simple sorting algorithms, shellsort, heapsort, mergesort, quicksort, indirect sorting, a general lower bound for sorting, bucket sort, external sorting. **Searching**: binary search, naive string searching.

Books:

1. Lipschuitz L. Seymour, 2001 : Data Structure, Schaum Outline Series, TMH, New Delhi.
2. Salaria, R. S. : Data Structur
3. es & Algorithm Using C, Khanna Book Publishing Co. (P.) Ltd., New Delhi.
4. Ellis Horowitz & Sartaj Sahni, "Fundamentals of Data structures in C",2nd Edition, Silicon Press, 2007
5. Kleinberg and Tardos. Algorithms Design. Addison Wesley, 2005.
6. Robert Lafore, Data Structures and Algorithms in Java, SAMS, (2nd Edn), 2002.

BDS-203 Statistics II

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks**

Objectives: To demonstrate the discrete distributions: Binomial, Poisson and uniform and the continuous distributions: normal, exponential, chi-square, t, F distributions. To address how to handle bivariate distributions, maximum likelihood and least squares estimates of unknown parameters, bias and mean squared error, random sampling, statistical inference and sampling distribution, Hypothesis tests, Null and alternative hypotheses, multiple linear regression using R and interpretation of output.
Course outcomes: On completion of the module the student will be able to understand binomial, Poisson and uniform and normal, exponential, chi-square, t, F distributions. Able to use the correlation coefficient for bivariate data and the coefficient of determination and perform multiple linear regression using R and interpret output.

Unit-I

Distribution theory Standard distributions: Discrete uniform, Normal, exponential, continuous ,uniform and multivariate Normal distribution and their use in modelling. **Expectation, variance** and generating functions. Sums of IID random variables, weak law of large numbers, central limit theorem. Joint, marginal and conditional distributions. Independence. **Covariance and correlation**. Moment generating functions to find moments of the probability distribution function(PDF) and distributions of sums of random variables.

Unit-II

Estimation Sampling distributions: Bias in estimators and mean squared error , efficiency and the Cramer-Rao lower bound for unbiased estimators. Maximum likelihood estimation and finding estimators analytically. **The mean and variance of a sample mean**. The distribution of the t-statistic for random samples from a normal distribution. The F distribution for the ratio of two sample variances from independent samples taken from normal distributions. Chi Square distributions for the sum of squared standard normal variates

Unit-III

Hypothesis testing and Confidence intervals: Confidence intervals for means, variances and differences between means. Hypothesis tests concerning means and variances. **Null and alternative hypotheses**: type I and type II errors, test statistic, critical region, level of significance, probability-value and power of a test. Use tables of the t-, F-, and chi-squared distributions.

Unit-IV

Linear models: Linear relationships between variables using regression analysis. The correlation coefficient for bivariate data and the coefficient of determination. Response and explanatory variables and the least squares estimates of the slope and intercept parameters in a simple linear regression model. Multiple linear regression with IID normal errors, **implemented in R**.

Books:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.
2. Murray R. Spiegel, John J. Schiller and R. Alu Srinivasan, Schaum's Outline of Probability and Statistics, 2012.
3. Ruth Bernstein & Stephen Bernstein, Schaum's Outline of Elements of Statistics II: Inferential Statistics, 1999 .
4. J. Crawshaw and J., Chambers, A concise course in advanced level statistics. Stanley Thomas Pub. Ltd, 2001.
5. T.T. Soong, Fundamentals of Probability and Statistics. Wiley, 2004.
6. Robert G. Easterling, Fundamentals of Statistical Experimental Design and Analysis. John Wiley & Sons, Ltd, 2015.
7. D. Sarkar. Lattice: Multivariate Data Visualization with R. Springer, New York, 2008.
8. Thomas Mailund, Advanced Object-Oriented Programming in R: Statistical Programming for Data Science, 2017

BDS-204 Introduction to Data Science

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objective: Students are to make familiar with the basics of data science, high level introduction to the spectrum of Data Science topics, Data sources, Sequential programming / scripting, Data cleaning/extraction.
Course Outcomes: On completion of the module the student will be able to understand exploring and wrangling data, writing basic functions and coding, summarizing, visualizing, and analyzing data, modeling and simulating deterministic and stochastic phenomena, presenting the results of a complete project in written, oral, and graphical forms.

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Unit-I

Introduction to Data : About the data, kinds of data: Static, spatial, temporal, text, media data. **Data sources**: Relational databases, web/API, streaming. Data collection: sampling, design (observational vs experimental) and its impact on visualization, modeling and generalizability of results. Description, prediction, inference from the data, Implementation on data, Adequacy of data in terms of number of variables, size, multiple tables, etc. Introduction to high level programming language, Integrated Development Environment (IDE) (R recommended)

Unit-II

Describing data: Exploratory Data Analysis (EDA), Data Visualization, Summaries, aggregation, smoothing, distributions, Modeling, Stochastics (understand notions of uncertainty, simulations, random number generator, etc., Notion of mathematical model AKA function e.g. linear, exponential programming concepts; vectors, tables/data frames, variables.

Unit-III

Sequential programming / scripting: Defining very simple functions, basic environment and scoping rules, conditional expressions and basic iteration, simulation w/wo data; probabilistic and/or resampling based. Algorithms: breaking a complex problem down into small steps, concept of an algorithm as a `recipe'.

Unit-IV

Data cleaning/extraction: Wrangling, regular expressions, SQL statements, **Data analysis/modeling**: Question/problem formation along with EDA, Introduction to estimation and inference (testing and confidence intervals) including simulation and resampling, Scope of inference, Assessment and selection e.g. training and testing sets.

Books:

1. John D. Kelleher and Brendan Tierney, Data Science. The MIT Press, 2018.
2. Murtaza Haider, Getting Started with Data Science: Making Sense of data with analytics. IBM Press, 2015.
3. Field Cady, The Data Science Handbook, John Wiley & Sons, 2017.
4. Laura Igual and Santi Seguí, Introduction to Data Science, Springer International Publishing, 2017.
5. Cathy O'Neil and Rachel Schutt, Doing Data Science, O'Reilly Media, Inc. 2014.

BDS-205 Linear Statistical Modelling & R

Total Credit =4 Duration of External Exam =3 Hrs Marks(Total) : 100
Marks (Theory) : 70
Marks (Internal Assessment) : 30

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To introduce the ideas and methods of statistical modelling and statistical model exploration. To introduce students to R software and its use as a tool for statistical modelling, specifically for working with linear models in a variety of different scenarios.
Course outcomes: On completion of the module the student will be able to understand R language fundamentals and its uses as Object-Oriented Programming for the checking of plausibility of a statistical model and diagnostic plots, coding and interpretation of ANOVA.

Unit-I

Introduction to the R software**, R language fundamentals**: attributes, sequence generating and vector subsetting, **Data structures**: atomic vectors, numerical computing, lists, environments and data frames, **Subscripting and subsetting**: vector and matrix subsetting, evaluation, lexical scope.

Unit-II

Object-Oriented Programming in R: The basics of OOP, S3 OOP, S3 generic functions and methods, S4 OOP, S4 generic functions and methods, the syntax of method declaration, replacement methods. **Documentation:** finding documentation , writing documentation, managing S3 and S4 together.

Unit-III

Input and Output in R: Basic file handling, connections, file input and output, capturing R output, **Working with Character Data:** builtin capabilities, regular expressions, prefixes, suffixes and substrings, matching patterns, **Foreign Language Interfaces:** calling C from R, writing C code to interface with R, using the R API.

Unit-IV

The use of R package to obtain important summary features in different data structures. Distributions of estimators and residuals in the simple linear regression, multiple regression and refinement of the model choice. The use of R to check the plausibility of a statistical model and diagnostic plots. The coding and interpretation of ANOVA models using R.

Books:

1. Christian Heumann, Michael Schomaker, Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Springer, 2016.
2. J. M. Chambers. Software for Data Analysis: Programming with R. Springer, New York, 2008.
3. R Development Core Team. R Data Import/Export. R Foundation for Statistical Computing, Vienna, Austria, 2007a. URL http://www.R-project.org. ISBN 3-900051-10-0.
4. R Development Core Team. R Language Definition. R Foundation for Statistical Computing, Vienna, Austria, 2007b. URL http://www.R-project.org. ISBN 3-900051-13-5.
5. R Development Core Team. Writing R Extensions. R Foundation for Statistical Computing, Vienna, Austria, 2007c. URL http://www.R-project.org. ISBN 3-900051-11-9.
6. R Development Core Team. R Internals. R Foundation for Statistical Computing, Vienna, Austria, 2007d. URL http://www.R-project.org. ISBN 3-900051-14-3.
7. Maindonald and Braun, Data Analysis and Graphics using R, Cambridge Series in Statistical and Probabilistic Mathematics.

