

Board of Studies in Computer Science

Curriculum Structure and Syllabus for III and IV Semesters

Bachelor of Computer Applications

in

Data Science

Choice Based Credit System

2024 - 25 onwards

Prof. G. S. S. S.

Acharya

Member

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THE CHIEF OFFICER
TUMKUR UNIVERSITY



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Bachelor of Computer Applications in Data Science

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Internal Assessment Marks for Theory and Practical

Internal Assessment Marks Allotment for Theory	
Internal Test 1	05
Internal Test 2	05
Assignment	05
Seminar/Quiz	05
TOTAL	20

Internal Assessment Marks Allotment for Practical	
Internal Test	05
Record and Attendance	05
TOTAL	10

Evaluation Scheme for Lab Examination

Assessment Criteria	
Writing 2 Programs	10
Execution of 2 Programs	20
Viva	10
Total	40 Marks

SEMESTER – III

Sl. No	Paper	Title of the Paper	Instruction Hrs. per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	BCADST 301	Statistics Using R Programming	4	4	3 Hrs.	20	80	100
2	BCADSP 302	Statistics Using R Programming Lab	4	2	3 Hrs.	10	40	50
3	BCADST 303	Linux Programming	4	4	3 Hrs.	20	80	100
4	BCADSP 304	Linux Programming Lab	4	2	3 Hrs.	10	40	50
5	BCADST 305	Database Management system	4	4	3 Hrs.	20	80	100
6	BCADSP 306	Database Management system Lab	4	2	3 Hrs.	10	40	50
Elective – 1 (Choose any one)								
7	BCADST 307 A	System Software	3	3	3 Hrs	20	80	100
	BCADST 307 B	Computer Architecture						
	BCADST 307 C	Mobile App Development						
	BCADST 307 D	Computer Networks						
TOTAL				21				550

NOTE:

Theory: 1 Hr. = 1 Credit Practical: 2 Hrs. = 1 Credit

BCADST: BCA Data Science Core Paper Theory

BCADSP: BCA Data Science Core Paper Practical

SEMESTER – IV

Sl. No	Paper	Title of the Paper	Instruction Hrs. per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	BCADST 401	Artificial Intelligence	4	4	3 Hrs.	20	80	100
2	BCADSP 402	Artificial Intelligence Lab	4	2	3 Hrs.	10	40	50
3	BCADST 403	Machine Learning	4	4	3 Hrs.	20	80	100
4	BCADSP 404	Machine Learning Lab	4	2	3 Hrs.	10	40	50
5	BCADST 405	Data Analysis with Python	4	4	3 Hrs.	20	80	100
6	BCADSP 406	Data Analysis with Python Lab	4	2	3 Hrs.	10	40	50
Elective – 2 (Choose any one)								
7	BCADST 407 A	Cloud Computing	3	3	3 Hrs.	20	80	100
	BCADST 407 B	Cyber Security						
	BCADST 407 C	Mobile Computing						
	BCADST 407 D	Internet of Things						
TOTAL				21				550

NOTE:

Theory: 1 Hr. = 1 Credit Practical: 2 Hrs. = 1 Credit

BCADST: BCA Data Science Core Paper Theory

BCADSP: BCA Data Science Core Paper Practical

Third Semester			
Subject Name: Statistics Using R Programming			
Subject code	BCADST 301	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

COURSE OBJECTIVES:

1. Understand R Environment & Syntax
2. Learn how to install and use R and RStudio
Understand data types, operators, and basic R syntax
3. This course provides a solid undergraduate foundation in both probability theory and mathematical statistics and at the same time provides an indication of the relevance and importance of the theory in solving practical problems in the real world
4. Manipulate data within R and to create simple graphs and charts used in introductory statistics

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Explore fundamentals of statistical analysis in R environment.
2. Describe key terminologies, concepts and techniques employed in Statistical Analysis.
3. Define Calculate, Implement Probability and Probability Distributions to solve a wide variety of problems.
4. Conduct and interpret a variety of Hypothesis Tests to aid Decision Making.
5. Understand, Analyse, and Interpret Correlation Probability and Regression to analyse the underlying relationships between different variables

Unit 1	Introduction of R programming language	Hours :15
	Introduction of R programming language: Introduction, Features of R, Data types in R: numeric, arithmetic, assignment, Operators, Data Objects in R : Arrays, Lists, vectors, Matrices and Data Frames, Factors Conditions and Loops: if, Switch, while, for, repeat loops, Strings handling in R, Calling Functions, Writing Functions, Exceptions,	
Unit 2	Reading and writing files	Hours :10
	Reading and writing files: Reading Tabular Data, Commands to Extract Rows and Columns, working with CSV files: reading, writing, analysis, working with JSON Files: reading, writing, Working with XML Files: reading, writing. Data cleaning and preparation with dplyr, Data transformation using tidyr, Date & Timings and Visibility, Packages in R.	
Unit 3	Statistics And Probability	Hours :15
	Statistics And Probability: Types of data-Primary and secondary data. Types of	

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	measurements: Nominal, ordinal, ratio, and interval. Classification and tabulation. R as a set of statistical tables: Statistics and Probability, Process of Descriptive Analysis, Average, Variance, Standard Deviation in R, Mean, Median and Mode in R, Covariance and Correlation in R, basic data visualization, probability, common probability distributions: common probability mass functions, bernoulli, binomial, poisson distributions, common probability density functions, uniform, normal, student's t-distribution.	
Unit 4	Statistical testing and modeling in R:	Hours :10
	Statistical testing and modeling in R: Sampling distributions, Hypothesis testing in R, components of hypothesis test, testing means, testing proportions, testing categorical variables, errors and power, Analysis of Variance.	
Unit 5	Regression	Hours :10
	Simple linear regression, multiple linear regression, linear model selection and diagnostics: Definition and Purpose of regression analysis Dependent vs independent variables, Types of regression Advanced graphics: plot customization, plotting regions and margins, point and click coordinate interaction, customizing traditional R plots, specialized text and label notation. Defining colors and plotting in higher dimensions, representing and using color, 3D scatter plots.	

TEXT BOOKS:

1. Maria Dolores Ugarte , Ana F. Militino , Alan T. Arnholt “Probability and Statistics with R” 2nd Edition on, CRC Press, 2016.
2. *Introductory Statistics with R* – Peter Dalgaard

REFERENCE BOOKS:

1. Vishwas R. Pawgi, “Statistical computing using R software”, Nirali prakashan publisher, 1st edition, 2022.
2. Tilman M. Davies, “The book of R: A first course in programming and statistics”, San Francisco,
3. <https://www.youtube.com/watch?v=KlsYCEWEWE>
<https://www.geeksforgeeks.org/r-tutorial/>
<https://www.tutorialspoint.com/r/index.htm>

Third Semester			
Subject Name: Statistics Using R Programming Lab			
Subject code	BCADSP 302	CIE Marks	10
No of Hours/Week:	4	SEE Marks	40
Total Hours:	60	Credits	2

LIST OF LAB PROGRAMS

Instructions: Install, Code and Use R Programming Language in R Studio IDE to perform basic tasks on Vectors, Matrices and Data frames. Explore fundamentals of statistical analysis in R environment.

