ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by
NAAC Recognized by UGC as College of Excellence

ST. JOSEPH'S INSTITUTE OF INFORMATION TECHNOLOGY

DEPARTMENT OF ADVANCED COMPUTING

SYLLABUS FOR UNDERGRADUATE PROGRAMME

SUMMARY OF CREDITS IN BCA(Data Analytics) - NEP
Revision Year - 2021

Department of Advanced Computing (UG)						
Semester 1	**Code Number**	**Title**	**No. of Hours of Instructions per semester**	**Number of Hours of teaching per week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCADA1121	Fundamentals of computing and programming skills using C	45	03	03	60-2Hrs
Theory	BCADA1221	Exploratory Data Analysis Using Excel	45	03	03	60-2Hrs
Theory	BCADA1321	Discrete Mathematics I	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Theory	OE 01	Basics of Data Science	45	03	03	60-2Hrs
Theory	OE 02	Python Programming	45	03	03	60-2Hrs
Practical	BCADA1P1	C Programming Lab	60	04	02	25- 4 Hrs
Practical	BCADA1P2	Data Analysis Lab (Excel)	60	04	02	25- 4 Hrs
Total Number of credits:			**19**			

Semester 2	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCADA2121	Principles and Practices of Data Science Using R	45	03	03	60-2Hrs
Theory	BCADA2221	Advanced Statistical Computing Using R	45	03	03	60-2Hrs
Theory	BCADA2321	Discrete Mathematics II	45	03	03	60-2Hrs
Theory		Language I	45	03	03	60-2Hrs
Theory		Language II	45	03	03	60-2Hrs
Theory	OE 3	Machine Learning using R programming	45	03	03	60-2Hrs
Theory	OE 4	Digital design using HDL	45	03	03	60-2Hrs
Practical	BCADA2P1	Data Science Lab (Using R)	60	04	02	25- 4 Hrs
Practical	BCADA2P2	Statistical Computing Lab (Using R)	60	04	02	25- 4 Hrs
Total Number of credits:			**22**			

Semester 3	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCADA3121	Python for Data Analytics	45	03	03	60-2Hrs

Theory	BCAD A3221	Econometrics	45	03	03	60-2Hrs
Theory	BCAD A3321	Mathematics III	45	03	03	60-2Hrs
Theory	OE 5	Business and Data Understanding	45	03	03	60-2Hrs
Theory	OE 6	Database Management System	45	03	03	60-2Hrs
Practical	BCAD A3P1	Python for Data Analytics	60	04	02	25- 4 Hrs
Total Number of credits:					**14**	
Semester 4	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCAD A4121	Database Management System	45	03	03	60-2Hrs
Theory	BCAD A4221	OS using Linux	45	03	03	60-2Hrs
Theory	BCAD A4321	Multivariate Statistics	45	03	03	60-2Hrs
Practical	BCAD A4P1	Database Management System Lab	60	04	02	25- 4 Hrs
Practical	BCAD A4P2	Multivariate Statistics Lab	60	04	02	25- 4 Hrs
Theory	OE 7	Visualization techniques using Tableau	45	03	03	60-2Hrs
Total Number of credits:					**16**	
Semester 5	**Code Number**	**Title**	**No. of Hours of Instruction**	**Number of teaching**	**Number of credits**	**Max marks for SE -**

			s	hrs /week		duration of examination
Theory	BCAD A5121	Java for Data Analytics	45	03	03	60-2Hrs
Theory	BCAD A5221	Machine Learning	45	03	03	60-2Hrs
Theory	BCAD A5321	Computer Networks	45	03	03	60-2Hrs
Theory	OSE 01	Design and Analysis of Algorithm	45	03	03	60-2Hrs
Practical	BCAD A5P1	Java for Data Analytics Lab	60	04	02	25- 4 Hrs
Practical	BCAD A5P2	Machine Learning Lab	60	04	02	25- 4 Hrs
Total Number of credits:					**16**	
Semester 6	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCAD A6121	Optimization Techniques	45	03	03	60-2Hrs
Theory	BCAD A6221	AI & Deep Learning	45	03	03	60-2Hrs
Theory	BCAD A6321	AI & IOT	45	03	03	60-2Hrs
Theory	OSE 02	Cloud Computing	45	03	03	60-2Hrs
Practical	BCAD A6P1	Optimization Techniques Lab	60	04	02	25- 4 Hrs
Practical	BCAD A6P2	AI & Deep Learning Lab	60	04	02	25- 4 Hrs

Total Number of credits:					**16**	
Semester 7	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCADA7121	Basics of Computer Vision	45	03	03	60-2Hrs
Theory	BCADA7221	Natural Language Processing	45	03	03	60-2Hrs
Theory	OE 8	Research Methodology	45	03	03	60-2Hrs
Practical	BCADA7P1	Basics of Computer Vision Lab	60	04	02	25- 4 Hrs
Practical	BCADA7P2	Natural Language Processing Lab	60	04	02	25- 4 Hrs
Total Number of credits:					**13**	
Semester 8	**Code Number**	**Title**	**No. of Hours of Instructions**	**Number of teaching hrs /week**	**Number of credits**	**Max marks for SE - duration of examination**
Theory	BCADA8121	Speech Processing and analytics	45	03	03	60-2Hrs
Theory	BCADA8221	Cognitive Science and analytics	45	03	03	60-2Hrs
Practical	BCADA8P1	Research Project	90	06	03	25- 4 Hrs
Theory	OSE 03	AI and Robotics	45	03	03	60-2Hrs
Total Number of credits:					**12**	

Course Outcomes and Course Contents

SEMESTER I

Semester	I
Paper Code	BCADA1121
Paper Title	FUNDAMENTALS OF COMPUTING AND PROGRAMMING SKILLS USING C
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

The course is oriented to those who want to learn the fundamental concepts associated with the digital logic and circuit design and programming basics using C programming language as an implementation tool. It introduces the basic concepts and laws involved in the Boolean algebra and logic families and digital circuits and familiarize with the different number systems. Apart from learning digital basics it will provide students with understanding of programming essentials, including algorithms, data types, elementary control structures and functions used within the framework of imperative and structural programming paradigms.

COURSE OUTCOMES:

CO1: To understand different number systems and their conversions and to analyse and minimize Boolean expressions.

CO2: Understanding foundation concepts of information and information processing in computer systems: a matter of information, data representation, coding systems, Algorithm and Flowchart.

CO3: Understanding of programming language syntax and its definition by example of C language with the knowledge of basic principles of imperative and structural programming.

CO4: To gain insight knowledge of Functions, Arrays, Structures and Unions.

CO5: Learn the basics of pointers, File operations and Data Structures.

UNIT 1: INTRODUCTION TO DIGITAL ELECTRONICS **10 Hrs.**

INTRODUCTION TO DIGITAL ELECTRONICS, NUMBER SYSTEMS, OPERATIONS AND CODES

Introduction, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Binary Arithmetic, 1's and 2's Complements of Binary Numbers, signed numbers, Arithmetic operations with signed numbers, Hexadecimal Numbers, Octal numbers, Binary Coded Decimal(BCD), Digital Codes.

LOGIC GATES, BOOLEAN ALGEBRA AND LOGIC SIMPLIFICATION

The Inverter, the AND Gate, the OR gate, the NAND Gate, the NOR Gate, the Exclusive-OR and Exclusive-NOR Gates, Basics of Digital Integrated Circuits. Boolean Operations and Expressions, Laws and Rules of Boolean Algebra, DE Morgan's Theorems, Boolean Analysis of Logic Circuits, Simplification Using Boolean Algebra, Standard Forms of Boolean Expressions, Boolean Expressions and Truth Tables, The Karnaugh Map, Karnaugh Map SOP Minimization, POS Minimization.

UNIT 2: BASICS OF PROGRAMMING **7 Hrs.**

Introduction – The Problem-Solving aspect – Steps in Problem Solving – Types of Problems – Types of Programming Methodologies – Types of Computer Languages – Compiler – Interpreter – How to Write Algorithms – Implementation of Algorithms – Analysis of Algorithms – Flowchart – Pseudocode

UNIT 3: INTRODUCTION TO C LANGUAGE **9 Hrs.**

Overview of C – Constants, Variables and Data Types – Operators and Expressions – Managing Input / Output Operations – Formatted I/O – Decision Making - Branching –- IF, Nested IF – Switch – goto - Looping- While, do, for statements.