BDS-206 P Practical Based on BDS-202

Total Credit =2 **Marks (Total) : 100**

Marks (Practical) : 70

Marks (Internal Assessment) : 30

Syllabus:

Practical based on the theory paper "Data Structures and Algorithms-I (BDS-202)"

BDS-207 P Practical Based on BDS-205

Total Credit =2 **Marks (Total) : 100**

Marks (Practical) : 70

Marks (Internal Assessment) : 30

Syllabus:

Practical based on the theory paper "Linear Statistical Modelling & R (BDS-205)"

B.Sc. (Hons) Computer (Data Science)

BDS-208: हिन्दी

Total Credit =2 **Duration of External exam =3 Hrs** **Marks(Total) : 100**

Marks (Internal Assessment) : 30

Marks (Theory) : 70

खण्ड (क)

निर्धारित कवि

1 कबीरदास 2 सूरदास
3 मीराबाई 4 रसखान

खण्ड (ख)

हिन्दी साहित्य का इतिहास भक्तिकालः पाठ्यक्रम में निर्धारित आलोचनात्मक प्रश्न–

1 सन्तकाव्य की प्रवृतियाँ 2 सूफी काव्य की प्रवृतियाँ
3 कृष्ण काव्य की प्रवृतियाँ 4 राम काव्य की प्रवृतियाँ
5 भक्तिकाल काः स्वर्णयुग

खण्ड (ग)

अलंकार–अनुप्रास, श्लेष, यमक, उपमा, रूपक, अतिश्योक्ति, मानवीकरण, अन्योक्ति, समासोक्ति आदि।

खण्ड (घ)

मुहावरे एवं लोकोक्तियाँ।

खण्ड(क) के लिए निर्धारित पाठ्यपुस्तक–मध्यकालीन काव्य–कुंज : सं. डॉ रामसजन पाण्डेय प्रकाशनःखाटूश्याम प्रकाशन, 1276/5 पीर जी मोहल्ला, प्रताप टाकीज, रोहतक।

निर्देशः– सभी प्रश्न अनिवार्य हैं।

1. खण्ड (क) में निर्धारित पाठ्यपुस्तक में से व्याख्या के लिए चार अवतरण पूछे जाएँगे, जिनमें से परीक्षार्थी को किन्हीं दो की सप्रसंग व्याख्या करनी होगी। प्रत्येक व्याख्या 6 अंक की होगी। पूरा प्रश्न 12 अंक का होगा।
2. खण्ड (क) में निर्धारित कवियों में से किन्ही दो कवियों के साहित्यिक परिचय पूछे जाएँगे, जिनमें से किसी एक कवि का साहित्यिक परिचय लिखना होगा। यह प्रश्न 8 अंक का होगा।

3. खण्ड (क) में पाठ्यपुस्तक से निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँगे, जिनमें से परीक्षार्थी को एक प्रश्न का उत्तर देना होगा। यह प्रश्न 10 अंक का होगा।

4. खण्ड(ख) में निर्धारित आलोचनात्मक प्रश्नों में से दो प्रश्न पूछे जाएँ गे , जिनमें से किसी एक का उत्तर देना होगा। यह प्रश्न 10 अंक का होगा।

5. खण्ड(ख) से 12 अति लघूत्तरात्मक प्रश्न पूछे जाँएगे। प्रत्येक प्रश्न एक–एक अंक का होगा। पूरा प्रश्न 12 अंक का होगा।

6.खण्ड (ग) में निर्धारित अलंकारों में से दो अलंकार पूछे जाएँगे,जिनमें से एक अलंकार उदाहरणो सहित लिखना होगा। जो 8 अंक का होगा।

7. खण्ड (घ) से दस मुहावरों और लोकोक्तियों में से किन्ही पांच मुहावरों का अर्थ एंव वाक्य प्रयोग लिखना होगा। जो 10 अंक का होगा।

Semester-III

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	**Internal**	**Total**
Ability Enhancement Compulsory Course-I	BDS-301	Environmental Sciences	2	2	70	30	100
Core Course-I	BDS-302	Data Warehousing and Data Mining	4	4	70	30	100
Core Course-II	BDS-303	Python Programming	4	4	70	30	100
Core Course-III	BDS-304	Operating System	4	4	70	30	100
Generic Elective-I	BDS-305	Multivariate Analysis	4	4	70	30	100
Generic Elective-II	BDS-306	Differential Equation and Linear Algebra	4	4	70	30	100
Core Course Practical-I	BDS-307 P	Linux Operating System	2	2x2=4	70	30	100
Core Course Practical-II	BDS-308 P	Python Programming Lab	2	2x2=4	70	30	100
		Total	**26**	**30**	**560**	**240**	**800**

BDS 301 : Environmental Science

Marks (Theory) : 70 **Marks(Total) : 100**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.

Objectives: To familiarize the students with basics concepts of Environmental Science.

Unit-I

The Multidisciplinary nature of environmental studies **8Hrs**

Definition, scope and importance, Need for public awareness. Natural resources: Renewable and non-renewable resources. Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestration

b) Water resources: Use and over-utilization of surface and ground water, floods and drought.

c) Mineral resources: Use and exploitation, environmental effects of extrading.

d) Food resources: World food problems, changes caused by agriculture, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

e) Energy Resources: Growing energy needs, renewable and non renewable energy sources use of alternative energy sources.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

Unit-II

Ecosystems **7Hrs**

Concept of an ecosystem, Structure and function of an ecosystem, Procedures, consumers and decomposers, Energy flow in the ecosystem, Ecological succession & Food chains, food webs and ecological pyramids.

Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a megadiversity nation.

Unit-III

Environmental Pollution **7Hrs**

Definition, Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution & Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

Unit-IV

Social Issues and the Environment **8Hrs**

From Unsustainable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation, Consumerism and waste products, environment Protection Act, Air (Prevention and Control of Pollution) Act, Water(Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environment legislation & Public awareness.

Suggested Readings:

1. De A. K. Environmental Chemistry, Wiley Eastern Ltd, 1999.
2. Bharucha E. Text book of Environmental studies, University press, Hydrabad 2005.
3. Cunningham W P., Cooper T H. Gorhani E. Hepworth M T, Environmental Enclopedia, Jaico publication House, Mumbai, 2001.
4. Miller T G. Environmental Science Wadsworth publishing corp, 2000.

BDS – 302
(B.Sc. Hons. Computer Data Science)
Data Warehousing and Data Mining

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of data mining and data warehousing.

Unit - 1

Data Mining: Introduction, Kind of data to be mined, Data Mining Functionalities, Technologies used in Data Mining. Applications of data Mining, Major Issues in Data Mining. Data Warehouse: Introduction, Data Warehouse and Database Systems. Data Warehouse Architecture, Data Warehouse Models. Data Cube and OLAP. Multidimensional data Model, Concept Hierarchies, OLAP operations, Data Warehouse Implementation

Unit - 2

Data Pre-Processing: Introduction, Need of pre-processing, Data Objects and Attribute type, Statistical description of data, Data Visualization, Measuring similarity and dissimilarity of data, data Cleaning, Data Integration, Data Reduction, Data Transformation Data Discretization.

Unit -3

Mining Frequent Patterns, Associations and Correlations: Introduction, Frequent itemset Mining using Apriori Algorithm and generate association Rule. Improving efficiency of Apriori, Pattern Growth Approach for mining Frequent Itemsets, Pattern evaluation.

Unit - 4

Classification: Introduction, Classification using Decision Tree Induction, Bayesian Classification Methods, Rule Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy.
Cluster Analysis: Introduction, Basic Clustering Methods, Partitioning Methods, Hierarchical Methods, Evaluation of Clustering.

Suggested Readings:

- Jiawei Han und Micheline Kamber, "Data Mining Concepts And Techniques", Third Edition, Elsevier.
- AlexBerson And Stephen J. Smith, "Data Warehousing, Data Mining & Olap", Tata Mcgraw - Hill Edition, Tenth Reprint.
- Pang-Ning Tan, Michael Steinbach And Vipin Kumar, "Introduction To Data Mining", Pearson Education.
- K.P. Socnan, Shyam Diwakar und V. Ajay, "Insight into Data Mining Theory and Practice", Easter Economy Edition, Prentice Hall of India
- G K Gupta, "Introduction To Data Mining With Case Studies", Easter Economy Edition, Prentice Hall Of India.
- Daniel T. Larcose, "Data Mining Methods And Models", Wile-Interscience.
- WH Inmon, "Building The Data Warehouse", 3rd , Wiley India.

BDS- 303
(B.Sc. Hons. Computer Data Science)
Python Programming

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Python Programming Language.

UNIT - I

Introduction to Python: History and Features of Python Programming, Python Interpreter. Variable, identifiers and literal. Token, keywords. Data Types. Arithmetic operators, Relational operators, Logical operators, Bitwise operators, Assignment operators, Membership operators, Identity operators. Operator precedence. Comment, Indentation, Need for indentation

Built-in Functions: input, eval, composition, print, type, round, min and max, pow. Type Conversion, Random Number Generation. Mathematical Functions. Getting help on a function, Assert Statement.

UNIT - II

Control Statements: if Conditional Statement, for and while Statements. break, continue and pass statements. **Functions:** Function Definition and Call, Function Arguments-Variable Function Arguments, Default Arguments, Keyword Arguments, Arbitrary Arguments. Command Line Arguments. Global and local Variables. Accessing local variable outside the scope, Using Global and Local variables in same code, Using Global variable and Local variable with same Name.

UNIT - III

Strings: String a a compound data type. String operations- Concatenation, Repetition, Membership operation, Slicing operation. String methods-count, find, rfind, capitalize, title, lower, upper, swapcase, islower, isupper istitle, replace, isalpha, isdigit, isalnum. String Processing examples.

Lists: List operations-multiplication, concatenation, length, indexing, slicing, min, max, sum, membership operator; List functions-append, extend, remove, pop, count, index, insert, sort, reverse.

Recursion: Recursive solutions for problems on Numbers, String and list.

UNIT - IV

Object Oriented Programming: Introduction to Classes, Method, Class object, Instance object, Method object. Class as abstract data type, Date Class. Access attributes using functions-getattr, hasattr, setattr, delattr. Built-In Class Attributes of Class object (__dict__, __doc__, __name__, module__).

Graphics: Screen Objects- Point and line, box, polygon, circle, arc. Screen Object Methods- move_to(), move_by(), rotate_by(), Text(). Sound- Sound(), play_sound(), stop_sound().

Suggested Readings:

1. Sheetal Taneja and Naveen Kumar, "Python Programming A modular Approach", Pearson
2. P. K. Sinha & Priti Sinha , "Computer Fundamentals", BPB Publications, 2007.
3. Dr. Anita Goel, "Computer Fundamentals", Pearson Education, 2010.
4. Programming and Problem Solving with Python, Author: "Ashok Namdev Kamthane" and "Amit Ashok Kamthane".
5. Python Crash Course A Hands-On, Project-Based Introduction to Programming, by Eric Matthes

BDS – 304
(B.Sc. Hons. Computer Data Science))
Operating System

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Operating System and other related concepts.