PART A

1. Write a R program that include variables, constants, data types.
2. Write a R program for different types of data structures in R.
3. Write a R program for to compute mean, median, minimum, maximum, variance, standard deviation, skewness, kurtosis and quantities (Q1, Q2, Q3)
4. Implement R script to show the usage of various operators and control structures available in R language.
5. Implement R Script to perform matrix and vector operations.
6. Write a R program to find the factorial of a number using a user-defined function.
7. Write a R program to Read data from a CSV file and display summary statistics.
8. Write an R program to perform a Linear Search on a numeric vector. The program should:
 1. Accept a vector of numbers from the user
 2. Accept a key (number to search)
 3. Search for the key using linear search
 4. Display the position of the key if found, otherwise show “Element not found”

PART B

1. Write a R program for finding stationary distribution of Markov chains.
2. Write a R program for calculating cumulative sums, and products minima, maxima and calculus.
3. Write a R program for with any dataset containing data frame objects, indexing and sub setting data frames, and employ manipulating and analyzing data.
4. Write a R program for quick sort and creation of Binary Search Tree traversal implementation.
5. Write a R program for any visual representation of an object with creating graphs using graphic functions: Plot(), Boxplot(), Scatterplots().
6. Write a R program for any visual representation of an object with creating graphs using graphic functions: Hist(), Linechart(), Pie().
7. Write a R program Perform a chi-square test on a categorical dataset
8. Write a program to create an any application of Linear Regression in multivariate context for predictive purpose.

Third Semester			
Subject Name: Linux Programming			
Subject code	BCADST 303	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

COURSE OBJECTIVES:

1. To understand the fundamental concepts and techniques of Operating Systems
2. To know the features of Linux OS and learn the Linux commands
3. To gain knowledge about Linux administration
4. To learn basic set of commands in Shell Programming

COURSE OUTCOMES:

At the end of the course students will be able to:

1. An ability to understand basic concepts of operating system.
2. Execute Linux commands
3. Install packages and manage user accounts in Linux
4. Implement basic scripts in shell
5. Ability to write Shell Programming using Linux commands

Unit 1	Introduction to Operating System	Hours 10
	Definition - System Components - Operating System Services - System Calls and its types - Types of Operating System in various computing environments – Operating System Structure – Open Source Operating Systems.	
Unit 2	Introduction to Linux	Hours 12
	History, Basic features, architecture, distributions. Installing Linux, Logging in / Logging out. File System: Introduction to files, Organization, Assessing File systems, Structure - boot block, super block, inode block, data block. Basic and Advanced Commands: Directory oriented commands, File oriented commands, File access permissions: chmod, umask, chgrp, groups. General purpose commands.	
Unit 3	File management and Compression	Hours 14
	File management and Compression: Computer devices, Disk related commands: dd, du, df, dfspace, fdisk, compressing and uncompressing files. Manipulating Processes and Signals: Basics, process states and transitions, zombie and orphan processes, process oriented commands. Handling foreground and background jobs. Process scheduling using cron, crontab, at, batch. Changing priority. Signal generation and Handling. System calls: Files related system calls for opening, creating, reading, writing,	

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	relocating file descriptors, closing, duplicating file descriptors, linking, unlinking, accessing file status information, checking permissions, changing ownership, groups and permissions of files. Process related system calls: exec, fork, wait, exit.	
Unit 4	System Administration and Networking Tools	Hours 14
	<p>System Administration: Booting and shutting down process. Creating, mounting and unmounting file systems.</p> <p>Managing User accounts: creating, modifying & deleting user accounts and groups.</p> <p>Networking Tools: Communication oriented commands. ping, nslookup, telnet, arp, netstat, route, ftp, trivial file transfer protocol, finger, rlogin. C language compiler, the make command and makefiles, general debugging techniques, debugging with gdb.</p> <p>Pipes and filters: Connecting processes with pipes, redirecting input and output.</p> <p>Filters: sort, grep, egrep, fgrep, uniq, more, pr, cut, paste, tr.</p>	
Unit 5	Shell Programming	Hours 10
	Shell meaning & types; Introduction to shell scripting, shell variables, exporting shell variables, Escape mechanisms, Shell meta characters, read command, conditional statements, looping and case statements, expr statement, command line arguments, sleep and basename commands, Bourne Shell Commands, string handling, arrays, shell functions, shell programs to automate system tasks.	

TEXT BOOKS:

1. Abraham Silberschatz, Greg Gagne, Peter Galvin. Operating Systems Principles. John Wiley Publications. 2006. 7th Edition.
2. The Unix programming Environment by Brain W. Kernighan & Rob Pike, Pearson.
3. Fundamentals of Linux, 1 st Edition, Maidsani D, Firewall Media, 2010

REFERENCE BOOKS:

1. Andrew S Tanenbaum, Modern Operating Systems, Prentice Hall of India Learning. 2009. 3rd Edition.
2. Unix Concepts and Applications, 4 th Edition, Sumitabha Das, Tata McGraw Hill Publication, 2017
3. Shell Scripting: Expert Recipes for Linux, Bash and more, Steve Parker, Wrox Publication, 2011
4. Introduction to Unix Shell Programming by M.G.Venkateshmurthy, Pearson.

Third Semester			
Subject Name: Linux Programming Lab			
Subject code	BCADSP 304	CIE Marks	10
No of Hours/Week:	4	SEE Marks	40
Total Hours:	60	Credits	2

LIST OF LAB PROGRAMS

PART A

1. Study of Unix/Linux general purpose utility command list: man, who, cat, cd, cp, ps, ls, mv, rm, mkdir, rmdir, echo, more, date, time, kill, history, chmod, chown, finger, pwd, cal, logout, shutdown.
2. Write a shell script that displays a list of all the files in the current directory.
3. Write a shell script to count lines, words & characters in its input. Without using wc command.
4. Write a shell program to find out reverse string of the given string and check the given string is palindrome or not.
5. Write a shell program to find out factorial of the given number.
6. Write a shell script to find out whether the given number is prime number or not.
7. Write a shell script to compute GCD & LCM of two numbers.
8. Write a shell script to print file names in directory showing date of creation & serial no. of file.
9. Write a shell script that delete all lines containing a specified word.
10. Write a shell program to concatenate to two strings given as input and display the resultant string along with its string length

PART B

1. If the second filename exists, then the contents of the first filename should be appended to it. If the second file name does not exist then create a new file with the contents of the first file.
2. Write a shell script that computes the gross salary of an employee according to the following
 - 1) if basic salary is <1500 then HRA 10% of the basic and DA =90% of the basic
 - 2) if basic salary is >=1500 then HRA 500 and DA =98% of the basic.
3. Write a shell script that deletes all lines containing a specified word in one or more files supplied as arguments to it.

4. Write a shell script that displays a list of all the files in the current directory to which the user has read, write and execute permissions.
5. Write a shell script that receives any number of file names as arguments checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported.
6. Write a shell script that counts English language articles (a, an, the) in a given text file.
7. Write a C program that takes one or more file/directory names as command line input and reports following information A) File Type B) Number of Links C) Time of last Access D) Read, write and execute permissions
8. Write a C program to list every file in directory, its inode number and file name
9. Write a C program to create child process and allow parent process to display “parent” and the child to display “child” on the screen
10. Write a C program that illustrate communication between two unrelated process using named pipes

Third Semester			
Subject Name: Database Management System			
Subject code	BCADST 305	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

COURSE OBJECTIVES:

1. To understand the basic concepts and the applications of database systems.
2. To understand the design of database.
3. To understand the relational database design principles
4. To Master the basics of SQL and construct queries using SQL
5. To become familiar with the basic issues of transaction processing and concurrency control

COURSE OUTCOME:

At the end of the course students will be able to:

1. Explain the various database concepts and the need for database systems.
2. Identify and define database objects, enforce integrity constraints on a database using DBMS.
3. Demonstrate a Data model and Schemas in RDBMS.
4. Identify entities and relationships and draw ER diagram for a given real-world problem.
5. Convert an ER diagram to a database schema and deduce it to the desired normal form.
6. Formulate queries in Relational Algebra, Structured Query Language (SQL) for database manipulation.
7. Explain the transaction processing and concurrency control techniques.