UNIT 4: ARRAYS, FUNCTIONS, STRUCTURES AND UNIONS **9 Hrs.**

Arrays – dynamic and multi-dimensional arrays - Character arrays and Strings – String handling Functions - User defined Functions – Categories of Functions – Recursion - Structures and Unions – Array of Structures – Structures and Functions

UNIT 5: POINTERS, FILES, DATA STRUCTURES **10 Hrs.**

Pointers – Declaration, Accessing a variable, character strings, pointers to functions and structures – Basic File Operations – Sorting – Searching – Stack – Queue - Trees

TEXTBOOKS:

1. M. Morris Mano "Digital Logic and Computer Design", Pearson, 2013.
2. Harry H. Chaudhary, "C Programming The ultimate way to learn the fundamentals of the C language", MIT- Createspace Inc. O-D-Publishing, LLC USA, 2016

3. Yashavant P. Kanetkar, “Let us C”, Fifth edition, BPB Publications, 2006

4. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, Computer Science Press, 2012

SUGGESTED BOOKS:

1. Thomos L. Floyd, “Digital Fundamentals”, Tenth Edition, Pearson, 2015.
2. V. Anton Spraul, “Think Like a Programmer – An Introduction to Creative Problem Solving”, no starch press, 2014
3. Deitel and Deitel "C How to Program ", Sixth edition, Pearson, 2017

Code number: **BCADA 1121**

Title of the paper: **FUNDAMENTALS OF COMPUTING AND PROGRAMMING SKILLS USING C**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	07	10
Unit III	09	20
Unit IV	09	10
Unit V	10	20
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	I
Paper Code	BCADA1221
Paper Title	EXPLORATORY DATA ANALYSIS USING EXCEL

Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

- To apply principles of study design and data collection
- Produce and Interpret graphical summaries of data
- Graphically and numerically describe the relation between two or more variables

COURSE OUTCOME:

Upon successful completion of this course student should be able to

CO1: Understand the basic concepts of data and its measure
CO2: Develop the basic understanding of probability and random variable
CO3: Understand the usage of different probability distributions
CO4: Evaluate relationship among variables and using the same for prediction
CO5: Develop analytical ability to solve real-world problems using these methodologies.

UNIT 1: STATISTICS –AN OVERVIEW 9 Hrs.

Need for data, types of data, principles of measurement, sources of data, classification, tabulation and graphical presentation of data, Measures of central tendency: objectives of Averaging, requisites of a measure of Central Tendency, Mathematical Averages: mean, median and mode and quartiles, Measures of dispersion: significance of Measuring Dispersion, different measures of variation: range, variance, standard deviation, mean deviation, quartile deviation

UNIT 2: FUNDAMENTALS OF PROBABILITY 9 Hrs.

Concepts, the parallels between sets and events, Axioms of probability, Probability problems using permutations and combinations, The additive law, the idea of independence, Conditional probability, Bayes Theorem (simple problems. Problems involving conditional probability and dependence)**,** theory of random variables, expectation and variance of random variables, idea of dependent random variables.

UNIT 3: PROBABILITY DISTRIBUTIONS 9 Hrs.

Discrete Probability Distributions: Binomial, Poisson, Negative Binomial Distribution, Hypergeometric Distribution, Continuous Probability Distribution: Normal, Exponential Chi square, t and F distributions,

Central Limit Theorem, Fitting distributions to data

UNIT 4: CORRELATION ANALYSIS **9 Hrs.**

Significance of measuring correlation, types of correlation, methods of correlation analysis, partial and multiple correlation

UNIT 5: REGRESSION **9 Hrs.**

Some important information about straight lines, the method of least squares, assessing the goodness of fit, assessing each individual predictor - Case Studies related to the above discussed topics using Excel

TEXTBOOKS:

1. Statistics for Managers Using Microsoft Excel, Eighth Edition, David M. Levine, David F. Stephan Kathryn A. Szabat, Pearson Publications

SUGGESTED BOOKS:

1. A First Course in Statistics, Eighth Edition, Ronald Ross. Pearson
2. Probability and Statistics, Second Edition Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, Schuam Outline Series, Mac Graw Hill
3. Business Statistics, Second Edition, Pearson Education India.

Code number: **BCADA1221**

Title of the paper: **EXPLORATORY DATA ANALYSIS USING EXCEL**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
	45	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	I
Paper Code	BCADA1321
Paper Title	DISCRETE MATHEMATICS I
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

Introduce concepts of mathematical logic for analyzing propositions, concepts of set theory, relations and functions, concepts of calculus and its applications.

COURSE OUTCOME:

CO1: Acquaint the students with mathematical/logical fundamentals including numerical techniques

CO2: Solve problems involving recurrence relations and generating functions.

CO3: Explain the relationship between the derivative and linear approximation.

CO4: Able to define the various concepts of graphs and its implementations

CO5: Solve the real life problems using finite state machines

UNIT 1: MATHEMATICAL LOGIC **9 Hrs.**

Basic Connectives and Truth Tables, Logic Equivalence – The Laws of Logic, Logical Implication – Rules of Inference, Fundamentals of Logic, The Use of Quantifiers, Quantifiers

UNIT 2: SET, RELATION AND FUNCTION **9 Hrs.**

Sets and Subsets, Set Operations and the Laws of Set Theory, Cartesian Products and Relations, Function: One-to-One, Onto Functions, Function Composition and Inverse Functions, Countable and Uncountable Sets,

UNIT 3: DIFFERENTIAL CALCULUS OF ONE VARIABLE **9 Hrs.**

Basic properties of Functions: Functions and Their Graphs, Shifting and Scaling Graphs, Limits and Continuity: Limit of a functions and Limit laws, One sided Limit continuity, Limits involving infinity, Asymptotes of Graphs, Derivatives - Tangent Lines and derivative at a Point, The derivative as a function, Differentiation rules, The Chain Rule, Implicit Differentiation, Application of Derivatives: Extreme values of a functions on Closed Intervals, The Mean Value Theorem, Monotonic Functions and First Derivative Test, Concavity and Curve Sketching.

UNIT 4: GRAPH THEORY **9 Hrs.**

Introduction to Graphs: Definition of Graph, Loop, Simple Graph, Graph as Models, Path and Cycle, Complete Graph, Bipartite Graph, Digraph, Tree, Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycle, Shortest path algorithms

UNIT 5: FORMAL LANGUAGES AND FINITE-STATE MACHINES **9 Hrs.**

Idea about formal languages, finite state machine
Case studies

TEXT BOOKS:

1. "Thomas's Calculus" Pearson, 14th Edition by Joel Hass, Christopher Heil, Maurice D Weir
2. "Introduction to Graph Theory" PHI Learning Pvt Ltd 2012, by Douglas B West
3. "Introduction to Real Analysis" Sarat Book Distributors, 2018, by S K Mapa

SUGGESTED BOOKS:

1. Discrete Mathematics with Applications by Thomas Koshy
2. Discrete Mathematics with Applications by Susanna S. Epp
3. Higher Engineering Mathematics by B.S.Grewal

Code number: **BCADA1321**

Title of the paper: **DISCRETE MATHEMATICS I**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
	45	**80**

Maximum marks for the paper (Excluding bonus questions) = 60

Semester	I
Paper Code	BCADA1P1
Paper Title	C PROGRAMMING LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

1. Implementation of Basic Data types in C.
2. Implementation of various operators in C.
3. Implementation of Decision-making statement and Looping statement.
4. Execution of Break, Continue and Switch case statements.
5. Creation of functions in C.
6. Implementing array in C.
7. Creation of Unions and Structures in C.
8. Creation of Pointers in C.
9. Various File Operations in C.
10. Various sorting algorithms in C.
11. Various searching algorithms in C.
12. Stack and Queue implementation.
13. Implementation of Tree in C.