UNIT-I

Introduction: Introduction to Operating System Concepts (Including Multitasking, Multiprogramming, Multi User, Multithreading etc.), Types of Operating System: Batch Operating System, Time-Sharing System, Distributed Operating System, Network Operating System, Real Time Operating System, Various Operating System services, architecture, System Program and Call.

UNIT-II

Process Management: Process Concept, Process Scheduling, Operations on Processes; CPU Scheduling, Scheduling Criteria, Scheduling Algorithms- First come First Serve(FCFS), Shortest Job First (SJF), Priority Scheduling, Round Robin(RR).
Deadlock: Methods for handling deadlock- Deadlock prevention, Avoidance & Detection.

UNIT-III

Memory Management: Logical & Physical Address Space, Swapping, Contiguous Memory allocation, non-contiguous memory allocation paging and segmentation techniques; Virtual Memory Management- Demand Paging & Page Replacement Algorithm; Demand Segmentation.

UNIT-IV

File System: Different types of files and their access methods, directory structure, various allocation methods, disk scheduling and management and its associated algorithms.

Suggested Readings

1. Operating System Concepts by Silberchartz et al 5th Edition 1998, Addison-Wesley.
2. Modern Operating System by A. Tanenbaum, 1992, Prentice Hall
3. Operating System By Peterson, 1985, AW.
4. Operating System By Milankovik, 1990, THM
5. Operating System Incorporating with Unix & Windows by Colin Ritche, 1974, THM.
6. Operating System Concepts 7th edition by "ABRAHAM SILBERSCHATZ".

BDS- 305
(B.Sc. Hons. Computer Data Science)
Multivariate Analysis

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Multivariate Analysis.

UNIT-I:

Review of vector and matrix algebra and its applicability to multivariate analysis. Concept of random vector, its expectation and Variance-Covariance matrix. Marginal and joint distributions. Multivariate Normal distribution, marginal and conditional distributions, properties of normal distribution.

UNIT-II:

Maximum likelihood estimates of mean vector and dispersion matrix (without proof). Sampling distributions of Hotelling's T^2 statistic and its relation with Mahalanobis's D^2 statistic. Tests of hypothesis about mean vector and difference of mean vectors. Wilks' λ criterion and its properties. Concepts of discriminant analysis, computation of linear discriminant function, classification between k ($\geq$2) multivariate normal populations based on LDF.

UNIT-III:

Principal Component Analysis: extraction of Principal Components from data using correlation and covariance matrices as input, properties and interpretation of PCs, computational steps for PCA, criterion for retaining PCs. Factor Analysis and difference between Factor Analysis & PCA. Exploratory Factor Analysis. Cluster Analysis, similarities and dissimilarities, Hierarchical clustering. Single, Complete and average linkage methods. K-means clustering and Ward's method.

UNIT-IV:

Canonical correlation and canonical variates, introduction to multidimensional scaling and its applications.

Suggested Readings:

Anderson TW. 1984. *An Introduction to Multivariate Statistical Analysis*. 2nd Ed. John Wiley.

Arnold SF. 1981. *The Theory of Linear Models and Multivariate Analysis*. John Wiley.

Buyan KC 2005. *Multivariate Analysis and its applications*. New Central Book Agency Pvt. Ltd. Publication

Giri NC. 1977. *Multivariate Statistical Inference*. Academic Press.

Johnson RA & Wichern DW. 1988. *Applied Multivariate Statistical Analysis*. Prentice Hall.

Kshirsagar AM. 1972. *Multivariate Analysis*. Marcel Dekker.

Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill

Muirhead RJ. 1982. *Aspects of Multivariate Statistical Theory*. John Wiley.

Rao CR. 1973. *Linear Statistical Inference and its Applications*. 2nd Ed. John Wiley.

Rencher AC. 2002. *Methods of Multivariate Analysis*. 2nd Ed. John Wiley.

Srivastava MS & Khatri CG. 1979. *An Introduction to Multivariate Statistics*. North Holland.

BDS- 306
(B.Sc. Hons. Computer Data Science)
Differential Equation and Linear Algebra

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Differential Equation and Linear Algebra.

Section – I

Geometrical meaning of a differential equation. Exact differential equations, integrating factors. First order higher degree equations solvable for x,y,p Lagrange's equations, Clairaut's equations. Equation reducible to Clairaut's form. Singular solutions.

Section – II

Linear differential equations with constant coefficients. Homogeneous linear ordinary differential equations. Equations reducible to homogeneous differential equations. Linear differential equations of second order: Method of variations of parameters. Method of undetermined coefficients.

Section – III

Vector spaces, Examples, Subspaces, linear combination, Span of a set, Sum of subspaces, Direct sum of subspaces, Linear dependence, independence of a set of vectors, Dimension and Basis.

Section – IV

Linear Transformations, definition and examples, One-one, onto linear transformation, equality of linear maps, Range and Kernel of a linear map, Rank Nullity Theorem.

Suggested Readings :

1. D.A. Murray, Introductory Course in Differential Equations. Orient Longaman (India). 1967
2. A.R.Forsyth, A Treatise on Differential Equations, Macmillan and Co. Ltd., London
3. E.A. Codington, Introduction to Differential Equations.
4. S.L.Ross, Differential Equations, John Wiley & Sons
5. B.Rai & D.P. Chaudhary, Ordinary Differential Equations, Narosa Publishing House Pvt. Ltd.
6. Linear Algebra by Schaum Outline series.
7. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).

BDS- 307 P
(B.Sc. Hons. Computer Data Science))
Linux Operating System

Credits: 02 (4Hrs /week) **External: 70**

Internal: 30 **Time: 3 Hours**

Objectives: To familiarize the students with basics of Linux Operating System.

List of Experiments Operating System Lab:

1. Study of Unix/Linux vi editor.
2. Shell Script To Display Logged in Users, Your UserName and Date / Time.
3. Shell script program to check whether given file is a directory or not.
4. Study of Unix/Linux Utility Programs (cut, paste, join, tr , uniq utilities, grep).
5. Program in C to report behaviour of Linux kernel including kernel version, CPU type and model. (CPU information)
6. Program in C to Copy a file using UNIX-system calls.
7. Program in C to implement FCFS Scheduling.

BDS- 308 P
(B.Sc. Hons. Computer Data Science))
Python Programming Lab

Credits: 02 (4Hrs /week) **External: 70**

Internal: 30 **Time: 3 Hours**

Objectives: To familiarize the students with basics of Python Programming Language.

List of Experiments Using PYTHON:

1. Write a Program to convert decimal number into binary, octal and hexadecimal number system using built-in functions.
2. Write a program to find the H.C.F of two input number using function.
3. Write a program to slice lists.
4. Write a program to change or add elements to a list.
5. Write a program to display calendar of given month of the year.
6. Write a program to compute factorial of a number using recursion.
7. Write a program to reverse the string using recursion.
8. Write a program to create copy of list using recursion.
9. Write a program to implement Bresenham's line drawing algorithm.
10. Write a program to implement mid-point circle drawing algorithm.
11. Write a program to clip a line using Cohen and Sutherland line clipping algorithm.
12. Write a program to clip a polygon using Sutherland Hodgeman algorithm.
13. Write a program to apply various 2D transformations.

Semester-IV

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	**Internal**	**Total**
Core Course-I	BDS-401	Software Engineering	4	4	70	30	100
Core Course-II	BDS-402	Cloud Computing	4	4	70	30	100
Core Course-III	BDS-403	Object Oriented Programming Using C++	4	4	70	30	100
Generic Elective-I	BDS-404	Time Series, Forecasting and Index Numbers	4	4	70	30	100
Generic Elective-II	BDS-405	Numerical Methods	4	4	70	30	100
Core Course Practical-I	BDS-406 P	Object Oriented Programming Using 'C++'-Lab	2	2x2=4	70	30	100
Generic Elective Practical-II	BDS-407 P	Numerical Methods-Lab	2	2x2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

BDS- 401
(B.Sc. Hons. Computer Data Science)
Software Engineering

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Software Engineering.

UNIT- I

Software Crisis – problem and causes, Software life cycle models: Waterfall, Prototype, Evolutionary and Spiral models. Software Project Planning: Cost estimation: COCOMO model, Project scheduling, project monitoring.

UNIT- II

Software Requirement Analysis and Specifications: Structured Analysis, Data Flow Diagram, Data Dictionaries, Software Requirement and Specifications, Behavioral and non-behavioral requirements. Software Design: Design fundamentals, problem partitioning and abstraction, design methodology, Cohesion & Coupling, Classification of Cohesiveness & Coupling.

UNIT- III

Software Configuration Management, Quality Assurance, Risk Management, Software Maintenance: Type of maintenance, Management of maintenance.

UNIT- IV

Coding: Programming style, structured programming. Software testing: Testing fundamentals, Functional testing: Boundary Value Analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Software testing strategies: Unit testing, integration testing, validation testing, System testing, Alpha and Beta testing.

Suggested Readings:

1. Pressman R.S., “Software Engineering- A Practitioner’s Approach”, Tata McGraw- Hill.
2. K.K. Aggarwal, Yogesh Singh, “Software Engineering”, New Age Pub.
3. Jalote P., “An Integrated approach to Software Engineering”, Narosa.
4.Sommerville, “Software Engineering”, Addison Wesley.
5.Fairley R., “Software Engineering Concepts”, Tata McGraw- Hill.
6.James Peter, W Pedrycz, “Software Engineering”, John Wiley & Sons.