Unit 1	Database Architecture	Hours 10
	Introduction to Database system applications. Characteristics and Purpose of database approach. People associated with Database system. Data models. Database schema. Database architecture. Data independence. Database languages, interfaces, and classification of DBMS.	
Unit 2	E-R Model	Hours 12
	Entity-Relationship modeling: E – R Model Concepts: Entity, Entity types, Entity sets, Attributes, Types of attributes, key attribute, and domain of an attribute. Relationships between the entities. Relationship types, roles and structural constraints, degree and cardinality ratio of a relationship. Weak entity types, E -R diagram.	
Unit 3	Relational Data Model	Hours 16
	Relational model concepts. Characteristics of relations. Relational model constraints: Domain constrains, key constraints, primary & foreign key constraints, integrity constraints and null values. <i>Relational Algebra:</i> Selection, projection, set operations, renaming, Joins ,Division, Relational calculus: Tuple relational Calculus, Domain relational calculus. <i>Introduction to SQL:</i> Overview of SQL, Data types, DDL, DML, DCL, TCL, Structure of SQL queries, Nested Sub queries, Joins, Views, Index and Triggers..	

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	Introduction to PL/SQL & programming of above operations in PL/SQL.	
Unit 4	Data Normalization	Hours 12
	Anomalies in relational database design. Decomposition. Functional dependencies. Normalization. First normal form, Second normal form, Third normal form. Boyce-Codd normal form. Higher Normal Forms - Introduction, Multi-valued dependencies and Fourth normal form, Join dependencies and Fifth normal form	
Unit 5	Query Processing Transaction Management	Hours 10
	Introduction Transaction Processing. Single user & multiuser systems. Transactions: read & write operations. Need of concurrency control: The lost update problem, Dirty read problem. Types of failures. Transaction states. Desirable properties (ACID properties) of Transactions. Concurrency Control Techniques: Locks and Time stamp Ordering.	

TEXT BOOKS:

1. Fundamentals of Database Systems, Ramez Elamassri, Shankant B. Navathe, 7th Edition, Pearson, 2015.
2. Database Systems Concepts, Abraham Silberschatz, Henry Korth, S.Sudarshan, 6th Edition, McGraw Hill, 2010.

REFERENCE BOOKS:

1. An Introduction to Database Systems, Bipin Desai, Galgotia Publications, 2010.
2. Introduction to Database System, C J Date, Pearson, 1999.
3. Database Management Systems, Raghu Rama Krishnan and Johannes Gehrke, 3rd Edition, McGraw Hill, 2002

Third Semester			
Subject Name: Database Management System Lab			
Subject code	BCADSP 306	CIE Marks	10
No of Hours/Week:	4	SEE Marks	40
Total Hours:	60	Credits	2

LIST OF LAB PROGRAMS

PART A

1. Execute DDL Commands

Consider the table:

STUDENT (regno number, name varchar2, dob date, marks number)

- a) Create the above table with suitable constraints.
- b) Remove the existing attribute marks from the table.
- c) Change the data type of regno from number to varchar2.
- d) Add a new attribute phno to the existing table.
- e) Insert 5 tuples into the table.
- f) Display the tuples in table

2. Execute DML Commands

Consider the table:

LIBRARY (bid number, title varchar2, author varchar2, publisher varchar2, yearof_pub number, price number)

- a) create the above table.
- b) Enter 5 tuples into the table.
- c) Display all the tuples from the table.
- d) Display different publishers from table.
- e) Update price of all books with 5% GST amount.
- f) Delete the details of book published by a specific Author.
- e) Arrange the tuples in the alphabetical order of book title.
- f) List the details of all books whose price range between 100 rs and 300 rs.

3. Execute DQL and group functions

Consider the table EMPLOYEE (EmpNo, EmpName, Dept, Salary, DOJ, Branch)

Perform the following operations:

- a) Create the table
- b) Insert 5 tuples into the table
- c) Retrieve average salary of all employee
- d) Retrieve number of employees
- e) Retrieve distinct number of employee
- f) Retrieve total salary of employee group by employee name and count similar names

g) Display details of employees whose salary is greater than 50000.

4. Demonstrate the use of TCL and DCL Commands:

TCL:

1. Create a table **accounts** (**account_id**, **account_holder_name**, **balance**)
2. Insert some sample data into the accounts table.
3. Start a transaction and perform the following operations:
 - Debit 1000 from account_id 1.
 - Credit 1000 to account_id 2.
4. Use the COMMIT command to save the changes.
5. Start a new transaction and perform the following operations:
 - Debit 500 from account_id 1.
 - Credit 500 to account_id 3.
6. Use the ROLLBACK command to undo the changes.
7. Create the save point and execute ROLLBACK TO previously created save point.

DCL:

1. Create a new user called user1 with a password.
2. Grant SELECT, INSERT, and UPDATE privileges on the accounts table to user1.
3. Login as user1 and perform the following operations:
 - Select data from the accounts table.
 - Insert a new row into the accounts table.
 - Update an existing row in the accounts table.
4. Revoke the INSERT privilege from user1.
5. Login as user1 and try to insert a new row into the accounts table.

5. Implement the Nested Queries.

An INVENTORY database has the following table.

ITEMS(itemcode number, name varchar2, price number)

PURCHASE(itemcode number, qty number)

- a) Create the tables with the above attributes.
- b) Enter 5 tuples into the tables.
- c) List the items purchased.
- d) List the items which are not purchased by anyone.

6. Implement Join operations in SQL

The COMPANY database consists of the tables:

EMPLOYEE (SSN, Name, Address, Sex, Salary, SuperSSN, DNo)

DEPARTMENT (DNo, DName, MgrSSN, MgrStartDate)

Create tables, Insert 5 tuples each and perform the following

- a) Give a 10 percent raise in salary for all employees working in the 'Research' Department.
- b) Retrieve the name of each employee Controlled by department number 5 (use EXISTS operator).
- c) Retrieve the name of each dept and number of employees working in each department which has at least 2 employees
- d) Retrieve the name of employees and their department name (using NATURAL JOIN)

- e) Perform EQUI join operation on the given tables.
- f) Perform NON-EQUI join operation on the given tables.
- g) Perform OUTER join operations on the given tables.

7. Create the following tables:

**Passenger(PassportID, Name, Age, Sex, Address) and
Reservation(PNRno, JourneyDate, Noofseats, Address, ContactNo.)**

Query the tables using ANY, ALL, IN, Exists, NOT EXISTS, UNION, INTERSECT etc.,

1. Display unique PNR_NO of all passengers
2. Display all the names of male passengers.
3. Display the ticket numbers and names of all the passengers.
4. Find the ticket numbers of the passengers whose name start with 'r' and ends with 'h'.
5. Find the names of Passengers whose age is between 30 and 45.
6. Display all the passengers names beginning with 'A'.
7. Display the sorted list of Passengers names

8. Create views for a particular table

The RAILWAY RESERVATION SYSTEM database consists of the tables:

TRAIN(TrainNo, TrainName, StartPlace, Destination)

AVAILABILITY(TrainNo, Class,StartPlace,Destination,No_of_seats)

- a) Create view sleeper to display train no, start place, destination which have sleeper class and perform the following
 - insert new record
 - update destination='Manglore' where train no='RJD16'
 - delete a record which have train no='KKE55'
- b) Create view details to display train no, train name, class
- c) Create view total_seats to display train number, start place, use count function to no of seats , group by start place and perform the following
 - insert new record
 - update start place='Hubli' where train no='JNS8'
 - delete last row of the view
- d) Rename view sleeper to class
- e) Delete view details

PART B

1. Write PL/SQL program to enter any two numbers and find out their sum, difference, product, quotient and remainder.
2. Write PL/SQL procedure to compute factorial of a number using recursion
3. Given the table EMPLOYEE (EmpNo, Name, Salary, Designation, DeptID) write a cursor in PL/SQL to select the five highest paid employees from the table.
4. Write PL/SQL program to increase the salary for the employees of a particular department and enter the no of records updated, date, time, deptno and name of the person who increased the salary into another table called cursor_ret.