Semester	I
Paper Code	BCADA1P2
Paper Title	DATA ANALYSIS LAB (EXCEL)
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

1. Understanding Excel Interface for data Analysis : Getting Stated with Excel , Working with Data
2. Using the fill , series and column commands, Conditional Formatting in Excel
3. Using the visualization tools like charts and graphs in Excel for data comprehension
4. Using the summary statistics in Excel
5. Understanding the variations in data set using Excel commands
6. Creating random numbers in an Excel Spreadsheet
7. Generating probability distributions in Excel
8. Using Excel to understand relationship among Variables
9. Using regression as a prediction tool in Excel
10. Case Study 1
11. Case Study 2

SEMESTER II

Semester	II
Paper Code	BCADA2121
Paper Title	PRINCIPLES AND PRACTICES OF DATA SCIENCE USING R
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

To make the students learn the process of working with data in large scale. Make the student understand the existence of data with its wilderness and make use of it.

COURSE OUTCOME:

CO1: Understand the fundamental concepts of data.

CO2: Understand the fundamental concepts of data science process.

CO3: Understand the fundamental concepts of Machine Learning

CO4: Fundamental concepts of large data & Data Visualization

CO5: To gain knowledge about the recent trends of Data Science.

UNIT 1: PREPARING AND GATHERING DATA AND KNOWLEDGE 9 Hrs.

Philosophies of data science - Data science in a big data world - Benefits and uses of data science and big data - facts of data- Overview of the data science process- Retrieving data –Data Preparation: Cleansing, integrating, and transforming data - Exploratory data analysis – Data Modeling: Model and variable selection, Model execution, Model diagnostic and model comparison - Presentation and automation: Presenting data, Automating data analysis

UNIT 2: BIG DATA 9 Hrs.

Problems when handling large data – General techniques for handling large data – Case study – Steps in big data – Distributing data storage and processing with Frameworks – Case study.

UNIT 3: MACHINE LEARNING **9 Hrs.**

Application for machine learning in data science- Tools used in machine learning- Modeling Process – Training model – Validating model – Predicting new observations –Types of machine learning Algorithm : Supervised learning algorithms, Unsupervised learning algorithms.

UNIT 4: DATA VISUALIZATION **9 Hrs.**

Introduction to data visualization – Data visualization options – Filters – MapReduce – Dashboard development tools – Creating an interactive dashboard with dc.js-summary.

UNIT 5 : ETHICS AND RECENT TRENDS **9 Hrs.**

Data Science Ethics – Doing good data science – Owners of the data - Valuing different aspects of privacy - Getting informed consent - The Five Cs – Diversity – Inclusion – Future Trends.

TEXTBOOKS:

1. Introducing Data Science, Davy Cielen, Arno D. B. Meysman and Mohamed Ali, Manning Publications, 2016.
2. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
3. Think Like a Data Scientist, Brian Godsey, Manning Publications, 2017.
4. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O' Reilly, 1st edition, 2018.

SUGGESTED BOOKS:

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

Code number: **BCADA2221**

Title of the paper: **PRINCIPLES AND PRACTICES OF DATA SCIENCE USING R**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	II
Paper Code	BCADA2221
Paper Title	ADVANCED STATISTICAL COMPUTING USING R
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE:

- To apply principles of sampling in data collection
- Learn the techniques of estimation
- Apply the regression techniques in solving real life problems

COURSE OUTCOME:

Upon successful completion of this course student should be able to -

CO1: Understand the basic concepts of sampling methods.
CO2: Understand the estimation procedures
CO3: Develop the skill to differentiate between parametric and non-parametric tests

CO4: Understand the use of multiple regression for prediction
CO5: Develop analytical ability to solve real-world problems using these methodologies

UNIT 1: SAMPLING AND SAMPLING DISTRIBUTIONS 9 Hrs.
Principles of Sampling, Sampling methods, Sampling Distributions: mean, difference and proportions

UNIT 2: ESTIMATION AND CONFIDENCE INTERVALS 9 Hrs.
Point Estimation, properties and drawback, Confidence Interval Estimation of population mean and proportions

UNIT 3: HYPOTHESIS TESTING 9 Hrs.
General Procedure, Errors in Hypothesis Testing, testing related to parametric test like Z test, t –test, non-parametric statistics: advantages and limitations, the Chi-Square Distribution, applications of Chi-Square Test Statistic, Mann Whitney U-Test

UNIT 4: MULTIPLE REGRESSION ANALYSIS 9 Hrs.
Assumptions, the basics, testing the accuracy of models, robust regression: bootstrapping, reporting the regression results, regression with categorical data, dummy coding

UNIT 5: ANALYSIS OF VARIANCE 9 Hrs.
One Way and Two-Way Classification, assumptions, logic of F Ratio, post hoc procedures and violations of test assumptions - Case Study related to the above discussed topics using R

TEXTBOOK:

1. Statistical Inference: P. J. Bickel and K. A. Docksum, 2nd Edition, Prentice Hall.
2. Introduction to Linear Regression Analysis: Douglas C. Montgomery
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013

SUGGESTED BOOK:

1. Computer Age Statistical Inference by Bradley Efron and Trevor Hastie
2. Introduction to Statistical Learning by Gareth James

Code number: **BCADA2221**

Title of the paper: **ADVANCED STATISTICAL COMPUTING USING R**

Chapter	Number of	Total marks for which the questions are to be asked (including bonus

	Hours	questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	80
Maximum marks for the paper (Excluding bonus question) =60		

Semester	II
Paper Code	BCADA 2321
Paper Title	DISCRETE MATHEMATICS II
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course will enable students to acquire further skills in the techniques of linear algebra, as well as understanding of the principles underlying the subject. This course will prepare students for further courses in mathematics and/or related disciplines.

COURSE OUTCOMES:

CO1: Use matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.

CO2: Understand vector spaces and related topics arising in magnification and rotation of images.

CO3: Students should understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus

UNIT 1: MATRICES **15 Hrs.**

System of linear equation, Row reduction and echelon forms, vector equation, Matrix equation, Solution sets of linear systems, Linear Independence, Introduction to Linear Transformation, The matrix of a Linear Transformation.

Matrix Operations, The Inverse of a matrix, Characterization of Invertible Matrices, Subspaces of R^n and Dimension and rank.

UNIT 2: VECTOR SPACES **15 Hrs.**

Vector spaces, subspaces, Null spaces, Column Spaces and Linear Transformation, linearly independent set and Bases, Coordinate system, The dimension of a vector space, Rank, Change of Basis, Eigenvectors and Eigenvalues, The characteristic equation, Diagonalization,

UNIT 3: INTEGRAL CALCULUS **15 Hrs.**

Area and Estimating with Finite Sums, Limits of Finite, The Definite Integral, The Fundamental Theorem of calculus, Area sums, Indefinite Integral and Substitution Method, Area between curves, Arc Length

Area of Surface Revolution, Techniques of Integration , Geometric significance of integration.

Case Studies

TEXT BOOKS:

1. "Linear Algebra and its Applications," 3rd edition, Pearson Education (Asia) Pte. Ltd,2005. David C. Lay
2. "Thomas's Calculus" Pearson, 14th Edition by Joel Hass, Christopher Heil, Maurice D Weir

SUGGESTED BOOKS:

1. “Discrete Mathematics with Applications” By Thomas Koshy
2. “Discrete Mathematics with Applications” By Susanna S. Epp
3. “Linear Algebra with Applications, 8th Edition By Steve Leon
4. “Introduction to Linear Algebra with Applications By James DeFranza, Daniel Gagliardi
5. “Introduction to Automata Theory, Languages and Computation – Hopcroft, Ullman, Pearson Education
6. “Linear Algebra,” 2nd edition, Pearson Education (Asia) Pte. Ltd/2004. Kenneth Hoffman and Ray Kunze

Code number: **BCADA2321**

Title of the paper: **DISCRETE MATHEMATICS II**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	15	30
Unit II	15	30
Unit III	15	20
TOTAL	**45**	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	II
Paper Code	BCADA2P1
Paper Title	DATA SCIENCE LAB (USING R)
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

1. Creating and manipulating vector in R
2. Creating matrix and manipulating matrix in R
3. Operations on Data Frames in R

4. Operations on Lists in R.
5. Programs on If – else statements in R
6. Programs on For Loops in R.
7. Customizing and Saving to Graphs in R.
8. PLOT Function in R to customize graphs
9. 3D PLOT in R to customize graphs
10. Implement in R Programming the concept to find Sum, Mean and Product of a Vector, ignore element like NA or NaN.
11. Implement in R Programming the concept to find missing values.
12. Implement the concept to create a list of data frames and access each of those data frames from the list using R.
13. Implement the concept of matrix multiplication and addition using R.
14. Implement linear regression model and compare predicted value with actual value using Visualization.
15. Implement logistic regression model and compare predicted value with actual value using Visualization.
16. Implement k-means clustering.