BDS - 402
B.Sc. Hons. Computer Data Science
Cloud Computing

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Cloud Computing and its Applications.

UNIT -I

Cloud Computing: Introduction to client server computing, Peer to Peer computing, Distributed computing, collaborative computing and cloud computing, Importance of cloud computing in current era, Characteristics, advantages and disadvantages of cloud computing.

UNIT -II

Cloud Services: Functioning of cloud computing, Classification of cloud on the basis of services: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (Iaas): Definition, characteristics and their benefits.

UNIT- III

Cloud Architecture: Cloud computing Logical and service architecture, Types of clouds: Private cloud, Public cloud and Hybrid cloud, Comparison of a Private, public and hybrid clouds, Migrating to a cloud, Seven step model to migrate.

UNIT -IV

Applications: Business opportunities using cloud, Managing Desktop and devices in cloud, cloud as a type of distributed infrastructure, Application of cloud computing for centralizing Email communication, collaboration on schedules, calendars. Overview of major cloud service providers - Amazon Ec2, Google App Engine.

Suggested Readings:

1. Srinivasan, A. Cloud Computing: A Practical Approach for Learning and Implementation. Pearson Education India, 2014.
2. Cloud Computing, A Practical Approach-McGraw-Hill Osborne Media by “Toby Velte, Anthony Velte, Robert Elsenpeter- (2009)”.
3. Cloud Computing Bible, Author: “Barrie Sosinsky”, Publisher: “Wiley”(2011)

BDS- 403

B.Sc. Hons. Computer Data Science

Object Oriented Programming Using C++

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Object Oriented Programming Using C++.

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UNIT- I

Introduction to C++, C++ Standard Library, Basics of a Typical C++ Environment, Header Files and Namespaces, Library files. Introduction to Objects and Object Oriented Programming, Encapsulation, Access Modifiers; Controlling access to a class, method or variable (public, private, protected, package), Other Modifiers, Polymorphism; overloading, Inheritance, Overriding Methods, Abstract classes, Reusability.

UNIT- II

Classes and Data Abstraction: Introduction, Structure Definitions, Accessing Members of Structure, Class Scope and Accessing Class Members, Initializing Class Objects, Constructor, Using Default Arguments with Constructor, Using Destructor, Classes: Const(Constant) Object and Const Member Function, Object as Member of Classes, Friend Function and Friend class, Function Overloading.

Operator Overloading: Introduction, Fundamentals of Operator Overloading, Restrictions on Operator Overloading, Operator Functions as Class Members vs. as Friend Function, Overloading, <<,>> Overloading Unary Operators, Overloading Binary Operators.

UNIT- III

Inheritance: Introduction, Inheritance: Base Classes and Derived Classes, Protected Members, Casting Base-Class Pointers to Derived-Class Pointer, Using Member Functions, Overriding Base-class members in a Derived class, Public, Protected, and Private Inheritance, Using Constructors and Destructors in Derived Classes, Implicit Derived-Class Object to Base-Class Object Conversion.

UNIT- IV

Virtual Functions and Polymorphism: Introduction to Virtual Functions, Abstract Base Classes and Concrete Classes, Polymorphism, New Classes and Dynamic Binding, Virtual Destructor, Polymorphism, Dynamic Binding.

File and I/O Streams: Files and Streams, Creating a Sequential Access File, Reading Data From A Sequential Access File, Updating Sequential Access File, Random Access File, Creating A Random Access File, Writing Data Randomly to a Random Access File, Reading Data Sequential from a Random Access File.

Suggested Readings:

1. C++ How to Program by H.M Deitel and P.J Deitel, 1998, Prentice Hall.

2. Object Oriented Programming in Turbo C++ by Robert Lafore, 1994.

3. Programming with C++ by D. Raichandan, 2003, T.M.H.

4. Object Oriented Programming with C++ by Balagurusamy, 2001, Tata McGraw-Hill.

5. The C++ programming language-Addison-Wesley by “Bjarne Stroustrup- (1997)”

6. C++ Primer-Addison-Wesley Professional “Stanley B. Lippman, Josée Lajoie- (1998)”

BDS- 404
(B.Sc. Hons. Computer Data Science)
Time Series, Forecasting and Index Numbers

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Time Series, Forecasting and Index Numbers.

UNIT-I

Index Number: Definition, problems involved in the construction of index numbers, calculation of index numbers-simple aggregate method, weighted aggregates method, simple average of price relatives, weighted average of price relatives, link relatives, chain indices, value index numbers, price and quantity index numbers.

UNIT-II

Laspeyre's, Paasche's, Marshall-Edgeworth and Fisher's index numbers, time and factor reversal tests of index numbers, consumer price index number and its uses. Base shifting, splicing and deflating of index numbers.

UNIT-III

Time Series Analysis: Definition, components of time series-trend, seasonal variations, cyclic variations, irregular component, additive and multiplicative models. Determination of trend: graphic method, method of curve fitting by principle of least squares, moving average method. Analysis of seasonal fluctuations, construction of seasonal indices using method of simple averages, ratio to trend method and ratio to moving average method.

UNIT-IV

Autocorrelation and Partial autocorrelation functions, Correlogram and periodogram analysis. Autoregressive, Moving average and Mixed processes. Autoregressive integrated moving average processes. Model identification, Objectives, Model estimation and forecasting. Seasonal and non-seasonal ARIMA models.

Suggested Readings:

Box GEP, Jenkins GM & Reinsel GC. 2007. *Time Series Analysis: Forecasting and Control*. 3rd Ed. Pearson Edu.

Brockwell PJ & Davis RA. 2002. *Introduction to Time Series and Forecasting*. 2nd Ed. Springer.

Chatterjee S, Hadi A & Price B.1999. *Regression Analysis by Examples*. John Wiley.

Draper NR & Smith H. 1998. *Applied Regression Analysis*. 3rd Ed. John Wiley.

Gupta, S.C. and Kapoor, V.K., 2019. *Fundamentals of applied statistics*. Sultan Chand & Sons.

Johnston J. 1984. *Econometric Methods*. McGraw Hill.

Judge GG, Hill RC, Griffiths WE, Lutkepohl H & Lee TC. 1988. *Introduction to the Theory and Practice of Econometrics*. 2nd Ed. John Wiley.

Montgomery DC & Johnson LA. 1976. *Forecasting and Time Series Analysis*. McGraw Hill.

Pankratz, A., 2009. *Forecasting with univariate Box-Jenkins models: Concepts and cases* (Vol. 224). John Wiley & Sons.

Shumway RH & Stoffer DS. 2006. *Time Series Analysis and its Applications: with R Examples*. 2nd Ed. Springer.

BDS- 405
(B.Sc. Hons. Computer Data Science)
Numerical Methods

Maximum Marks: 100 **External:70**
Minimum Passing Marks: 40 **Internal:30**
Time: 3Hour **Credits: 04**

Note: Attempt five questions in all. The question paper will consist of **four** sections. **Question No. 1** will contain **seven** short answer type questions without any internal choice covering the entire syllabus and shall be **compulsory.** Each of the four sections (**I-IV**) will contain two questions and the students are required to attempt **one** question from each section. **All questions carry equal marks.**

Objectives: To familiarize the students with basics of Numerical Methods and their Applications.

Section – I

Solution of Algebraic and Transcendental equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson's method. Newton's iterative method for finding pth root of a number. Simultaneous linear algebraic equations: Gauss-elimination method, Gauss-Jordan method. Iterative method, Jacobi's method, Gauss-Seidal's method.

Section – II

Interpolation with equal intervals: Newton's forward and Newton's backward interpolation formulae. Central Differences: Gauss forward and Gauss's backward interpolation formulae. Interpolation with unequal intervals: Newton's divided difference, Lagrange's Interpolation formulae.

Section – III

Numerical Differentiation: Derivative of a function using interpolation formulae as studied in Sections II. Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one- third and three-eighth rule.

Section – IV

Numerical solution of ordinary differential equations: Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods. Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.

Suggested Readings:

1. Babu Ram, Numerical Methods: Pearson Publication.
2. R.S. Gupta, Elements of Numerical Analysis, Macmillan's India 2010.
3. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method, Problems and Solutions, New Age International (P) Ltd., 1996
4. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Method for Scientific and Engineering Computation, New Age International (P) Ltd., 1999
5. C. E. Froberg, Introduction to Numerical Analysis (2^{nd} Edition).
6. Melvin J. Maaron, Numerical Analysis-A Practical Approach, Macmillan Publishing Co., Inc., New York
7. R.Y. Rubnistein, Simulation and the Monte Carlo Methods, John Wiley, 1981

BDS- 406 P
(B.Sc. Hons. Computer Data Science)
Object Oriented Programming Using 'C++'-Lab

Credits: 02 (4Hrs /week) **External: 70**

Internal: 30 **Time: 3 Hours**

Objectives: To familiarize the students with basics of Object Oriented Programming Using 'C++'.

List of Experiments Using C++:

1. Write a program to perform different arithmetic operation such as addition, subtraction, division, modulus and multiplication using inline function.
2. Write a program to find area of square, rectangle, circle using function overloading.
3. Define a class to represent an item class with data members as number and cost. Write member functions to read and display the data. Write a main program to test the data.
4. Define a class to represent a bank account with the following members

   Data members:

   1. Account holder Name
   2. Account number
   3. Type of account
   4. Balance amount in the account

   Member functions:

   1. to assign initial value
   2. To deposit an amount
   3. To withdraw an amount after checking the balance
   4. To display name and balance

   Write a main program to test it.
5. Write a program to explain the concept of static data member.
6. Write a program to explain the concept of static member function.
7. Write a program to swap private data of two different classes using friend function.
8. Define a class for complex number with default, parameterized, copy constructor. Write a program to add two complex numbers using friend function.
9. Define a class string with dynamic constructors. Write a program to concatenate two strings.