5. Create a row level trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old & new Salary on UPDATE operation and display the new or old salary for INSERT and DELETE operations, respectively.

CUSTOMERS(ID,NAME,AGE,ADDRESS,SALARY)

6. Given the table MOVIE(MID,MTitle, Language,Director,Year) write a function in PL/SQL to find the total number of Movies in the table.
7. Given the Table CUSTOMERS(CID,CName, Address) write a PL/SQL program which asks for customer ID, if the user enters invalid ID then the exception **invalid_id** is raised.
8. Write a PL/SQL program to demonstrate Packages.

Third Semester			
Elective - 1			
Subject Name: System Software			
Subject code	BCADST 307 A	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. Understand the role and structure of system software and differentiate it from application software.
2. Explore language processors, their functions, and development tools used in language processing.
3. Gain knowledge of internal data structures like search and allocation data structures used in language processing.
4. Identify various software tools such as editors, debug monitors, and user interface tools that assist in software development.
5. Comprehend the concepts and design of assemblers, including single-pass and two-pass assembler mechanisms.

COURSE OUTCOME:

At the end of the course students will be able to:

1. Explain the fundamental concepts of system software including language processing activities and language processor tools.
2. Describe and apply various data structures used in language processing, such as search and allocation structures.
3. Demonstrate the use of software tools like editors, debuggers, and programming environments in software development.
4. Understand the elements and structure of assemblers, including design and implementation of single-pass and two-pass assemblers.
5. Analyze macro definitions and expansions, and design a macro processor with advanced features.

	Introduction to System Software and software tools	8 Hours
Unit 1	Language Processors: Introduction, Language Processing Activities, Fundamentals of Language Processing & Language, Specification, Language Processor Development Tools. Data Structures for Language Processing: Search Data structures, Allocation Data Structures, Software Tools: Software Tools for Program Development, Editors, Debug Monitors, Programming Environments, User Interfaces.	
Unit 2	Assemblers	8 Hours

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	Elements of Assembly Language Programming, A Simple Assembly Scheme, Pass Structure of Assemblers, Design of a Two Pass Assembler, A single pass Assembler for IBM PC.	
Unit 3	Macros and Macro Processors	9 Hours
	Macro Definition and Call, Macro Expansion, Nested Macro Calls, Advanced Macro Facilities, Design of a Macro Preprocessor.	
Unit 4	Interpreters and Introduction of Compilers	8 Hours
	Interpreters: Use and overview of interpreters, Pure and impure interpreters, Phases of the Compiler, Introduction of scanning and parsing, Aspects of compilation.	
Unit 5	Linkers and Loaders	8 Hours
	Introduction to linkers, Relocation and Linking Concepts, Design of a Linker, Self-Relocating Programs, A Linker for MS-DOS, Linking for Overlays and Loaders.	

TEXT BOOK:

1. D. M. Dhamdhere, "Systems Programming and Operating Systems", Second Revised Edition, Tata McGraw-Hill, 1999.

REFERENCE BOOKS:

1. Leland L. Beck, "System Software – An Introduction to Systems Programming", 3rd Edition, Pearson Education Asia, 2000.
2. Santanu Chattopadhyay, "System Software", Prentice-Hall India, 2007

Third Semester			
Elective – 1			
Subject Name: Computer Architecture			
Subject code	BCADST 307 B	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. This course introduces the students to the fundamental concepts of digital computer organization, design and architecture.
2. It aims to develop a basic understanding of the building blocks of the computer system and highlights how these blocks are organized together to architect a digital computer system.

COURSE OUTCOMES:

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

1. Design and Simplify Combinational and sequential circuits using basic building blocks.
2. Represent data in binary form, convert numeric data between different number systems and perform arithmetic operations in binary.
3. Explain instruction cycle, pipelining and interrupts.
4. Explain data communication between CPU, memory and I/O devices.
5. Simulate the design of a basic computer using a software tool.

Unit 1	Digital Logic Circuits	8 Hours
	Logic Gates, Truth Tables, Boolean Algebra, Digital Circuits, Combinational Circuits, Introduction to Sequential Circuits, Circuit Simplification using Karnaugh Map, Don't Care Conditions, Flip-Flops, Characteristic Tables, Excitation Table.	
Unit 2	Digital Components (Fundamental building blocks)	10 Hours
	Designing of combinational circuits- Half Adder, Full Adder, Decoders, Encoders, Multiplexers, Registers and Memory (RAM, ROM and their types), Arithmetic Microoperations, Binary Adder, Binary Adder-Subtractor.	
Unit 3	Data Representation and Basic Computer	8 Hours

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	Arithmetic	
	Number System, r and (r-1)'s Complements, data representation and arithmetic operations.	
Unit 4	Basic Computer Organization and Design	8 Hours
	Bus organization, Micro programmed vs Hardwired Control, Instruction Codes, Instruction Format, Instruction Cycle, Instruction pipelining, Memory Reference, Register Reference and Input Output Instructions, Program Interrupt and Interrupt Cycle.	
Unit 5	Processors	11 Hours
	General register organization, Stack Organization, Addressing Modes, Overview of Reduced Instruction Set Computer (RISC), Complex Instruction Set Computer (CISC), Multicore processor and Graphics Processing Unit (GPU) Memory hierarchy (main, cache and auxiliary memory), Input-Output Interface, Modes of Transfer: Programmed I/O, Interrupt initiated I/O, Direct memory access.	

TEXT BOOKS

1. David A. Patterson and John L. Hennessy. "Computer Organization and Design: The Hardware/Software interface", 5th edition, Elsevier, 2012.
2. Mano, M. Computer System Architecture, 3rd edition, Pearson Education, 1993.

REFERENCE BOOKS

1. Mano, M. Digital Design, Pearson Education Asia, 1995.
2. Null, L., & Lobur, J. The Essentials of Computer Organization and Architecture. 5th edition. (Reprint) Jones and Bartlett Learning, 2018.
3. Stallings, W. Computer Organization and Architecture Designing for Performance 8th edition, Prentice Hall of India, 2010.

Third Semester			
Subject Name: Mobile Application Development			
Subject code	BCADST 307 C	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. To provide foundational understanding of the Android development environment, including the setup of Android Studio, AVDs, and essential tools for building applications.
2. To teach the structure and core components of Android applications, such as activities, services, intents, and permissions, with emphasis on Android app design principles.
3. To enable hands-on experience with Android APIs, UI/UX components, and data handling techniques using SQLite, Content Providers, and Web APIs for real-world deployment.

COURSE OUTCOMES:

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

1. Develop and deploy basic Android applications using Android Studio with proper setup of layouts, permissions, and manifest settings.
2. Design responsive and user-friendly Android user interfaces, implement animations, and manage multiple device configurations and resources.
3. Integrate core Android APIs, including database management, data sharing, and networking features, to create fully functional mobile applications for real-world use.