Semester	II
Paper Code	**BCADA2P2**
Paper Title	**STATISTICAL COMPUTING LAB (USING R)**
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

1. Getting Started with R environment : downloading , installing , using scripts , R workspace, installing packages in R
2. Getting data into R workspace : creating variables, creating data frames , organizing data

3. Manipulating Data : selecting parts of a data frame , data frames and matrices
4. Exploring data with graphs in R
5. Exploring the assumptions of normality in R
6. Understanding Interval Estimation in R
7. Parametric and Non-Parametric Tests in R
8. Testing the Regression models for accuracy
9. Comparing means Using ANOVA
10. Case Study 1
11. Case Study 2

OPEN ELECTIVES

Semester	I
Paper Code	OE 1
Paper Title	BASICS OF DATA SCIENCE
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

To make the students learn the process of working with data in large scale. Make the student understand the existence of data with its wilderness and make use of it.

COURSE OUTCOMES:

CO1: Understand the fundamental concepts of data.

CO2: Understand the fundamental concepts of data science process.

CO3: Understand the fundamental concepts of Machine Learning

CO4: Fundamental concepts of large data & Data Visualization

CO5: To implement the aspects of Data Science through case studies.

UNIT 1: PREPARING AND GATHERING DATA AND KNOWLEDGE 9 Hrs.

Philosophies of data science - Data science in a big data world - Benefits and uses of data science and big data - facts of data: Structured data , Unstructured data, Natural Language, Machine generated data, Audio, Image and video streaming data - The Big data Eco system: Distributed file system, Distributed Programming framework, Data Integration frame work, Machine learning Framework, NoSQL Databases, Scheduling tools, Benchmarking Tools, System Deployment, Service programming and Security.

UNIT 2: THE DATA SCIENCE PROCESS 9 Hrs.

Overview of the data science process- Retrieving data –Data Preparation: Cleansing, integrating, and transforming data - Exploratory data analysis – Data Modeling: Model and variable selection, Model execution, Model diagnostic and model comparison - Presentation and automation: Presenting data, Automating data analysis

UNIT 3: MACHINE LEARNING 9 Hrs.

Application for machine learning in data science- Tools used in machine learning- Modeling Process – Training model – Validating model – Predicting new observations –Types of machine learning Algorithm : Supervised learning algorithms, Unsupervised learning algorithms.

UNIT 4: VISUALIZATION 9 Hrs.

Introduction to data visualization – Data visualization options – Filters – MapReduce – Dashboard development tools.

UNIT 5: CASE STUDIES 9 Hrs.

Distributing data storage and processing with frameworks - Case study: e.g, Assessing risk when lending money.

TEXT BOOKS:

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

SUGGESTED BOOKS:

1. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, O' Reilly, 1st edition, 2013.

2. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Cambridge University Press, 2nd edition, 2014
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013

Code number: **OE 1**

Title of the paper: **BASICS OF DATA SCIENCE**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	II
Paper Code	OE 2
Paper Title	PYTHON PROGRAMMING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

COURSE OUTCOMES:

CO1: To understand the basic concepts in Python programming.

CO2: Learn how to write, debug and execute Python program.

CO3. Understand and demonstrate the use of Branching and Looping Structures.

CO4: To get insight knowledge related to advanced data types such as lists, tuples, dictionaries.

CO5: Acquire the basic knowledge of Object-Oriented Programming Concept and Exception Handling.

UNIT 1: INTRODUCTION **9 Hrs.**

Introduction to Python Programming, History of Python, its features, Scope of Python, Downloading and installing Python, Python code execution process, run a simple program on Python interpreter and IDLE.

UNIT 2: DATA TYPES AND OPERATORS **9 Hrs.**

The concept of data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages; Illustrative programs.

UNIT 3: BRANCHING AND LOOPING **10 Hrs.**

Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation. Illustrative programs

UNIT 4: LISTS, TUPLES AND DICTONARIES **10 Hrs.**

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values, Illustrative programs

UNIT 5: OOPS AND EXCEPTION HANDLING **7 Hrs.**

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, exception handling, Illustrative programs

TEXTBOOKS:

1. Python in easy steps - Mike McGrath, In Easy Steps Limited, Second Edition

2. “Hello World” - Computer Programming for Kids and other Beginners - Warren and Carter, Manning Publications, 2014

SUGGESSTED BOOKS:

1. Python3 Tutorial – Tutorialspoint
2. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010

Code number: **OE 2**

Title of the paper: **PYTHON PROGRAMMING**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	10	20
Unit IV	10	10
Unit V	07	10
TOTAL	**45**	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	II
Paper Code	OE 3
Paper Title	MACHINE LEARNING USING R PROGRAMMING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

To make the students learn the statistics & mathematical concepts, Hypothesis & Dimension Reduction Technique, R Programming Concepts and Machine Learning.

COURSE OUTCOMES:

CO1: Understand the fundamental concepts of Statistics & Mathematics

CO2: Understand Hypothesis & Dimension Reduction Techniques

CO3: Hands on Experience in R Programming

CO4: Understand Machine Learning Concepts using R

CO5: To have basic knowledge of various predictive models.

UNIT 1: STATISTICS & MATHEMATICAL ESSENTIALS 9 Hrs.

Measure of Central Tendency - Mean, Median, Mode - Dispersion Technique - Range Inter Quartile Range - Variance, Standard Deviation - Mean Square Error & Root Mean Square - Probability Distribution.

UNIT 2: HYPOTHESIS AND DIMENSION REDUCTION TECHNIQUE 9 Hrs.

Types of Hypothesis - Sample testing - T-test - Z-test - Chi-square test - Anova test -. One Way Anova. Two Way Anova - Principle component analysis - Collinearity and multicollinearity

UNIT 3: R PROGRAMMING CONCEPTS **9 Hrs.**

The Data types in R & its uses -Build in functions in R- Data Manipulation - Data import Techniques – Exploratory Data Analysis – Data Visualization.

UNIT 4: MACHINE LEARNING **9 Hrs.**

ML Fundamental & common use cases - Approach to Machine Learning - Understanding Supervised learning technique - Unsupervised learning technique

UNIT 5: PREDICTIVE MODELLING IN R **9 Hrs.**

Introduction to predictive modeling - Regression Problem - Classification Problem - Linear Regression - Logistic Regression – Clustering - Distance measure types- K means clustering – Decision Tree Classifier – Random Forest Classifier – Support Vector Machine.

TEXTBOOK:

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

SUGGESTED BOOK:

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

Code number: **OE 3**

Title of the paper: **MACHINE LEARNING USING R PROGRAMMING**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	II
Paper Code	OE 4
Paper Title	DIGITAL DESIGN USING HDL
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. Learn different Verilog HDL constructs.
2. Familiarize the different levels of abstraction in Verilog.
3. Understand Verilog Tasks and Directives.
4. Understand timing and delay Simulation.

COURSE OUTCOMES:

CO1: Design and analyze combinational & sequential circuits
CO2: Understand different design methodologies

CO3: Write Verilog programs in gate, dataflow (RTL), behavioral and switch modeling levels of Abstraction.
CO4: Write the programs more effectively using Verilog tasks and directives
CO5: To learn and implement the Behavioral Modeling Concepts

UNIT I: DESIGN OF COMBINATIONAL LOGIC & SEQUENTIAL LOGIC 9 Hrs.

Decoders, Encoders, Digital multiplexers, Adders and subtractors, Look ahead carry, Binary comparators. Latches, Flipflops, Counters, Design of sequential counters, state machine & State diagrams.

UNIT II: OVERVIEW OF DIGITAL DESIGN WITH VERILOG HDL 9 Hrs.

Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL?, trends in HDLs. Hierarchical Modeling Concepts : Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block.

UNIT III: VERILOG BASIC CONCEPTS & MODULES & PORTS 9 Hrs.

Lexical conventions, data types, system tasks, compiler directives. Module definition, port declaration, connecting ports, hierarchical name referencing.