10. Write a program to show the order in which objects are created and destroyed using constructor and destructor.
11. Write a program to overload unary minus (-) operator using space class.
12. Write a program to overload binary plus (+) operator as member function to add two complex numbers.
13. Write a program to overload binary plus (+) operator as friend function to add two complex numbers.
14. Write programs to explain single, multiple, multilevel, hierarchical and hybrid inheritance.
15. Write a program to explain manipulators.

BDS- 407 P
(B.Sc. Hons. Computer Data Science)
Numerical Methods- Lab

Credits: 02 (4Hrs /week) **External: 70**

Internal: 30 **Time: 3 Hours**

Objectives: To familiarize the students with basics of Numerical Methods and their implementation in C Programming Language.

There will be a separate practical paper consisting of implementation of numerical methods in C Programming Language, studied in the theory paper BDS 405.

Semester-V

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Generic Elective-I	BDS-501	Fundamentals of Econometrics	4	4	70	30	100
Core Course-I	BDS-502	Artificial Intelligence	4	4	70	30	100
Core Course-II	BDS-503	Internet and Web Technology	4	4	70	30	100
Core Course-III	BDS-504	Machine Learning	4	4	70	30	100
Core Course-IV	BDS-505	Digital Logic Design and Computer Organization	4	4	70	30	100
Core Course Practical-I	BDS-506P	Practical Lab of Internet and Web Technology	2	2 X 2=4	70	30	100
Core Course Practical-II	BDS-507P	Practical Lab of Machine Learning	2	2 X 2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-501	Fundamentals of Econometrics	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Introduce Regression Analysis to students so that they are able to understand its applications in different fields.
- Train the students to undertake empirical studies applying their knowledge in economic theory and econometric methods and provide scope to do empirical analysis.
- Apply understanding of core concepts and quantitative tools to analyze and research real world problems and evaluate alternative economic policy proposals on various economic issues.

Course Outcomes:

On completion of this course, the student will be able to:

- Specify assumptions, formulate and estimate appropriate models.
- Interpret the results and test their statistical significance.
- Students are required to conduct research in teams where they apply the techniques learnt during the course and present their results.

Unit -I

Introduction to econometrics; Nature, scope, objectives and methodology of econometrics, Types of econometrics, Nature of the regression analysis, Basic assumptions, Simple Linear Regression Model: Two Variable Case, Estimation of model by method of ordinary least squares, properties of estimators, goodness of fit, Gauss-Markov theorem.

Unit-II

Classical Normal Linear Regression Model, Normality Assumption for Disturbances, Properties of ordinary least squares, Estimators under the Normality Assumption, Method of Maximum Likelihood, Multiple regression analysis: Three variable case, ordinary least squares and Maximum Likelihood Estimation of the Partial Regression Coefficients, Multiple Coefficient of Determination, Multiple Coefficient of Correlation.

Unit-III

Nature of Dummy Variables and Multicollinearity, Estimation in the Presence of Perfect Multicollinearity, Estimation in the Presence of "High" but "Imperfect" Multicollinearity, Detection of Multicollinearity, Heteroscedasticity: OLS Estimation in the Presence of Heteroscedasticity, Method of Generalized Least Squares, Detection of Heteroscedasticity.

Unit-IV

Nature of the Autocorrelation: OLS Estimation in the Presence of Autocorrelation, BLUE Estimator in the Presence of Autocorrelation, Detecting Autocorrelation, Graphical Method, Runs Test, Durbin–Watson Test, Breusch–Godfrey Test.

Suggested Reading:

1.	Basic Econometrics	Gujarati D.N.	McGraw Hill.	2003
2.	Essentials of Econometrics	Gujarati D.N. and Porter D.C.	McGraw Hill, 4th edition	2009
3.	Introduction to Econometrics	Koop G.	John Wiley	2007
4.	Introduction to Econometrics	Maddala GS.	MacMillan	1992

5.	Econometrics	Maddala GS.	McGraw Hill	1997
6.	Introduction to Econometrics	Maddala G.S. and Lahiri, K.	John Wiley and Sons, 4th edition	2009
7.	Econometrics Models and Econometric Forecasts	Pindyck R.S. and Rubinfeld D.L.	McGraw Hill	1990

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-502	Artificial Intelligence	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving, knowledge representation, and learning.
- Investigate applications of AI techniques in intelligent agents, expert systems and other machine learning models.

Course Outcomes:

On completion of this course, the student will be able to:

- Understand what the AI is.
- Take hold of basic theoretical techniques for analyzing computer algorithms.
- Have ability to identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem.

Unit-I

Introduction: Background and History, Overview of AI applications areas.

Problem solving: Search space control, Depth first search, Breadth First Search, Hill climbing, Branch and bound, Best First Search, A* algorithm, AND / OR Graphs, Problem Reduction, Means End Analysis. Production system: Types of production system, Control of search in production system.

Unit-II

Knowledge Representation: Propositional & Predicate Logic; First Order Predicate Calculus; Skolemnisation; Resolution; Inference, Semantic Networks; Frame Systems; Scripts; Conceptual Dependency.

Rule Based Systems: Inference Rules, Conflict Resolution, Forward & Backward Reasoning.

Unit-III

Fuzzy logic: Definition, Difference between Boolean and Fuzzy logic, fuzzy subset, fuzzy expert system.

Learning: Types of learning, genetic algorithms, learning by induction, learning by explanation. Programming with Prolog.

Unit-IV

Expert System: Expert system development life cycle: Problem selection, Prototype construction, Formalization, Implementation, Knowledge acquisition: Knowledge engineer, Acquisition techniques. Case Study of MYCIN.

Applications of AI: Game Playing, techniques, Mini-max search procedure, Natural Language and its links with AI, Speech Synthesis and its recognition, Syntactic and semantic analysis with AI, Bio-medical application of AI in context of Fuzzy Sets, Image Processing with AI.

Suggested Readings:

1.	Artificial Intelligence	Rich Elaine and Knight Kevin	Tata McGraw Hill	2nd Edition
2.	Artificial Intelligence: A Modern Approach	Stuart Russel and Peter Norvig	Pearson Education, PHI	2nd Edition
3.	Foundation Artificial Intelligence & Expert Systems	VS Janakiraman K, Sarukesi P Gopalakrishnan	Macmillan Series in Computer Science	
4.	Artificial Intelligence	George F. Luger, William A. Stubblefield	The Benjamin / Cummings Publishing Company, Inc.	

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-503	Internet and Web Technology	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Expose students to the basic tools and applications used in Web publishing
- Learn HTML, XML and design various web pages.
- Learn JavaScript and its uses in web designing process with HTML.

Course Outcomes:

On completion of this course, the student will be able to:

- Become skilled at Web Designing Complete Process.
- Make Web Pages using HTML and XML.
- Build dynamic web pages using JavaScript (Client side programming).

Unit – I

Introduction to Internet and World Wide Web; Evolution and History of World Wide Web; Basic features; Web Browsers; Web Servers; Hypertext Transfer Protocol, Overview of TCP/IP and its services; URLs; Searching and Web-Casting Techniques; Search Engines and Search Tools;

Unit – II

Web Development: Introduction to HTML; Hypertext and HTML; HTML Document Features; HTML command Tags; Creating Links; Headers; Text styles; Text Structuring; Text colors and Background; Formatting text; Page layouts , Images and Multimedia, Links and webs.

Unit – III

Cascading Style Sheet: Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, XML: Introduction of XML- Some current applications of XML, Features of XML, Anatomy of XML document, The XML Declaration, Element Tags- Nesting and structure, XML text and text formatting element

Unit – IV

Introduction to JavaScript ,Variable Naming Rules and JavaScript Data Types, Expressions and Operators, Flow Control, Objects and Arrays, Defining Functions and Methods , The Document Object Model (DOM), How to Get Input and Output, JavaScript in Browsers, Handling Web Page Events

Suggested Readings:

1.	Internet and Web Technologies	Raj Kamal	Tata McGraw-Hill
2.	Web Design	Satinder Bal Gupta & Brij Mohan Goel	Shree Mahavir Book Depot (Publishers) , New Delhi
3.	Developing Web Applications	Savaliya	Wiley India Ltd, 2ed
4.	Web Technologies Black Book		Dreamtech Press
5.	Web Applications : Concepts and Real World Design	Knuckles	Wiley-India
6.	Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, ASP.NET, XML and Ajax, Black Book	Kogent	Wiley India Ltd.

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-504	Machine Learning	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms
- Introduce students to the basic techniques of Machine Learning.
- Develop skills of using recent machine learning software for solving practical problems.

Course Outcomes:

On completion of this course, the student will be able to:

- Understand machine learning concepts and range of problems that can be handled by machine learning.
- Apply structured thinking to unstructured problems.
- Apply the machine learning concepts in real life problems.

Unit I

Introduction: Well posed learning problems, designing a learning system, Issues in machine learning, the concept learning task, Concept learning as search, Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm, Remarks on version spaces and candidate-eliminations, Inductive bias.

Unit II

Supervised Learning: Introduction to linear regression, estimating the coefficients, Accessing the accuracy of the coefficient estimates, Accessing the accuracy of the regression model, Multiple linear regression, Logistic regression, basic decision tree learning (ID3) algorithm, Hypothesis space search in decision tree learning algorithm, Inductive bias in decision tree learning, Issues in decision tree learning, k-nearest neighbour learning.

Unit III

Unsupervised Learning: About clustering, type of data in clustering analysis, k-means and k-medoids, DBSCAN density-based clustering method, Performance analysis of clustering algorithms,

Artificial Neural networks: Neural Network representations, Appropriate problems for neural network learning, Perceptron. The perceptron training rule, Gradient descent and delta rule, Multilayer Networks and back propagation algorithm.

Unit IV

Bayesian Learning: Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least-squared error hypotheses, Naïve Bayes Classifier.