Unit 1	Android OS Design and Features	8 Hours
	Introduction to Android development framework: Key SDK features, Installing and running applications using Android Studio ,Creating Android Virtual Devices (AVDs),Types of Android applications, Best practices in Android programming, Common Android tools, Building your first Android application	
Unit 2	Introduction to Android development framework	10 Hours
	Important Android terms , Understanding Application Context ,Core components: Activities, Services, and Intents , Receiving and broadcasting intents, Android Manifest File and its main settings, Using Intents and Filters ,Working with Permissions.	
Unit 3	Android User Interface (UI) Design Essentials	10 Hours
	UI screen elements overview, Designing layouts for different screen sizes ,Working with various UI components, Using drawing tools and animations	

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	in UI, Managing Android application resources, Testing and publishing Android apps, Using preferences and handling multiple resource types	
Unit 4	Using Common Android APIs	10 Hours
	Data and storage APIs in Android, Using SQLite database, Sharing data between apps with Content Providers, Basics of Android Networking APIs, Using Web APIs in Android apps ,Deploying applications to the real world	
Unit 5	Consuming Web Services	7 Hours
	Consuming Web Services Using HTTP-Consuming JSON Services- Creating Your Own Services - Binding Activities to Services -Understanding Threading.	

TEXTBOOKS:

1. Lauren Darcey & Shane Conder, *Android Wireless Application Development*, Pearson Education, 2nd Ed. (2011).
2. Reto Meier, *Professional Android 2 Application Development*, Wiley India Pvt. Ltd.

REFERENCE BOOKS:

1. Barry Burd, *Android Application Development All-in-One for Dummies*, Edition I.
2. Wei-Meng Lee, *Beginning Android 4 Application Development*, Wiley India (Wrox), 2013.

Third Semester			
Elective - 1			
Subject Name: Computer Networks			
Subject code	BCADST 307 D	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. Fundamentals of data communication networks.
2. Software and hardware interfaces
3. Application of various physical components and protocols
4. Communication challenges and remedies in the networks.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Define various data communication components in networking.
2. Describe networking with reference to different types of models and topologies..
3. Understand the need for Network and various layers of OSI and TCP/IP reference model.
4. Explain various Data Communications media.
5. Describe the physical layer functions and components
6. Identify the different types of network topologies and Switching methods.
7. Describe various Data link Layer Protocols.
8. Identify the different types of network devices and their functions within a network.

Unit 1	Introduction	Hours 7
	Introduction: Computer Network: Definition, Goals, Structure; Broadcast and Point-To- Point Networks; Network Topology and their various Types; Types of Network, Network software, Design issues for the layers, Connection-oriented vs. Connectionless service, Applications of Computer network, The OSI Reference Model, The TCP/IP Protocol suite, Comparison between OSI and TCP/IP Reference model.	
Unit 2	Physical Layer	Hours 10
	Physical Layer: Functions of Physical Layer, Analog signals, Digital signals, Transmission Impairment, Data Rate Limits, and Performance. Data Transmission Media: Guided Transmission Media, Magnetic Media, Twisted Pairs, Coaxial Cable, Power Lines, Fiber Optics, Wireless Transmission, Electromagnetic Spectrum, Radio Transmission, Microwave Transmission, Infrared Transmission, Light Transmission,	
Unit 3	Data Link Layer	Hours 10
	Data Link Layer: Functions of Data Link Layer, Data Link Control: Framing, Flow and Error Control, Error Detection and Correction, High-Level Data Link Control (HDLC) & point-to-Point protocol(PPP), Channel Allocation Problem,	

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	Multiple Access: Radom Access(ALOHA, CSMA, CSMA/CD, CSMA/CA), Controlled Access(Reservation, Polling, Token Passing	
Unit 4	Transport layer:	Hours 10
	Transport Layer: Functions of Transport Layer, Elements of Transport Protocols: Addressing, Flow Control & Buffering, Error Control, Multiplexing & De-multiplexing, User Datagram Protocol (UDP): User Datagram, UDP Operations, Uses of UDP, RPC, Principles of Reliable Data Transfer: Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocol, Go Back-N(GBN)	
Unit 5	Application Layer	Hours 8
	Application layer: Functions of Application layer, Application Layer Protocols: DNS, DHCP, WWW, HTTP, HTTPS, TELNET, FTP, SMTP,	

TEXT BOOKS:

1. Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw-Hill, Fourth Edition
2. William Stallings, Data and Computer Communications, 7th Edition, PHI.

REFERENCE BOOKS:

1. Larry L. Peterson, Bruce S. Davie, -Computer Networks: A Systems Approachll, Morgan Kaufmann Publishers, Fifth Edition, 2011.
2. Brijendrasingh, Data Communication and Computer Networks, PHI.
3. Andrew S Tanenbaum, David. J. Wetherall, -Computer Networks, Pearson Education, 5th Edition,
4. Kurose and Ross, Computer Networking- A Top-Down approach, Pearson, 5th edition
5. Douglas E.Comer, "Internetworking with TCP / IP – Principles, Protocols and Architectures, Fourth Edition, Prentice – Hall of India Private Limited, 2002.
6. <http://highered.mheducation.com/sites/0072967757/index.html>

Fourth Semester			
Subject Name: Artificial Intelligence			
Subject code	BCADST 401	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

COURSE OBJECTIVES:

1. To understand the primitives of AI
2. To familiarize Knowledge Representation Issues
3. To understand fundamentals of Statistical Reasoning, Natural Language Processing.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Identify the problems where the adaptation of AI has significant impact.
2. Analyze the different approaches of Knowledge Representation.
3. Explain Symbolic Reasoning under Uncertainty and Statistical reasoning.
4. Derive the importance of different types of Learning Techniques.
5. Explain Natural Language Processing and Expert System.

Unit 1	Introduction	10 Hours
	What is artificial intelligence? The Foundations of Artificial Intelligence. The History of Artificial, Applications of AI, AI vs Machine Learning vs Deep Learning, Intelligent Agents: structure, types.	
Unit 2	Problem Solving and Search Techniques	15 Hours
	Problem Solving and Search Techniques: Problem-solving methods, State-space representation, Uninformed search strategies: BFS, DFS, Depth-limited, Iterative deepening, Informed search strategies: Greedy, A*, Heuristic functions, Constraint satisfaction problems (CSPs)	
Unit 3	Knowledge Representation and Reasoning	15 Hours
	Knowledge Representation and Reasoning: Propositional and First-order Logic, Inference rules, Semantic networks and frames, Ontologies and Description Logic, Introduction to reasoning under uncertainty: Bayesian Networks, Statistical reasoning.	
Unit 4	NLP Basics	10Hours
	NLP basics: syntax, semantics, pragmatics, Text preprocessing, Tokenization,	

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	stemming, lemmatization, POS tagging and parsing, Sentiment analysis basics.	
Unit 5	Expert System	10 Hours
	Learning, Expert Systems: Components of an expert system, Rule-based systems, Inference engines, Applications of expert systems, AI Applications and Ethics: AI in robotics, healthcare, finance, and education, Ethical issues in AI: bias, transparency, job displacement.	