UNIT IV: GATE LEVEL & DATA FLOW MODELLING 9 Hrs.

Gate-Level Modeling

Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays.

Dataflow Modeling

Continuous assignments, delay specification, expressions, operators, operands, operator types.

UNIT V: BEHAVIORAL MODELING 9 Hrs.

Structured procedures, initial and always, blocking and non-blocking statements, delay control, generate statement, event control, conditional statements, structural modeling.

TEXTBOOK:

1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Pearson Education, Second Edition.
2. John M Yarbrough,-Digital Logic Applications and Design, Thomson Learning,2001

SUGGESTED BOOK:

1. Donald E. Thomas, Philip R. Moorby, “The Verilog Hardware Description Language”, Springer Science+Business Media, LLC, Fifth edition.
2. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL” Pearson (Prentice Hall), Second edition.

BLUE PRINT

Code number: **OE 4**

Title of the paper: **DIGITAL DESIGN USING HDL**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20
Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

SEMESTER III

Semester	III
Paper Code	BCADA 3121
Paper Title	PYTHON FOR DATA ANALYTICS

Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course is designed to teach students how to analyse different types of data using Python. Students will learn how to prepare data for analysis, perform simple statistical analysis, create meaningful data visualizations and predict future trends from data.

COURSE OUTCOMES:

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

CO1: Understanding basics of python for performing data analysis

CO2: Use different python packages for mathematical, scientific applications and for web data analysis.

CO3: Able to get knowledge about Data Wrangling.

CO4: Develop the model for data analysis and evaluate the model performance.

CO5: Understanding the data, performing pre-processing, processing and data visualization to get insights from data.

UNIT I: DATA STRUCTURES AND OOP **9 Hrs**

Python Program Execution Procedure – Statements – Expressions – Flow of Controls – Functions – Numeric Data Types – Sequences – Strings – Tuples – Lists – Dictionaries.
Class – Constructors – Object Creation – Inheritance – Overloading. Text Files and Binary Files – Reading and Writing.

UNIT II: NUMPY AND PANDAS PACKAGES **9 Hrs**

NumPy ndarray - Vectorization Operation - Array Indexing and Slicing - Transposing Array and Swapping Axes - Saving and Loading Array - Universal Functions - Mathematical and Statistical Functions in NumPy .
Series and DataFrame data structures in pandas - Creation of Data Frames – Accessing the columns in a DataFrame - Accessing the rows in a DataFrame - Panda's Index Objects - Reindexing Series and DataFrames - Dropping entries from Series and Data Frames - Indexing, Selection and Filtering in Series and Data Frames - Arithmetic Operations between Data Frames and Series - Function Application and Mapping.

UNIT III: DATA WRANGLING **9 Hrs**

Combining and Merging Data Sets – Reshaping and Pivoting – Data Transformation – String manipulations – Regular Expressions.

UNIT IV: DATA AGGREGATION AND GROUP OPERATIONS **9 Hrs**

Group By Mechanics – Data Aggregation – GroupWise Operations – Transformations – Pivot Tables – Cross Tabulations – Date and Time data types.

UNIT V: VISUALIZATION IN PYTHON **9 Hrs**

Matplotlib and Seaborn Packages – Plotting Graph - Controlling Graphs – Adding Text – More Graph Types – Getting and Setting Values – Patches.

REFERENCES:

1. Gowrishanker and Veena, "Introduction to Python Programming", CRC Press,

2019.

2. Python Crash Course, 2nd Edition, By Eric Matthes, May 2019

3. NumPy Essentials, By Leo Chin and Tanmay Dutta, April 2016

4. Joel Grus, "Data Science from scratch", O'Reilly, 2015.

5. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012.

6. Kenneth A. Lambert, (2011), "The Fundamentals of Python: First Programs",

Cengage Learning

7. Jake Vanderplas. Python Data Science Handbook: Essential Tools for

Working with Data 1st Edition.

BLUE PRINT

Code number: **BCADA 3121**

Title of the paper: **PYTHON FOR DATA ANALYTICS**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	09	20

Unit II	09	20
Unit III	09	20
Unit IV	09	10
Unit V	09	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	III
Paper Code	BCADA 3221
Paper Title	ECONOMETRICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

To equip the students with the knowledge of the techniques of modern econometrics, required for applied research in data analytic industry.

COURSE OUTCOMES:

Upon successful completion of this course student should be able to

CO1: To get familiar with the concept of multiple regression

CO2: To get insights into non linear relationships and dummy variables

CO3: To solve the Simultaneous equations using different methods

CO4: To familiarise the concept of time series analysis

CO5: To get insights of Panel Data

UNIT I : MULTIPLE REGRESSION **8 Hrs.**

Reviewing regression , interpretation of multiple regression coefficients , properties of regression coefficients , multicollinearity , goodness of fit

UNIT II: UNDERSTANDING NON LINEAR LINEARSHIPS 8 Hrs.

Transformation of variables - Logarithmic transformations , Engel curve, semi- logarithmetic transformation, non linear regression , use of dummy variables in regression

UNIT III: SIMULTANEOUS EQUATIONS SYSTEM 6 Hrs.

Identification problem , Least Squares estimation , Bias Problem

UNIT IV : TIME SERIES ANALYSIS 8 Hrs.

Basic idea of time series , autoregressive models, stationarity , stationarity tests , simple AR models , moving average model ,auto regressive moving average , ARIMA

UNIT V : ANALYSIS OF PANEL DATA 15 Hrs.

Importance of panel data , Fixed Effects Estimation, limitation of FE model , Random Effects Model, or ECM model , difference between FE model and RE model, Hausman Test, Case study

SUGGESTED BOOKS:

1. Cristopher Dougherty Introduction to Econometrics
2. Johnson , Econometric Methods
3. Damodar Gujrati , Econometrics
4. The Econometrics of Financial Markets : J. Campbell, A.Lo and C. Mackinlay Econometric Analysis : William H. G

BLUE PRINT

Code number: **BCADA 3221**

Title of the paper: **Econometrics**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	08	20
Unit II	08	20
Unit III	06	10
Unit IV	08	10
Unit V	15	20

TOTAL	45	80
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	III
Paper Code	BCADA 3321
Paper Title	MATHEMATICS III
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

UNIT I: NUMERICAL METHODS **10 Hrs.**

Errors in Numerical Calculations, Solutions of Algebraic and Transcendental Equations: Bisection Method, Method of False Position, Newton-Raphson Method. Interpolation: Error in Polynomial Interpolation, Finite differences: Forward and Backward differences, Newton's divided difference formula, Lagrange's interpolation formula and inverse interpolation formula. Central differences: Gauss difference formulae. Numerical Linear Algebra: Gauss-elimination method, Numerical Integration: Trapezoidal Rule, Numerical solution to ordinary differential equations: Solution by Taylor Series,

UNIT II: CALCULUS OF SEVERAL VARIABLE **15 Hrs.**

Functions of Several variables, Limit and Continuity in Higher Dimensions, Geometric significance of derivatives, Partial differentiations, The Chain Rule, Directional Derivatives and Gradient Vectors, Extremal Values and Saddle Point, Lagrange's Multipliers.

UNIT III: DIFFERENTIAL EQUATIONS **10 Hrs.**

Introduction to differential equations, Formation of differential equations, Equations of First Order and First Degree: Existence Theorem, Exact Equations, Integrating Factors, Separation of Variables, Solving equations which are both homogeneous and exact, Equations reducible to the homogeneous form.,

Solving equations of second and higher order homogeneous equations with constant coefficients, solving equations of second and higher order non-homogeneous equations with constant coefficients by finding the complementary function particular integral.

UNIT IV: GROUP **5 Hrs.**

Introduction to Groups: Binary Operation, Definition of Groups, Examples of Group, Introduction to set of Integers modulo n, Uniqueness of identity element and Uniqueness of Inverse element, Subgroups: Order of an element, One-Step Subgroup Test (proof not required), Examples of Subgroups

SELF STUDY **5 Hrs.**

TEXT BOOKS:

1. "An introduction to Differential Equation" , New Central Book Agency, 2011, R K Ghosh and K C Maity
2. "Introductory Method to Numerical Analysis", Prentice Hall India Learning Private Limited; Fifth edition (1 January 2012), S S Sastry
3. "Thomas's Calculus" Pearson, 14th Edition by Joel Hass, Christopher Heil, Maurice D Weir

SUGGESTED BOOKS :

1. Higher Engineering Mathematics by B.S.Grewal
2. David C. Lay, "Linear Algebra and its Applications," 3rd edition, Pearson Education (Asia) Pte. Ltd,2005.
3. Kenneth Hoffman and Ray Kunze, "Linear Algebra," 2nd edition, Pearson Education (Asia) Pte. Ltd/2004.