Evaluating Hypotheses: Estimating hypothesis Accuracy, Basics of sampling theory, Error estimation and estimating Binomial proportions, The binomial distribution, Mean and variance, Bias and variance, Confidence intervals, Two sided or one sided bounds, Central limit theorem, Hypothesis testing, Comparing learning algorithms.

Suggested Readings:

1.	Machine Learning	Tom M. Mitchell	McGraw-Hill	1997
2.	Pattern Recognition and Machine Learning	Bishop Christopher	Springer Verlag	2006
3.	The Elements of Statistical Learning: Data Mining, Inference and Prediction	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Springer, 2nd edition	2009
4.	Data Mining Concepts and Techniques	J. Han and M. Kamber	Elsevier, 3rd Edition	2012
5.	Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications	S. Rajeshkaran, G. A. Vijayalakshmi Pai	PHI	2003

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-505	Digital Logic Design and Computer Organization	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Demonstrate the basics involved in data representation and digital logic circuits used in the computer system.
- Explain basic architecture of processing, memory and I/O organization in a computer system.
- Understand the Instruction execution stages and the functions of the various computer hardware components.

Course Outcomes:

On completion of this course, the student will be able to:

- Identify, understand and apply different number systems and codes.
- Understand the digital representation of data in a computer system, I/O and memory organization in depth.
- Understand the functions of the various computer hardware components and Instruction execution stages.

Unit- I

Digital Logic Circuits : Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic expressions, Combinational Circuits, Flip-flops, Registers, Binary counters, Decoders, Multiplexers.

Unit- II

Basic Structure of Computers: Computer Types, Functional units, Basic operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers, Computer Generations.

Data Representation: Binary Numbers, Fixed Point Representation. Floating – Point Representation. Number base conversions, Octal and Hexadecimal Numbers, complements, Signed binary numbers, Binary codes.

Unit- III

Processor Organization: Introduction to CPU, Register Transfers, Execution of Instructions, Multiple Bus Organization, Hardwired Control, Microprogrammed Control

Instruction Set & Addressing: Memory Locations and Addresses, Machine addresses and sequencing, Various Addressing Modes, Instruction Formats, Basic Machine Instructions.

Unit- IV

Memory Organization: Concept of Memory, RAM, ROM memories, memory hierarchy, cache memories, virtual memory, secondary storage, memory management requirements.

Input / Output Organization: Introduction to I/O, Interrupts- Hardware, Enabling and disabling Interrupts, Device Control, Direct memory access, buses, interface circuits, standard I/O Interfaces.

Suggested Readings :

1.	Computer Organization	Carl Hamacher, Zvonko Vranesic, Safwat Zaky	McGraw Hill, Fifth Edition
2.	Computer Architecture and Organization- An Integrated Approach	Miles Murdocca, Vincent Heuring	Wiley India, Second Edition
3.	Computer Systems Architecture	M.Moris Mano	Pearson, IIIrd Edition
4.	Computer Organization and Architecture	William Stallings	Pearson, Sixth Edition
5.	Computer- organization and Design	David A. Paterson and John L.Hennessy	Elsevier
6.	Fundamentals or Computer Organization and Design	Sivarama Dandamudi	Springer Int. Edition

7.	Digital Design	M.Morris Mano	Pearson Education/PHI, Third Edition
8.	Fundamentals of Logic Design	Charles H. Roth, Jr. Larry L. Kinney	Cengage Learning, 7th Edition

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-506P	Practical Lab of Internet and Web Technology	2	2 X 2=4	70	30	100

Note: An internal practical examination is conducted by the course coordinator. The end semester practical examination is conducted jointly by external and internal examiners.

Objectives:

The objectives of this lab course are to:

- Teach the basics involved in publishing content on the World Wide Web including the 'language of the Web' – HTML.
- Build dynamic web pages using JavaScript (Client side programming).
- Create XML documents and Schemas.

Course Outcomes:

On completion of this course, the student will be able to:

- Analyze a web page and identify its elements and attributes.
- Understand Static and Dynamic concepts of web designing.
- Design web pages that apply various dynamic effects on the web site.
- Solve complex and large problems using Scripting Language & Markup Language.

List of Experiments:

1. Design index page of a book Titled Web Designing.
2. Create a simple HTML page to demonstrate the use of different tags.
3. Display Letter Head of your department on a web page & it must be scrolling Right to Left.
4. Create a link to move within a single page rather than to load another page.
5. Display "Name of University" using different Text formatting Tags.
6. Design Time Table of your department and highlight most important periods.
7. Use Tables to provide layout to your web page.
8. Embed Audio and Video into your web page.
9. Divide a web page vertically and display logo of your department in left pane and logo of university in right pane.
10. Create Bio- Data of an employee.
11. Design front page of a hospital with different styles.
12. Design a web page and display horizontally two different web pages at a time.
13. Write a program to create a login form. On clicking the submit button, the user should get navigated to a profile page.
14. Write a HTML code to create a Registration Form. On submitting the form, the user should be asked to login with the new credentials.
15. Write a HTML code to create website in your department and create link for Tutorial of specific subject.
16. Write a program to perform following operations on two numbers input by the user:
    1) Addition 2) Subtraction 3) Multiplication 4) Division.
17. Design a program to solve quadratic equations.
18. Write a program to determine greatest number of three numbers.
19. Write a script to compute, the Average and Grade of students marks.
20. Design a scientific calculator and make event for each button using scripting language.
21. Write a script to check whether a number is even or odd?
22. Write a program to show whether a number is prime or not?
23. Write a program to show multiplication table of any number.
24. Write a program to find the factorial of any number.
25. Write a program to show Fibonacci Series between 0 to 74.

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-507P	Practical Lab of Machine Learning	2	2 X 2=4	70	30	100

Note: An internal practical examination is conducted by the course coordinator. The end semester practical examination is conducted jointly by external and internal examiners.

Objectives:

The objectives of this lab course are to:

- Get an idea of various tools that are using for machine learning algorithms all over the world
- Make use of Data sets in implementing the machine learning algorithms
- Implement the machine learning concepts and algorithms in any suitable language of choice.

Course Outcomes:

On completion of this course, the student will be able to:

- Understand the implementation procedures for the machine learning algorithms.
- Apply appropriate data sets to the Machine Learning algorithms.
- Identify and apply Machine Learning algorithms to solve real world problems.

List of Experiments:

1. Install WEKA/R/Python/Octave and learn to use these software packages.
2. Two experiments related to classification algorithms and interpreting the results of these algorithms.
3. Two experiments related to clustering algorithms and interpreting the results of these algorithms.
4. Three experiments related to designing neural networks for solving learning problems.
5. Two experiments related to ranking or selecting relevant features.
6. Two experiments related to linear regression and logistic regression.

Note: The experiments must meet the objective of the course and the levels of the given course outcomes.

Semester-VI

Course Opted	Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
					External	Internal	Total
Core Course-I	BDS-601	Big Data Analytics	4	4	70	30	100
Core Course-II	BDS-602	Computer Networks	4	4	70	30	100
Core Course-III	BDS-603	Neural Network and Deep Learning	4	4	70	30	100
Elective Course-I	BDS-604	Elective I	4	4	70	30	100
Elective Course-II	BDS-605	Elective II	4	4	70	30	100
Core Course Practical-I	BDS-606P	Practical Lab of Big Data Analytics	2	2 X 2=4	70	30	100
Core Course Practical-II	BDS-607P	Practical Lab of Computer Networks	2	2 X 2=4	70	30	100
		Total	**24**	**28**	**490**	**210**	**700**

Elective-I

Paper Code	Nomenclature
BDS-604-i	Data Visualization
BDS-604-ii	Internet of Things
BDS-604-iii	Natural language Processing

Elective-II

Paper Code	Nomenclature
BDS-605-i	Statistical Simulation and Data Analysis
BDS-605-ii	Social Network Analysis
BDS-605-iii	Cryptography and Network Security

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-601	Big Data Analytics	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Study the basic technologies that forms the foundations of Big Data.
- Understand the specialized aspects of big data including big data application, and big data analytics.
- Study different types case studies on the current research and applications of the Hadoop and big data in industry

Course Outcomes:

On completion of this course, the student will be able to:

- Understand the building blocks of Big Data.
- Represent the analytical aspects of Big Data.
- Know the recent research trends related to Hadoop File System and MapReduce etc.

Unit I

Introduction: Overviews of Big Data, State of the Practice in Analytics, The Data Scientist, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle Challenges of Conventional Systems, Statistical Concepts: Sampling Distributions, Re-Sampling, Statistical Inference, Prediction Error, Regression Modelling, Multivariate Analysis, Bayesian Modelling.

Unit II

Mining Data Streams: Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics, Platform (RTAP) Applications, Case Studies, Real Time Sentiment Analysis, Stock Market Prediction

Unit III

Frequent Itemset and Clustering: Mining Frequent Itemsets, Market Based Model: Apriori Algorithm, Handling Large Data Sets in Main Memory, Limited Pass Algorithm, Counting Frequent Itemsets in a Stream, Clustering based Techniques: Hierarchical, K-Means etc., Clustering High Dimensional Data, CLIQUE And PROCLUS, Frequent Pattern based Clustering Methods, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Unit IV

Frameworks and Visualization: Overview of MapReduce, Hadoop, Hive, MapR, Sharding, NoSQL Databases, S3, HADOOP, Distributed File System (HDFS), Visualizations: Visual Data Analysis Techniques, Interaction Technique and Applications.