TEXT BOOKS:

1. E. Rich, K. Knight & S. B. Nair, Artificial Intelligence, 3rd Edition, McGraw Hill.,2009
2. Prateek Joshi, Artificial Intelligence with Python, Standard Edition (27 January 2017); CBS Publishers And Distributors Pvt. Ltd

REFERENCE BOOKS:

1. Stuart Rusell, Peter Norving, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, 1st Edition, Prentice Hal of India, 2015
3. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem Solving, 4th Edition, Pearson Education, 2002.
4. N.P. Padhy “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2015

Fourth Semester			
Subject Name: Artificial Intelligence Lab			
Subject code	BCADSP 402	CIE Marks	10
No of Hours/Week:	4	SEE Marks	40
Total Hours:	60	Credits	2

LIST OF LAB PROGRAMS

Instructions:

Software and Tools:

- Familiarize yourself with Python, Jupyter Notebook, Anaconda, TensorFlow, PyTorch, OpenCV, and other relevant tools.
- Use the designated IDEs like VS Code, Spyder, or Colab for coding tasks.

PART A

1. Installation and running of python codes with hello world and simple accessing user inputs from console examples.
2. Use of Python List methods for Stack and Queue implementation, for examples, append() and pop().
3. Use of NumPy array methods: arrange(), shape(), ndim(), size(), add(), subtract(), multiply(), divide(), mat() etc.
4. Use of NumPy matrix multiplication methods: dot(), matmul(), multiply() etc.
5. Linear search and binary search in an array.
6. Generation of random numbers in python following a Gaussian distribution and filling up random arrays.
7. Plotting Gaussian distribution with a given mean and standard deviation.

PART B

1. Implement and Demonstrate Depth First Search Algorithm on Water Jug Problem.
2. Implement and Demonstrate Best First Search Algorithm on Missionaries-Cannibals Problems using Python.
3. Implement A* Search algorithm.
4. Implement AO* Search algorithm.
5. Solve 8-Queens Problem with suitable assumptions.
6. Implementation of TSP using heuristic approach.
7. Implementation of the problem-solving strategies: either using Forward Chaining or Backward Chaining.
8. Implement resolution principle on FOPL related problems.
9. Implement Tic-Tac-Toe game using Python.
10. Build a bot which provides all the information related to text in search box.

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Fourth Semester			
Subject Name: Machine Learning			
Subject code	BCADST 403	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

Course Objectives

- 1) Understand the fundamental concepts and applications of machine learning.
- 2) Identify and differentiate between supervised, unsupervised, and reinforcement learning.
- 3) Apply preprocessing techniques and perform feature selection and dimensionality reduction.
- 4) Implement and evaluate regression and classification models using real-world data.
- 5) Apply clustering algorithms and interpret the outcomes effectively.
- 6) Use appropriate tools and libraries (like Scikit-learn, Pandas, Matplotlib) for ML model building.

Course Outcomes

- 1) Explain the core concepts and categories of machine learning.
- 2) Preprocess data and apply feature engineering techniques.
- 3) Develop and evaluate regression models for prediction tasks.
- 4) Design and compare classification models using various algorithms.
- 5) Perform unsupervised learning using clustering methods.
- 6) Demonstrate practical skills through hands-on implementation of ML algorithms.

Unit 1	Fundamentals of Machine Learning	Hours 10
	Introduction to Machine Learning and its importance, Human vs. Machine Learning paradigms, Applications in Data Science, Data Mining, and Big Data Analytics, Core concepts and terminologies in Machine Learning, Categories of Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Key challenges and scope of ML	
Unit 2	Data Preparation and Feature Engineering,	Hours 14
	Data Collection methods and sources, Data Preprocessing: Handling missing values, encoding, normalization/standardization, Feature Selection Techniques: Subset Selection, Ranking Methods, Decision Tree-based feature importance, Entropy and Information Gain, Exhaustive Search, Best-First, Greedy Forward and Backward, Dimensionality Reduction Techniques: PCA, LDA.	
Unit 3	Regression Techniques	Hours 12
	Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Interpreting Regression Output: Coefficients, R ² score, P-values and significance testing groups and permissions of files. Process related system calls: exec, fork, wait, exit.	
Unit 4	Classification Algorithms	Hours 14
	Logistic Regression, K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Naïve Bayes Classifier, Decision Tree Classifier, Random Forest Classifier,	
Unit 5	Clustering Techniques	Hours 10
	k-Means Clustering: Initialization traps, Elbow method for selecting clusters, Hierarchical Clustering: Agglomerative vs Divisive, Dendrograms and Linkage methods	

TEXT BOOKS:

1. "Introduction to Machine Learning with Python", Andreas C. Müller & Sarah Guido, O'Reilly
2. "Machine Learning" Tom M. Mitchell, McGraw-Hill.
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", Author: Aurélien Géron, O'Reilly

REFERENCE BOOKS:

1. "Pattern Recognition and Machine Learning", Christopher M. Bishop, Springer
2. "Understanding Machine Learning: From Theory to Algorithms", Shai Shalev-Shwartz and Shai Ben-David, Cambridge University Press

Fourth Semester			
Subject Name: Machine Learning Lab			
Subject code	BSCDST 404	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

Lab Exercises (Using Python/Jupyter Notebook):

- 1) Data Preprocessing & EDA: Handle missing data, normalize features, and visualize dataset.
- 2) Feature Selection using Decision Trees: Apply entropy and information gain methods.
- 3) Dimensionality Reduction with PCA & LDA: Visualize results using 2D projection.
- 4) Simple & Multiple Linear Regression: Predict numerical output, evaluate MSE and R².
- 5) Polynomial Regression: Model nonlinear patterns and compare with linear regression.
- 6) Classification using Logistic Regression and KNN: Measure accuracy and confusion matrix.
- 7) Support Vector Machine and Naïve Bayes: Build classifiers and analyze performance.
- 8) Decision Tree and Random Forest Classifier: Visualize trees and analyze feature importance.
- 9) k-Means Clustering: Apply elbow method and interpret clustering output.
- 10) Hierarchical Clustering: Generate dendrograms and compare with k-means.

Machine Learning Project Topics

Based on the **Machine Learning syllabus**, here are **10 project work suggestions** that align well with the course outcomes, lab exercises, and real-world applicability. These projects reinforce theoretical concepts while encouraging hands-on practice using tools like Python, Scikit-learn, Pandas, and Matplotlib. Students are instructed to submit any one project from the following Machine Learning Project Topics.

1. House Price Prediction using Regression
2. Student Performance Classification.
3. Customer Segmentation using Clustering
4. Diabetes Prediction System.
5. Fake News Detection
6. Sales Forecasting using Time-based Regression
7. Movie Recommendation System Using Clustering
8. Employee Attrition Prediction
9. Credit Card Fraud Detection
10. Handwritten Digit Classification (MNIST Dataset)

Guidelines

- All lab exercises must be submitted as Jupyter Notebooks (.ipynb) or .py files.
- Include output screenshots for each task.
- Final mini-project to be submitted as a report + code notebook.

Fourth Semester			
Subject Name: Data Analysis with Python			
Subject code	BCADST 405	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

Course Objectives

1. To develop the ability to analyze data using Python.
2. To understand data manipulation, cleaning, and preprocessing techniques.
3. To apply statistical tools for extracting meaningful insights.
4. To build effective data visualizations.
5. To conduct exploratory and inferential data analysis on real-world datasets.

Course Outcomes

Upon successful completion, students will be able to:

1. Understand the data analysis process and Python’s role in it.
2. Clean, manipulate, and preprocess structured datasets using Python libraries.
3. Visualize data insights effectively using Matplotlib and Seaborn.
4. Apply statistical concepts and test hypotheses on datasets.
5. Analyze real-world problems using data and communicate insights.