BLUE PRINT

Code number: **BCADA 3321**

Title of the paper: **Mathematics III**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	15	20
Unit III	10	20
Unit IV	5	20
SELF STUDY	5	

TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	III
Paper Code	BCADA3P1
Paper Title	PYTHON FOR DATA ANALYTICS LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	III
Paper Code	OE 5
Paper Title	BUSINESS AND DATA UNDERSTANDING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES :

The course aims to equip the students with basic understanding of data and business decision making

COURSE OUTCOMES:

CO1: To familiarize the students with business environment and its problems

CO2: To get an insight into the data generation in business and its analysis

CO3: To familiarize students with different methods for data analysis

CO4: To get an insight into the concepts of probability and distribution

CO5: To get an insight into the decision making framework

UNIT I: BUSINESS ENVIRONMENT **8 Hrs.**

An Overview of the business environment , how it operates -characteristics of business environment – types of environment – environment analysis- -socio culture environment -political and government environment

UNIT II: DATA UNDERSTANDING **8 Hrs.**

Data generation process in business environment - collecting and utilizing data for business solutions - variables selection and sampling process -role of softwares

UNIT III: EXPLORING DATA **12 Hrs.**

Describing the distribution of a single variable - descriptive measures for Categorical variable - descriptive measures for Numerical variable - Charts for Numerical Variables - Time series data - Outliers and missing values - Finding relationships among variables - Understanding Time series Data - components of time series data - measures of accuracy - testing for randomness- modeling time series data

UNIT IV: CRISP DECISION MAKING FRAMEWORK **8 Hrs.**

Probability and Distributions-Probability essentials - Distribution of single Random variable- summary measures of a Probability Distribution - Binomial -Poisson and Normal distributions and their applications

UNIT V: CRISP DECISION MAKING FRAMEWORK: **4 Hrs.**

Heart of Data Analysis: Modelling, model development and deployment

SELF STUDY **5 Hrs.**

SUGGESTED BOOKS:

1. Starling, Grower (1996) The changing Environment of Business Cincimmati, OH, South Western College Publishing

2. S. Christian Albright, Wayne L. Winston, Business Analytics: Data Analysis and Decision Making, Cengage Learning

3. S. Christian Albright & Wayne L. Winston, Business Analytics: Data Analysis and Decision making , Cengage Learning

4. Christian Heuman , Michael Schomaker and Shalabh : Introduction to Statistics and Data Analysis : With Exercises, Solutions and Applications in R,

5. Drew Bentley (2017) , Business Intelligence and Analytics , Library Press

BLUE PRINT

Code number: **OE 5**

Title of the paper: **Business and data understanding**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	8	10
Unit II	8	20
Unit III	12	20
Unit IV	8	20
Unit IV	4	10
SELF STUDY	5	
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Database Management System

Semester	III
Paper Code	OE 6

Paper Title	DATABASE MANAGEMENT SYSTEM
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for databases, tables, database management system and application area related to it and understand the underlying core concepts.

COURSE OBJECTIVES:

This course concentrates on introduction, principles, design and implementation of DBMS. It introduces about the distributed system and brief about data mining and data warehouse. To provide strong foundation of database concepts and develop skills for the design and implementation of a database application with a brief exposure to advanced database concepts.

COURSE OUTCOMES:

CO1: Understanding the fundamental concepts of Database Management systems
CO2: Understanding the concepts of Database models.
CO3: Understanding the core terms, concepts, and tools of relational database management systems.
CO4:Understanding database design and logic development for database programming.

UNIT 1: DATABASE MANAGEMENT SYSTEM INTRODUCTION 10 Hrs.

Data- Database- Database management system- Characteristics of the database approach- Role of Database administrators- Role of Database Designers- End Users- Advantages of Using a DBMS-Data models, Schema and Instances –Database design - Database Engine – 1 tier architecture – 2 tier architecture- 3 tier architecture – History of Database Management systems- Types of Databases.

UNIT 2: DATABASE MODELS AND IMPLEMENTATION 10 Hrs.

Data Model and Types of Data Model- Relational Data Model- Hierarchical Model- Network Data Model- Object/Relational Model- Object-Oriented Model- Entity-Relationship Model- Modeling using E-R Diagrams- Notation used in E-R Model- Relationships and Relationship Types- Cardinalities.

UNIT 3: RELATIONAL DATABASES 10 Hrs.

Structure of relational databases- Properties of relational databases and Tables –Structure of relational databases – Database Schema – Armstrong Axioms – Functional Dependency-Anomalies in a Database- Properties of Normalized Relations- First Normalization- Second Normal Form Relation- Third Normal Form.

UNIT 4: SQL AND ADDITIONAL CONCEPTS 10 Hrs.

Categories of SQL Commands; Data Definition; Data Manipulation Statements, SELECT - The Basic Form, Subqueries, Functions, GROUP BY Feature, Updating the Database, Data Definition Facilities.

SELF STUDY 5 Hrs.

Text Books And Reference Books:

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

Essential Reading / Recommended Reading

1. Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.
2. O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.

BLUE PRINT

Code number: **OE 6**

Title of the paper**: DATABASE MANAGEMENT SYSTEM**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	10	20
Unit III	10	20
Unit IV	10	20
SELF STUDY	5	
TOTAL	**45**	**80**

Maximum marks for the paper (Excluding bonus question) = 60

SEMESTER IV

Semester	IV
Paper Code	BCADA 4121
Paper Title	DATABASE MANAGEMENT SYSTEM
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for databases, tables, database management system and application area related to it and understand the underlying core concepts.

COURSE OBJECTIVES:

This course concentrates on introduction, principles, design and implementation of DBMS. It introduces about the distributed system and brief about data mining and data warehouse. To provide strong foundation of database concepts and develop skills for the design and implementation of a database application with a brief exposure to advanced database concepts.

COURSE OUTCOMES:

CO1: Understanding the fundamental concepts of Database Management systems
CO2: Understanding the concepts of Database models.
CO3: Understanding the core terms, concepts, and tools of relational database management systems.
CO4:Understanding database design and logic development for database programming.
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UNIT 1: DATABASE MANAGEMENT SYSTEM INTRODUCTION 10 Hrs.

Data- Database- Database management system- Characteristics of the database approach- Role of Database administrators- Role of Database Designers- End Users- Advantages of Using a DBMS-Data models, Schema and Instances –Database design - Database Engine – 1 tier architecture – 2 tier architecture- 3 tier architecture – History of Database Management systems- Types of Databases.

UNIT 2: DATABASE MODELS AND IMPLEMENTATION 10 Hrs.

Data Model and Types of Data Model- Relational Data Model- Hierarchical Model- Network Data Model- Object/Relational Model- Object-Oriented Model- Entity-Relationship Model- Modeling using E-R Diagrams- Notation used in E-R Model- Relationships and Relationship Types- Cardinalities. Subclasses, Super classes and Inheritance – Specialization and Generalization – Characteristics of Specialization and Generalization – Modeling of UNION types with categories- An example University EER Schema.

UNIT 3: RELATIONAL DATABASES 10 Hrs.

Structure of relational databases- Properties of relational databases and Tables –Structure of relational databases – Database Schema – Armstrong Axioms – Functional Dependency-Anomalies in a Database- Properties of Normalized Relations- First Normalization- Second Normal Form Relation- Third Normal Form- Boyce-Codd Normal Form (BCNF).

UNIT 4: SQL AND ADDITIONAL CONCEPTS 10 Hrs.

Categories of SQL Commands; Data Definition; Data Manipulation Statements, SELECT - The Basic Form, Subqueries, Functions, GROUP BY Feature, Updating the Database, Data Definition Facilities. MongoDB Overview- MongoDB Data modeling.