Suggested Readings:

1.	Intelligent Data Analysis	Michael Berthold, David J. Hand	Springer	2007
2.	Mining of Massive Datasets	A. Rajaraman, J.D. Ullman	Cambridge University Press	2012
3.	Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics	Bill Franks	John Wiley & Sons	2012
4.	Making Sense of Data	Glenn J. Myatt	John Wiley & Sons	2007
5.	Big Data Glossary	Pete Warden	O'Reilly	2011

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-602	Computer Networks	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Develop an understanding of computer networking basics.
- Develop an understanding of different components of computer networks, various protocols, modern technologies and their applications.
- Develop an understanding of how computers communicate with each other and the methods employed to assure that the communication is reliable.

Course Outcomes:

On completion of this course, the student will be able to:

- Have depth knowledge of the fundamental concepts of computer networking.
- Explain the role of each layer of the OSI model and TCP/IP and their functions.
- Understand the general principles behind multiplexing, addressing, routing, reliable transmission and other stateful protocols as well as specific examples of each.

UNIT – I

Introduction to Computer Communications and Networking Technologies, Uses of Computer Networks, Network Devices, Nodes, and Hosts, Types of Computer Networks and their Topologies; Network Software: Network Design issues and Protocols; Connection-Oriented and Connectionless Services; Network Applications and Application Protocols; Computer Communications and Networking Models: Decentralized and Centralized Systems, Distributed Systems, Client/Server Model; Network Architecture and the OSI Reference Model, Example Network: The Internet, X.25, Frame relay;

UNIT – II

Analog and Digital Communications Concepts: Representing Data as Analog Signals, Representing Data as Digital Signals, Data Rate and Bandwidth, Capacity, Baud Rate; Digital Carrier Systems; Guided and Wireless Transmission Media; Communication Satellites; Switching and Multiplexing; Dial Up Networking; Analog Modem Concepts; DSL Service

UNIT - III

Data Link Layer: Framing, Flow Control, Error Control, Error Detection and Correction, Sliding Window Protocols, Media Access Control, Random Access Protocols, Token Passing Protocols, Token Ring, Introduction to LAN technologies: Ethernet, switched Ethernet, VLAN, Fast Ethernet, gigabit Ethernet, token ring, FDDI, Wireless LANs; Bluetooth;

UNIT – IV

Network Hardware Components: Connectors, Transceivers, Repeaters, Hubs, Network Interface Cards and PC Cards, Bridge, Switches, Routers, Gateways; Routing Concepts: Virtual Circuits and Datagrams, Routing Algorithms, Flooding, Shortest Path Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Congestion Control Algorithms, Internetworking;

Suggested Readings :

1. Computer Communications and Networking Technologies — Michael A. Gallo, William M. Hancock — CENGAGE Learning
2. Computer Networks — Andrew S. Tanenbaum — Pearson Education
3. Computer Networking — James F. Kurose, Keith W. Ross — Pearson Education
4. Data Communications and Networking — Behrouz A Forouzan — McGraw Hill

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-603	Neural Network and Deep Learning	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Introduce the fundamental techniques and principles of Neural Networks
- Study the different models in ANN and their applications
- Familiarize deep learning concepts with Convolutional Neural Network case studies

Course Outcomes:

On completion of this course, the student will be able to:

- Identify the deep learning algorithms for various types of learning tasks in various domains.
- Develop an understanding what is involved in learning models from data.
- Implement deep learning algorithms and solve real-world problems.

Unit- I

Fundamentals of Neural Networks – Model of Artificial Neuron – Neural Network Architectures – Learning Methods – Taxonomy of Neural Network Architectures – Applications

Unit- II

Perceptron Models: Discrete, Continuous and Multi-Category –Training Algorithms: Discrete and Continuous Perceptron Networks – Limitations of the Perceptron – Model. XOR problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, and Summary of Back propagation Algorithm

Unit- III

Deep Feed Forward network, regularizations, training deep models, dropouts, Training Deep Neural Networks using Back Propagation-Setup and initialization issues, vanishing and exploding Gradient problems, Gradient- Descent Strategies

Unit-IV

Convolutional Neural Network, Basic structure of Convolutional Network, Applications of CNN– Object Detection, Content based image Retrieval, Case studies: Alex net, VGGNet, GoogLeNet.

Suggested Readings :

1.	Neural Networks and Deep learning	CharuC.Aggarwal	Springer International Publishing	2018
2.	Deep Learning	Goodfellow, I., Bengio,Y., and Courville, A.	MIT Press	2016
3.	Neural Networks, A Classroom Approach	Satish Kumar	Tata McGraw -Hill	2007
4.	Neural Networks: A Comprehensive Foundation	Simon Haykin	Addison Wesley Longman, 2nd Edition	2001
5.	Artificial Neural Networks	Yegnanarayana, B.	PHI Learning Pvt. Ltd	2009
6.	Pattern Recognition and Machine Learning	Bishop, Christopher M..	Springer	2006
7.	Pattern Classification	Duda, Richard, Peter Hart, and David Stork	Wiley- Interscience 2nd ed. New York, NY	2000

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-604-i	Data Visualization	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Understand why visualization is an important part of data analysis
- Understand the various information about visualization techniques.
- Understand the components involved in visualization design.

Course Outcomes:

On completion of this course, the student will be able to:

- Design and create data visualizations.
- Apply the various operations on data source.
- Understand and apply principles of data visualization.

Unit-I

Introduction: Context of data visualization: Definition, Methodology, Visualization design objectives. Key Factors: Purpose, visualization function and tone, visualization design options: Data representation, Data Presentation, Seven stages of data visualization, widgets, data visualization tools.

Unit-II

Visualizing Data Methods: Mapping, Time series, Connections and correlations, Scatterplot maps, Trees, Hierarchies and Recursion, Networks and Graphs, Info graphics.

Unit-III

Visualizing Data Process : Acquiring data, Where to Find Data, Tools for Acquiring Data from the Internet, Locating Files for Use with Processing, Loading Text Data, Dealing with Files and Folders, Listing Files in a Folder, Asynchronous Image Downloads, Advanced Web Techniques, using a Database, Dealing with a Large Number of Files.

Unit-IV

Parsing data: Levels of Effort, Tools for Gathering Clues, Text Is Best, Text Mark-up Languages, Regular Expression, Grammars and BNF Notation, Compressed Data, Vectors and Geometry, Binary Data Formats, Advanced Detective Work.

Suggested Readings :

1.	Interactive data visualization for the web	Scott Murray	O'Reilly Media, Inc.	2013
2.	Visualizing Data	Ben Fry	O'Reilly Media, Inc.	2007
3.	Security Data Visualization: Graphical Techniques for Network Analysis	Greg Conti	No Starch Press Inc	2007

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-604-ii	Internet of Things (IoT)	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Give a basic understanding about Internet of Things (IoT).
- Understand the working of different techniques, protocol and algorithms which are commonly used in IoT applications.
- Expose the various architecture for developing IoT applications.

Course Outcomes:

On completion of this course, the student will be able to:

- Understand the Machine to Machine and Internet of things.
- Find various applications of IoT
- Design and implement IoT based application

Unit I

Introduction to IoT - Current technological trends and future prospects – Evolution of IoT- Business Scope - Relation with embedded system - Basic Architecture of an IoT - From M2M to IoT - M2M towards IoT - IoT Value Chains - An emerging industrial structure for IoT

Unit II

Elements of IoT: Application Sensors & Actuators - Edge Networking (WSN) – Gateways - IoT Communication Model – WPAN & LPWA, IoT platform for available applications, Hardware Devices: Arduino, Raspberry pi and Smartwifi, etc, Wearable Development Boards, Softwares, Programs and Stacks available for building IoT applications, Installation of various packages necessary for project and list of tools.

Unit III

Communication and Connective Technologies : IoT Communication Model - Cloud computing in IoT - IoT in cloud architecture - Logging on to cloud - Selecting and Creating cloud service - cloud based IoT platforms - IBM Watson - Google cloud.

Unit IV

Data Analytics and IoT Platform: Big Data Analytics - Apache Hadoop - Using Hadoop Map Reduce for Batch Data Analysis - Apache Storm - Data Visualization - Visualization tools for IoT

Suggested Readings:

1.	The Internet of Things: Applications and Protocols	Oliver Hersent, David Boswarthick, Omar Elloumi	Wiley publications
2.	Architecting the Internet of Things	Dieter Uckelmann, Mark Harrison, Florian Michahelles	Springer publications
3.	Internet of Things with Arduino Cookbook	Marco Schwatrz	Packt Publications
4.	Internet of Things and Data Analytics Handbook	Hwaiyu Geng (ed.)	Wiley Publications

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-604-iii	Natural Language Processing	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Make the students familiar with difference levels/stages of natural language processing and to introduce concept of Formal languages and grammars: Chomsky hierarchy and problems associated (like Left-Associative grammars, ambiguous grammars) with them.
- Make the students familiar with grammar types like ATN & RTN and basic techniques of parsing like CKY, Earley & Tomita's algorithms
- Introduce the students with Morphology of natural languages by taking examples from Hindi, English.

Course Outcomes:

On completion of this course, the student will be able to:

- Difference levels / stages of natural language processing and the concept of Formal languages and grammars: Chomsky hierarchy and problems associated (like LeftAssociative grammars, ambiguous grammars) with them.
- Write small ATN & RTN grammars for simple English sentences.
- Do Morphology of words from natural languages like Hindi, English and Semantics-knowledge and its important to understand the documents.

Unit-I

Components of natural language processing: lexicography, syntax, semantics, pragmatics: word level representation of natural languages prosoty & natural languages.

Formal languages and grammars: chomsky hierarchy, Left-Associative grammars, ambiguous grammars, resolution of ambiguities. Introduction of top down and bottom up parsers

Unit-II

Computation linguistics: Morphology of natural languages like Hindi, English etc., recognition and parsing of natural language structures: ATN & RTN, General techniques of parsing: CKY, Earley & Tomitas algorithm.

Unit-III

Semantics-knowledge representation semantic networks logic and inference pragmatics, graph models and optimization, prolog for natural language semantic (e.g. DCG).