Unit 1	Introduction to Data Analysis	Hours 10
	What is Data Analysis, Types of Data: Structured vs Unstructured Data, Qualitative vs Quantitative, Continuous vs Discrete, Time-series vs Cross-sectional data, Data Analysis Process: Data Collection, Data Cleaning, Data Exploration (EDA), Data Modeling (basic concepts only), Interpretation and Reporting, Skills Required for Data Analysis, Tools and Libraries Used in Python: NumPy, Pandas, Matplotlib, Seaborn, (Optional: Scikit-learn for further analysis), Sources of Data: CSV, Excel files, Databases (SQL), APIs and Web scraping, Public datasets (Kaggle, UCI, etc.) Challenges in Data Analysis: Missing or inconsistent data, Data bias, Choosing the right model or visualization, Data privacy and ethics	
Unit 2	Data Handling with Python	Hours 14
	Python as a Data Analysis Tool, Jupyter Notebooks and Working with Environments, Loading and Saving Data (CSV, Excel, JSON, APIs), Python Lists, Dictionaries, Loops, Functions NumPy: Arrays and Operations, Indexing, Slicing, Vectorization. Pandas: Series and DataFrames Reading and Writing Files, Filtering, Sorting, Grouping, Handling Missing and Duplicate Data, Data Transformation: merge, join, pivot, melt.	
Unit 3	Data Cleaning & Preprocessing	Hours 12
	Importance of Clean Data, Detecting and Handling: Missing Values, Outliers, Inconsistent Data, Data Encoding: Label Encoding, One-Hot Encoding, Feature Scaling: Min-Max, Standardization, Data Type Conversion	
Unit 4	Data Visualization	Hours 14
	Purpose of Visualization in Data Analysis, Matplotlib: Line, Bar, Scatter, Histogram, Plot Customization, Seaborn: Boxplot, Violin Plot, Heatmap, Pairplot, Styling and Themes Introduction to Interactive Visualization, Plotly.	
Unit 5	Exploratory and Statistical Data Analysis	Hours 10
	Central Tendency: Mean, Median, Mode, Dispersion: Range, Variance, Standard Deviation, Correlation & Covariance, Cross-tabulations and Pivot Tables, Sampling Methods, Hypothesis Testing: t-test, ANOVA, Chi-square	

TEXT BOOKS:

1. "Introduction to Machine Learning with Python", Andreas C. Müller & Sarah Guido, O'Reilly
2. "Doing Data Science Cathy O'Neil & Rachel Schutt".
3. "Python for Data Analysis Wes McKinney

REFERENCE BOOKS:

1. Python Data Science Handbook, Jake VanderPlas
2. Interactive Data Visualization for the Web Scott Murray

Fourth Semester			
Subject Name: Data Analysis with Python Lab			
Subject code	BCADST 406	CIE Marks	20
No of Hours/Week:	4	SEE Marks	80
Total Hours:	60	Credits	4

1: Python Refresher

Write a Python program to:

- Create a list, tuple, dictionary and perform basic operations (add, delete, update).
- Define a function to compute factorial of a number using recursion.
- Read and write a text file using file handling.

2: NumPy Basics

Write a program to:

- Create NumPy arrays and perform slicing, indexing, and reshaping.
- Perform element-wise operations (addition, multiplication) on arrays.
- Use NumPy to calculate mean, median, standard deviation of a dataset.

3: Working with Pandas – DataFrames

Using the **Titanic** dataset or any sample dataset:

- Load the dataset using `pd.read_csv()`
- Display basic information: shape, columns, data types.
- Filter rows where `Age > 30`.
- Sort the data based on `Fare` in descending order.

4: Data Cleaning and Missing Values

Using a dataset with missing values:

- Identify missing values using `isnull()`
- Fill missing values with mean/median.
- Drop columns or rows with too many null values.
- Detect and handle duplicate rows.

5: Data Transformation and Encoding

Using a dataset with categorical variables:

- Perform label encoding and one-hot encoding.
- Normalize/standardize numerical columns.
- Combine multiple datasets using merge and join operations.

6: Data Visualization with Matplotlib

Write a program to:

- Plot a line chart, bar chart, histogram, and scatter plot using Matplotlib.
- Customize plots: add title, labels, legends, grid, and color.

7: Data Visualization with Seaborn

Using the **Iris dataset** or Titanic:

- Create a boxplot of sepal length by species.
- Plot a heatmap of correlation matrix.
- Generate pairplot for all numeric variables.
- Customize plot aesthetics using Seaborn themes.

8: Descriptive Statistics

Write a program to compute:

- Mean, median, mode, variance, standard deviation of a dataset.
- Correlation between two numeric columns.
- Covariance matrix of a DataFrame.

9: Hypothesis Testing

Using a sample or real dataset:

- Perform a one-sample t-test to compare mean of a column to a fixed value.
- Perform a two-sample t-test between two groups (e.g., male vs. female fares).
- Apply chi-square test for independence between two categorical columns.

10: Exploratory Data Analysis (EDA) Project

Choose any dataset (from [Kaggle](#), UCI, etc.) and perform:

- Data loading and inspection
- Data cleaning and preprocessing
- Visual exploration of features
- Statistical summary and correlation analysis
- Write a summary report or present findings

Sample Datasets to be used

- Titanic Dataset (titanic.csv)
- Iris Dataset (iris.csv)
- COVID-19 Dataset
- Sales Data
- Superstore Dataset

Guidelines

- All lab exercises must be submitted as Jupyter Notebooks (.ipynb) or .py files.
- Include output screenshots for each task.
- Final mini-project to be submitted as a report + code notebook.

Fourth Semester			
Elective – 2			
Subject Name: Cloud Computing			
Subject code	BCADST 407 A	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	3	Credits	3

COURSE OBJECTIVES:

1. Understand the fundamentals of cloud computing including cloud models (public, private, hybrid) and key building blocks.
2. Gain insight into virtualization concepts, types, benefits, and how virtualization supports cloud infrastructure.
3. Learn how to set up a private cloud using open-source tools and plugins, including cloud provisioning and tool integrations.
4. Understand the relationship between IoT and Cloud Computing, and how they integrate in real-world applications.

COURSE OUTCOMES:

At the end of the course students will be able to:

1. Explain the fundamentals of cloud computing, virtualization concepts, and different types of cloud environments (public, private, hybrid).
2. Set up and configure a private cloud using open-source tools, and integrate tools like Docker and Nagios.
3. Differentiate between Cloud Computing, IoT, and Fog Computing, and describe their roles in modern IT infrastructures.
4. Demonstrate how to connect IoT devices to the cloud, manage cloud storage, and handle data communication protocols and APIs.
5. Analyze real-time IoT-cloud applications including device-to-cloud communication, data normalization, and infrastructure management.

	Introduction to Cloud	8 Hours
Unit 1	Virtualization concepts, Types of Virtualization & its benefits, Introduction to Various Virtualization OS, HA/DR using Virtualization, Moving VMs, Cloud Fundamentals, Cloud Building Blocks, Understanding Public & Private cloud environments, Private Cloud Environment, Public Cloud Environment, Managing Hybrid Cloud environment.	
Unit 2	The Cloud Setup	8 Hours

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	Setting up your own Cloud: Build private cloud using open source tools, Understanding various cloud plugins, Setting up your own cloud environment, Auto-provisioning, Custom images, Integrating tools like Nagios, Integration of Public and Private cloud. Micro services using Docker	
Unit 3	IoT and the Cloud	8 Hours
	Introduction to cloud computing, Difference between Cloud Computing and IoT, Fog Computing: The Next Evolution of Cloud Computing, Role of Cloud Computing in IoT. Living on the Edge, An Abstract Edge Architecture Model, Connecting devices at the edge and to the cloud	
Unit 4	Connecting Things to Cloud	8 Hours
	Various Real time applications of IoT, Connecting IoT to cloud, Cloud Storage for Iot. Cloud-to-Device Connectivity, Device Ingress/Egress, Data Normalization and Protocol Translation, Infrastructure, APIs, The Topology of the Cloud.	
Unit 5	Challenge in Integration of Things with Cloud	10 Hours
	Security, Scalability, Reliability, Performance, Mobility, Resource Optimization & cost efficiency, Cloud data management, cloud data monitoring, Cloud data Exchange, Infrastructure Configuration & reconfiguration, IoT Overarching Challenges.	