Unit-IV

Application of NLP: intelligent work processors: Machine translation, user interfaces, Man- Machine interfaces, natural language querying, tutoring and authoring systems, speech recognition, commercial use of NLP.

Suggested Readings :

1.	Natural Language Understanding	James Allen, Benjamin	Cummings Pub. Comp. Ltd.	1995
2.	Language as a cognitive process	Terry Winograd	AW	1983
3.	Natural Language processing in prolog	G. Gazder	Addison Wesley	1989
4.	Introduction of Formal Language Theory	Mdlj Arbib & Kfaury	Springer Verlog	1988

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-605-i	Statistical Simulation and Data Analysis	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Acquaint graduate students in statistics, mathematics, and related fields with the modern methodologies and issues associated with computational statistics.
- Strikes a balance between theoretical foundations and computational implementation.
- Use Monte Carlo methods to solve statistical problems.

Course Outcomes:

On completion of this course, the student will be able to:

- Solve simple problems related to simulation.
- Explain the needs of complexity measures and complexity modelling.
- Carry out simulations of statistical models, analyze the results statistically, and will be able to make assessments of uncertainty in the results.

Unit-I

Introduction and need of statistics simulation, general principles, advantages and disadvantages of simulation, Review of simulation methods, Simulation of random variable from discrete, continuous, multivariate distributions and stochastic processes, Types of models, Steps in simulation study, Model development life cycle, Areas of application.

Unit-II

Random Number generation: Generation of Pseudo-Random numbers, Random Number generation methods, Properties of Random Numbers, Test for random numbers, Generating discrete distribution, Inversion, Rejection sampling.

Unit- III

Variance reduction techniques. Implementation of simulation methods - for various probability models, and resampling methods: theory and application of the jack-knife, bootstrap and cross validation, Simulating multivariate distributions.

Unit-IV

Univariate density estimation, kernel smoothing multivariate density estimation. Markov Chain Monte Carlo methods: Markov chains, Gibbs sampling, Hastings Metropolis algorithms, critical slowing-down and remedies, auxiliary variables. Practical Simulation from various probability models;

Suggested Readings

1.	Simulation, Modeling and Analysis	Law, A. M., Kelton, W. D., & Kelton, W. D	New York: McGraw-Hill.	2000
2.	Advances in Stochastic Simulation Methods.	Balakrishnan, N., Melas, V. B., & Ermakov, S.	Springer Science & Business Media.	2012
3.	Handbook of Simulation: Principles, Methodology, Advances, Applications, And Practice.	Banks, J	John Wiley & Sons.	1998
4.	A Guide to Simulation.	Bratley, P., Fox, B. L., & Schrage, L. E.	Springer Science & Business Media.	2011
5.	Bootstrap Methods and their Application	Davison, A. C., & Hinkley, D. V.	Cambridge university press.	1997

6.	Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference.	Gamerman, D., & Lopes, H. F.	CRC Press	2006
7.	Time Series: Forecasting, Simulation, Applications	Janacek, Gareth J., and Louise Swift	Ellis Horwood Limited	1993
8.	Simulation: A Statistical Perspective.	Kleijnen, J. P., & van Groenendaal, W	John Wiley & Sons, Inc.	1992
9.	Simulation Modeling and Analysis	Law, A. M., Kelton, W. D., & Kelton, W. D.	New York: McGraw-Hill press.	2000
10.	Stochastic Simulation	Ripley, B. D.	John Wiley & Sons.	2009

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-605-ii	Social Network Analysis	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Understand the concept of semantic web and related applications.
- Learn knowledge representation using ontology and visualization of social networks
- Understand human behaviour in social web and related communities.

Course Outcomes:

On completion of this course, the student will be able to:

- Develop semantic web related applications and visualize social networks.
- Represent knowledge using ontology.
- Predict human behaviour in social web and related communities.

Unit- I

Introduction: Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Web-based networks – Applications of Social Network Analysis.

Unit- II

Modelling, Aggregating and Knowledge Representation: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

Unit- III

Extraction and Mining Communities in Web Social Networks : Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – Multi-Relational characterization of dynamic social network communities.

Unit- IV

Predicting Human Behaviour and Privacy Issues: Understanding and predicting human behaviour for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and countermeasures.

Suggested Readings:

1.	Social Networks and the Semantic Web	Peter Mika	Springer, First Edition	2007
2.	Handbook of Social Network Technologies and Applications	Borko Furht	Springer, 1st Edition	2010
3.	Web Mining and Social Networking – Techniques and applications	Guandong Xu ,Yanchun Zhang and Lin Li	Springer, First Edition	2011
4.	Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively	Dion Goh and Schubert Foo	IGI Global Snippet	2008

5.	Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling	Max Chevalier, Christine Julien and Chantal Soulé-Dupuy	IGI Global Snippet	2009
6.	The Social Semantic Web	John G. Breslin, Alexander Passant and Stefan Decker	Springer	2009

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-605-iii	Cryptography and Network Security	4	4	70	30	100

Note: The syllabus is divided into four units. For the end semester examination, nine questions are to be set by the examiner. Question number one is compulsory and contains seven short answer questions covering entire syllabus. Rest eight questions are set by giving two questions from each of the unit of the syllabus. A candidate is required to attempt any of four questions selecting at least one from each of the four units. All questions carry equal marks. The duration of end semester examination is 3 hours.

Objectives:

The objectives of this course are to:

- Introduce fundamental concepts of symmetric and asymmetric cipher models.
- Introduce fundamental concepts of authentication.
- Introduce network security and web security protocols

Course Outcomes:

On completion of this course, the student will be able to:

- Identify mathematical concepts for different cryptographic algorithms and demonstrate cryptographic algorithms for encryption/key exchange
- Summarize different authentication and digital signature schemes
- Identify security issues in network, transport and application layers and outline appropriate security protocols

Unit I

Introduction Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security

Symmetric Encryption Symmetric Encryption Principles, Symmetric Block Encryption Algorithms (Data Encryption Standard, IDEA and Advanced Encryption Standard), Random and Pseudorandom Numbers, Stream Ciphers and RC4, Cipher Block Modes of Operation

Unit II

Message Authentication and Hash Functions Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes

Public Key Cryptography Public-Key Cryptography Principles, Public-Key Cryptography Algorithms: RSA, Diffie-Hellman, Elliptic Curve, Digital Signature Standard

Unit III

Key Distribution and User Authentication Kerberos, X.509 Certificates, Public-Key Infrastructure

Transport-Level Security Web Security Considerations, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS, Secure Shell (SSH)

Unit IV

Electronic Mail Security Pretty Good Privacy (PGP), S/MIME

IP Security IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations

Suggested Readings:

1.	Introduction to Computer and Network Security: Navigating Shades of Gray	Richard R. Brooks	1st Edition	2013
2.	Network Security: Private Communication in a public world	Charlie Kaufman, Radia Perlman and Mike Speciner	PrenticeHall PTR, 2nd Edition	2002
3.	Cryptography and Network Security	Atul Kahate	McGraw-Hill; Fourth edition	2019
4.	Cryptography and Network Security: Principles and Practice	William Stallings	Pearson, Seventh edition	2017

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	Internal	Total
BDS-606P	Practical Lab of Big Data Analytics	2	2 X 2=4	70	30	100

Note: An internal practical examination is conducted by the course coordinator. The end semester practical examination is conducted jointly by external and internal examiners.

Objectives:
The objectives of this lab course are to:

- Provides an overview of key technology used in manipulating, storing, and analyzing big data
- Impart necessary and practical knowledge of components of Big Data Analytics and develop skills required to build real-life based projects.
- Incorporates big data analytics and use of Hadoop

Course Outcomes:
On completion of this course, the student will be able to:

- Implement solutions for big data problem.
- Analyse the results of big data algorithms.
- Build and maintain reliable, scalable, distributed systems.

List of Experiments:

1. Installing and configuring Hadoop cluster.
2. Two experiments related to manipulating files in HDFS using Hadoop fs commands.
3. Two experiments related to Hadoop File Systems: IBM GPFS, MapR-FS, Lustre, Amazon S3 etc.
4. Writing an Inverted Index MapReduce Application.
5. Two experiments related to Distributed Cache MapReduce Design Patterns Sorting Joins.
6. Writing a streaming MapReduce job in Hadoop.

Note : The experiments must meet the objective of the course and the levels of the given course outcomes.

Paper Code	Nomenclature	Credit	Hours/ Week	Marks		
				External	**Internal**	**Total**
BDS-607P	Practical Lab of Computer Networks	2	2 X 2=4	70	30	100

Note: An internal practical examination is conducted by the course coordinator. The end semester practical examination is conducted jointly by external and internal examiners.

Objectives:

The objectives of this lab course are to:

- Provide the understanding of basic concepts of computer networking
- Acquire practical notions of protocols with the emphasis on TCP/IP
- Develop skills to configuring network devices (Switches, Routers etc), establishing Local area networks (LAN), implement different routing and wide area network (WAN) protocols.

Course Outcomes:

On completion of this course, the student will be able to:

- Understand fundamental underlying principles of computer networking
- Understand details and functionality of layered network architecture.
- Analyze performance of various communication protocols.

List of Experiments:

1. To familiarize with the Lab Network Topology.
2. To learn and observe the usage of different networking commands e.g. PING, TRACEROUTE.
3. To explore the working of netstat command.
4. To familiarize with the network packet sniffer, ethereal.
5. Case study of client/server scenario.
6. To explore the non-privileged mode of the installed routers.
7. To observe the working of TCP three-way-hand-shaking procedure.
8. To learn different congestion avoidance techniques.
9. To observe the working of IP protocol.
10. To explore Broadcast and Multicast routing.
11. To observe the working of Address Resolution Protocol (ARP).
12. To configure the routers for performing IP routing.