TEXT BOOKS:

1. Biron, J., & Follett, J. (2016). Foundational elements of an iot solution. O'Reilly Media, Incorporated
2. Buyya, R., Broberg, J., & Goscinski, A. M. (Eds.). (2010). Cloud computing: Principles and paradigms (Vol. 87). John Wiley & Sons.

REFERENCE BOOK:

1. Hwang, K., Dongarra, J., & Fox, G. C. (2013). Distributed and cloud computing: from parallel processing to the internet of things. Morgan kaufmann.

Fourth Semester			
Elective - 2			
Subject Name: Cyber Security			
Subject code	BCADST 407 B	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. This course introduces the students to the fundamental concept of Cyber security and issues and challenges associated with it.
2. It aims to develop a basic understanding of the basic security aspects related to Computer and Mobiles. They will be able to use basic tools and technologies to protect their devices.

COURSE OUTCOMES:

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

1. After completion of this course, students would be able to understand the concept of Cyber security and issues and challenges associated with it.
2. After completion of this course, students would be able to understand the concept of Cyber security and issues and challenges associated with it.
3. On completion of this course, students should be able to appreciate various privacy and security concerns on online Social media and understand the reporting procedure of inappropriate content, underlying legal aspects and best practices for the use of Social media platforms.
4. After the completion of this module, students would be able to understand the basic concepts related to E-Commerce and digital payments. They will become familiar with various digital payment modes and related cyber security aspects, RBI guidelines and preventive measures against digital payment frauds.

Students, after completion of this module will be able to understand the basic security aspects related to Computer and Mobiles. They will be able to use basic tools and technologies to protect their devices.

Unit 1	Introduction to Cyber security	10 Hours
	Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.	
Unit 2	Cyber-crime and Cyber law	10 Hours

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	Classification of cybercrimes, Common cybercrimes- cyber-crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi, Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments,	
Unit 3	Social Media Overview and Security	10 Hours
	Introduction to Social networks Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content.	
Unit 4	E- Commerce and Digital Payments	8 Hours
	Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Advantage of e-commerce, Survey of popular e-commerce sites. Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures.	
Unit 5	Security	7 Hours
	End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third-party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.	

TEXT BOOKS:

1. Cyber Crime Impact in the New Millennium, by R. C Mishra, Auther Press. Edition 2010.
2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by SumitBelapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011).
3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson , 13th November, 2001)

REFERENCE BOOKS:

1. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
2. Fundamentals of Network Security by E. Maiwald, McGraw Hill.
3. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.

Fourth Semester			
Elective - 2			
Subject Name: Mobile Computing			
Subject code	BCADST 407 C	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. To introduce the field of mobile communication and focuses on digital data transfer.
2. To address how mobile phone system works.
3. To understand the technology in wireless local area networks.
4. To focuses on mobility influencing applications, security, or IP networks

COURSE OUTCOMES:

1. An ability to understand the field of mobile communication.
2. An ability to understand how mobile phone system works
3. This course aims to understand the technology in wireless local area networks and its latest trends.

Unit 1	Introduction	09 Hours
	Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA- Different Generations of Wireless Networks- 1G, 2G, 3G, 4G,5G.	
Unit 2	Mobile Telecommunication System	09 Hours
	Introduction to Cellular Systems – GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security – GPRS- UMTS – Architecture – Handover – Security.	
Unit 3	Mobile Network Layer	09 Hours
	Mobile IP – DHCP – AdHoc– Proactive protocol-DSDV, Reactive Routing Protocols – DSR, AODV, Hybrid routing –ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET) –MANET Vs VANET – Security	
Unit 4	Mobile Transport and Application Layer	10 Hours
	Traditional TCP, Classical TCP Improvements: Indirect TCP-Snooping TCP, Mobile TCP-Fast retransmit/fast recovery- Transmission /time-out freezing- Selective retransmission-Transaction oriented TCP-Wireless Application Protocol (WAP) –Architecture – XML – WML Script – Applications	
Unit 5	Mobile Platforms And Applications	08 Hours

	Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues
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TEXT BOOKS:

1. Jochen Schiller, —Mobile Communications, PHI, Second Edition, 2003.

2. Prasant Kumar Pattnaik, Rajib Mall, —Fundamentals of Mobile Computing, PHI Learning Pvt.Ltd, New Delhi – 2012

REFERENCE BOOKS:

1. Dharma Prakash Agarwal, Qing and An Zeng, —Introduction to Wireless and Mobile systems, Thomson Asia Pvt Ltd, 2005.

2. Android Developers: <http://developer.android.com/index.html>

3. Apple Developer: <https://developer.apple.com/>

4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, —Principles of Mobile Computing, Springer, 2003.

5. William. C.Y.Lee —Mobile Cellular Telecommunications-Analog and Digital Systems, Second Edition, Tata McGraw Hill Edition ,2006.

Fourth Semester			
Elective - 2			
Subject Name: Internet of Things			
Subject code	BCADST 407 D	CIE Marks	20
No of Hours/Week:	3	SEE Marks	80
Total Hours:	45	Credits	3

COURSE OBJECTIVES:

1. To understand the concepts of Internet of Things and the application of IoT.
2. To Determine the Market perspective of IoT.
3. To Understand the vision of IoT from a global context

COURSE OUTCOME:

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

1. Use of Devices, Gateways and Data Management in IoT.
2. Design IoT applications in different domain and be able to analyze their performance
3. Implement basic IoT applications on embedded platform.

Unit 1	IoT & Web Technology	10 Hours
	The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.	
Unit 2	M2M to IoT	10 Hours
	A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, The international driven global value chain and global information monopolies.M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	
Unit 3	IoT Architecture	8 Hours

Bachelor of Computer Applications in Data Science

	Introduction, State of the art, Architecture. Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.	
Unit 4	IoT Applications for Value Creations	10 Hours
	Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	
Unit 5	IoT Privacy, Security and Governance	7 Hours
	Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.	

TEXT BOOK:

1. Vijay Madiseti and ArshdeepBahga, "Internet of Things: (A Hands-on Approach)", Universities Press (INDIA) Private Limited 2014, 1st Edition.

REFERENCE BOOKS:

1. Michael Miller, "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", Pearson Education 2015.
2. Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications 2013, 1st Edition.
3. Walteneus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley 2014.
4. CunoPfister, "Getting Started with the Internet of Things", O'Reilly Media 2011.

**Question Paper Pattern for Semester End Examination (SEE)
(Common for III and IV Semester)
SUBJECT NAME**

Time: 3 Hrs

Max. Marks: 80

Instruction to Candidate: Answer all the Sections

SECTION A

I. Answer any ten of the following questions (10X2 = 20)

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.

SECTION B

II. Answer any five of the following questions (5X5 = 25)

- 13.
- 14.
- 15.
- 16.
- 17.
- 18.
- 19.

SECTION C

III. Answer any five of the following questions (5X7 = 35)

- 20.
- 21.
- 22.
- 23.
- 24.
- 25.
- 26.