SELF STUDY 5 Hrs.

Text Books And Reference Books:

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

Essential Reading / Recommended Reading

3. Silberschatz, Korth, Sudarshan, Database System Concepts, 5 Edition, McGraw Hill, 2006.
4. O`neil Patricand, O`neil Elizabeth, Database Principles, Programming and Performance, 2nd Edition, Margon Kaufmann Publishers Inc, 2008.

BLUE PRINT

Code number: **BCADA 4121**

Title of the paper**: DATABASE MANAGEMENT SYSTEM**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	10	20
Unit III	10	20
Unit IV	10	20
SELF STUDY	5	
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	IV
Paper Code	BCADA 4221
Paper Title	OS USING LINUX
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES :

1. To be able to read and understand sample open source programs and header files.
2. To understand how the processes are implemented in Linux along with File System.
3. To study Linux memory management data structures and algorithms.
4. To acquire the knowledge in the implementation of interprocess communication.

5. To understand various process communication and how program execution happens in Linux.

COURSE OUTCOMES:

At the end of this course, the students should be able to:

CO1:To explain the functionality of a large software system by reading its source.
CO2: To revise any algorithm present in a system.
CO3: To design a new algorithm to replace an existing one.
CO4: To appropriately modify and use the data structures of the Linux kernel for a different software system.

UNIT I: INTRODUCTION **9 Hrs.**

Basic Operating System Concepts - Overview of Unix File System - Files - Links - Types - Inodes - Access Rights - System Calls - Overview of Unix Kernels -Model - Implementation - Reentrant Kernels - Address Space - Synchronization - Interprocess Communication - Process Management - Memory Management - Device Drivers.

UNIT II: PROCESSES **9 Hrs.**

Processes, Lightweight Processes, and Threads - Process Descriptor - State - Identifying a Process - Relationships among processes - Organization - Resource Limits - Creating Processes - System Calls - Kernel Threads - Destroying Processes -Termination - Removal.

UNIT III: FILE SYSTEM **9 Hrs.**

The Virtual File System (VFS) - Role - File Model -System Calls - Data Structures - Super Block, Inode, File, dentry Objects - dentry Cache - Files Associated with a Process - Filesystem Types - Special Filesystems - Filesystem Type Registration - Filesystem Handling - Namespaces - Mounting - Unmounting - Implementation of VFS System Calls.

UNIT IV: MEMORY MANAGEMENT **9 Hrs.**

Page frame management -page descriptors - non-uniform memory access - memory zones - reserved page frames - zoned page frame allocator - kernel mappings - buddy system algorithm - page frame cache - zone allocator.

UNIT V: PROCESS COMMUNICATION AND PROGRAM EXECUTION 9Hrs.

Process Communication - Pipes -Usage - Data Structures - Creating and Destroying a Pipe - Reading from and Writing into a Pipe. Program Execution - Executable Files - Process Credentials - Command-Line Arguments and Shell Environment - Libraries - Program Segments and Process Memory Regions - Execution tracing - Executable Formats - Execution Domains - The exec Functions

SUGGESTED BOOKS:

1. Daniel P. Bovet and Marco Cesati, "Understanding the Linux Kernel", 3rd Edition, O'Reilly Publications, 2005.
2. Harold Abelson, Gerald Jay Sussman and Julie Sussman, ―Structure and Interpretation of Computer Programs‖, Second Edition, Universities Press, 2013.
3. Maurice J. Bach, ―The Design of the Unix Operating System‖ 1 st Edition Pearson Education, 2003.
4. Michael Beck, Harald Bohme, Mirko Dziadzka, Ulrich Kunitz, Robert Magnus, Dirk Verworner, ―Linux Kernel Internals‖, 2nd Edition, Addison-Wesley, 1998.
5. Robert Love, ―Linux Kernel Development‖, 3 rd Edition, Addison-Wesley, 2010.

BLUE PRINT

Code number: **BCADA 4221**

Title of the paper**: OS using LINUX**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	IV
Paper Code	BCADA4321
Paper Title	MULTIVARIATE STATISTICS
Number of teaching hrs per week	3 Hrs

Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE: The aim of this course is to appraise the students about the concepts and methods of multivariate analysis

COURSE OUTCOMES:

CO1: To get an insight into the application of multivariate analysis

CO2: To familiarize the students with the concept of multivariate normal distribution

CO3: To familiarize the students with multiple regression

CO4: To get insights into the concepts of data reduction using principal component analysis

CO5: To get insights into factor analysis

UNIT I: ASPECTS OF MULTIVARIATE ANALYSIS **5 Hrs.**

Application of Multivariate Techniques, the organization of data , data displays and pictorial representations , matrix algebra and random vectors

UNIT II: THE MULTIVARIATE NORMAL DISTRIBUTION **10 Hrs.**

The Multivariate Normal Density and its properties, mean vector , Covariance Matrix , Correlation Matrix , Relationship between Correlation and covariance matrix , Multivariate Normal Distribution – Geometric interpretation , Examining data for multivariate Normal Distribution , Multivariate Inferential Statistics : Hotelling's T^2, Confidence Region , Hypothesis Testing for Equality of two population mean Vectors

UNIT III: MULTIPLE LINEAR REGRESSION **8 Hrs.**

Assumptions and Estimation of Model Parameters , Sampling distribution of parameter estimates , Model Adequacy Test, Tests of assumptions , Remedy against violations of assumptions, multivariate Linear Regression ,

UNIT IV: PRINCIPAL COMPONENT ANALYSIS **7 Hrs.**

Conceptual Model , Extraction of Principal Components , Model Adequacy and Interpretation

UNIT V: FACTOR ANALYSIS **5 Hrs.**

Factor Analysis : Basic and Orthogonal Models , Types of Models , parameter estimation , Model Adequacy Tests and Factor Rotation

SELF STUDY **5 Hrs.**

SUGGESTED BOOKS:

1. Applied Multivariate Statistical Analysis by R A Johnson and D W Wichern, Sixth Edition, PHI, 2012.
2. Multivariate data analysis by Joseph F. Hair Jr, Rolph E. Anderson, Ronald L Tatham, and William C. Black, Fifth Edition, Pearson Education, 1998.
4. Analysing multivariate data by J Lattin, J D Carroll and P E Green, Cengage Learning, 2010.
5. Applied multivariate analysis by N H Timm, Springer, 2002.
6. An Introduction to multivariate Statistical Analysis , T.W Anderson , Third Edition , Wiley Student Edition

BLUE PRINT

Code number: **BCADA 4321**

Title of the paper**: Multivariate statistics**

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	5	10
Unit II	10	20
Unit III	8	20
Unit IV	7	20
Unit V	5	10
SELF STUDY	5	
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	IV
Paper Code	BCADA4P1
Paper Title	DATABASE MANAGEMENT SYSTEM LAB
Number of teaching hrs per week	4 Hrs

Total number of teaching hrs per semester	60
Number of credits	2

Semester	IV
Paper Code	BCADA4P2
Paper Title	MULTIVARIATE STATISTICS LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	IV
Paper Code	OE 7
Paper Title	VISUALIZATION TECHNIQUES USING TABLEAU
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

1. Getting started with Tableau
2. Handling data with Tableau
3. Built in visuals(different types of charts, Maps, visualizing Geographical data)

SEMESTER V

Semester	V
Paper Code	BCADA 5121
Paper Title	JAVA FOR DATA ANALYTICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVE

This course introduces computer programming using the JAVA programming language with object-oriented programming principles. Emphasis is placed on event-driven programming methods, including creating and manipulating objects, classes, and using object-oriented tools such as the class debugger.

COURSE OUTCOMES

CO1: Understand the basic Java programming concept using OOP principles.

CO2: Develop Java programs with the concepts of inheritance and interfaces.

CO3: Able to Build Java applications using exceptions and I/O streams

CO4: Gain in depth knowledge towards Java applications using threads, generic classes and Event Driven concepts.

UNIT I: INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 10 Hrs.

Object Oriented Programming - Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File - Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages - Javadoc comments.

UNIT II: INHERITANCE AND INTERFACES 10 Hrs.

Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface,

implementing interface, differences between classes and interfaces and extending interfaces - Object cloning -inner classes, Array Lists - Strings

UNIT III: EXCEPTION HANDLING AND I/O **10 Hrs.**

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files

UNIT IV: MULTITHREADING, GENERIC PROGRAMMING AND EVENT DRIVEN PROGRAMMING **10 Hrs.**

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming – Generic classes – generic methods – Bounded Types – Restrictions and Limitations. Graphics programming - Frame – Components - working with 2D shapes - Using colour, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events.

SELF STUDY **5 Hrs.**

TEXT BOOKS

1. Herbert Schildt, ―Java The complete reference‖, 8th Edition, McGraw Hill Education, 2011.

2. Cay S. Horstmann, Gary cornell, ―Core Java Volume –I Fundamentals‖, 9th Edition, Prentice Hall, 2013.

SUGGESTED BOOKS

1. Paul Deitel, Harvey Deitel, ―Java SE 8 for programmers‖, 3rd Edition, Pearson, 2015.

2. Steven Holzner, ―Java 2 Black book‖, Dreamtech press, 2011.

3. Timothy Budd, ―Understanding Object-oriented programming with Java‖, Updated Edition, Pearson Education, 2000.

Code number: BCADA4221

Title of the paper: JAVA for Data Analytics

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	10	20
Unit III	10	20

Unit IV	10	20
Self-Study	05	
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question) = 60		

Semester	IV
Paper Code	BCADA 5221
Paper Title	MACHINE LEARNING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course will provide the students to understand the concepts of Machine Learning, supervised learning and their applications, the concepts and algorithms of unsupervised learning, the concepts and algorithms of advanced learning.

COURSE OUTCOMES:

CO1: Design a learning model appropriate to the application.

CO2: Design a supervised learning for an application of your choice.

CO3: Design an unsupervised learning for an application of your choice.

CO4: Identify applications dimensionality reduction suitable for different types of Machine Learning with suitable justification.

UNIT 1: MACHINE LEARNING INTRODUCTION 10 Hrs.

Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning Probability theory – Probability Distributions – Decision Theory.

UNIT 2: SUPERVISED LEARNING **10 Hrs.**

Linear Models for Regression, Linear Models for Classification, Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, Decision Tree Learning, Bayesian Learning, Naïve Bayes, Ensemble Methods – Bagging and Boosting, Mixture of experts, Support Vector Machines.

UNIT 3: UNSUPERVISED LEARNING **10 Hrs.**

Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Estimating means of K Gaussians

UNIT 4: DIMENSIONALITY REDUCTION **10 Hrs.**

Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis, TSNE.

SELF STUDY **5 Hrs.**

SUGGESTED BOOKS:

1. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
2. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007. \
3. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman andHall, CRC Press, Second Edition, 2014.
4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.

BLUE PRINT

Code number: BDA2321

Title of the paper: Machine Learning I

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	10	20
Unit II	10	20
Unit III	10	20
Unit IV	10	20

Self-Study	5	
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	V
Paper Code	BCADA5P1
Paper Title	JAVA FOR DATA ANALYTICS LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	IV
Paper Code	BCADA5P2
Paper Title	MACHINE LEARNING LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	V
Paper Code	OSE 1
Paper Title	DESIGN AND ANALYSIS OF ALGORITHM
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

Upon completion of this course, students will be able to do the following:

1. Analyze the asymptotic performance of algorithms.
2. Write rigorous correctness proofs for algorithms.
3. Demonstrate a familiarity with major algorithms and data structures.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient algorithms in common engineering design situations.

COURSE OUTCOMES:

CO1: Argue the correctness of algorithms using inductive proofs and invariants.
CO2: Analyze worst-case running times of algorithms using asymptotic analysis.
CO3: Describe the divide-and-conquer paradigm and dynamic-programming paradigm to explain when an algorithmic design situation calls for it. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
CO4: Develop the iterative improvement.
CO5: Learn to cope with the limitations of algorithm power

UNIT I: INTRODUCTION **9 Hrs**

Notion of an Algorithm — Fundamentals of Algorithmic Problem Solving — Important Problem Types — Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and their properties. Analysis Framework — Empirical analysis — Mathematical analysis for Recursive and Non-recursive algorithms — Visualization

UNIT II: BRUTE FORCE AND DIVIDE-AND-CONQUER **9 Hrs**

Brute Force — Computing an — String Matching — Closest-Pair and Convex-Hull Problems — Exhaustive Search — Travelling Salesman Problem — Knapsack Problem — Assignment problem. Divide and Conquer Methodology — Binary Search — Merge sort — Quick sort — Heap Sort — Multiplication of Large Integers — Closest-Pair and Convex — Hull Problems.

UNIT III: DYNAMIC PROGRAMMING AND GREEDY TECHNIQUE 9 Hrs

Dynamic programming — Principle of optimality — Coin changing problem, Computing a Binomial Coefficient — Floyd?s algorithm — Multi stage graph — Optimal Binary Search Trees — Knapsack Problem and Memory functions. Greedy Technique — Container loading problem — Prim?s algorithm and Kruskal?s Algorithm — 0/1 Knapsack problem, Optimal Merge pattern — Huffman Trees.

UNIT IV: ITERATIVE IMPROVEMENT 9 Hrs

The Simplex Method — The Maximum-Flow Problem — Maximum Matching in Bipartite Graphs, Stable marriage Problem.

UNIT V: COPING WITH THE LIMITATIONS OF ALGORITHM POWER 9 Hrs

Lower — Bound Arguments — P, NP NP- Complete and NP Hard Problems. Backtracking — n-Queen problem — Hamiltonian Circuit Problem — Subset Sum Problem. Branch and Bound — LIFO Search and FIFO search — Assignment problem — Knapsack Problem — Travelling Salesman Problem — Approximation Algorithms for NP-Hard Problems — Travelling Salesman problem — Knapsack problem.

TEXT BOOK:

1. Ellis Horowitz, SartajSahni, SanguthevarRajasekharan, Computer algorithms/C++,Second

REFERENCE BOOKS:

1. AnanyLevitin- Introduction to design and analysis of algorithms, Third Edition, Addison Wesley, Low price edition.

2. Richard Neapolitan &KumarssNaimipour,Foundation of Algorithms using C++ Pseudocode, Third edition, Jones and Bartlett Publishers.

BLUE PRINT

Code number: OSE 1

Title of the paper: Design and analysis of algorithm

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions

Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

SEMESTER VI

Semester	VI
Paper Code	BCADA 6121
Paper Title	OPTIMIZATION TECHNIQUES
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

The objective of this course is to enable the student to

1. Formulate and solve linear programming problems (LPP)
2. Evaluate Integer Programming Problems, Transportation and Assignment Problems.
3. Obtain solution to network problems using CPM and PERT techniques.
4. Able to optimize the function subject to the constraints.
5. Identify and solve problems under Markovian queuing models.

COURSE OUTCOMES:

On successful completion of this course, the student will able to

CO1: Formulate and solve linear programming problems (LPP)

CO2: Evaluate Integer Programming Problems, Transportation and Assignment Problems.

CO3: Obtain solution to network problems using CPM and PERT techniques.

CO4: Able to optimize the function subject to the constraints.

CO5: Identify and solve problems under Markovian queuing models

UNIT I: LINEAR MODELS **9 Hrs.**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Big M method, Two-Phase method

UNIT II: INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS 9 Hrs.

Integer programming: Branch and bound method- Transportation and Assignment problems -Travelling salesman problem.

UNIT III: PROJECT SCHEDULING **9 Hrs.**

Project network -Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM

UNIT IV: CLASSICAL OPTIMISATION THEORY **9 Hrs.**

Unconstrained problems – necessary and sufficient conditions - Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

UNIT V: QUEUING MODELS **9 Hrs.**

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models, multiple service channels.

TEXT BOOK:

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017.

REFERENCE BOOKS:

4. ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011.
5. J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012.
6. Hiller F.S, Liberman G.J, Introduction to Operations Research, 10th Edition McGraw Hill, 2017.
7. Jit. S. Chandran, Mahendran P. Kawatra, KiHoKim, Essentials of Linear Programming, Vikas Publishing House Pvt.Ltd. New Delhi, 1994.

8. Ravindran A., Philip D.T., and Solberg J.J., Operations Research, John Wiley, 2nd Edition, 2007.

BLUE PRINT

Code number: BCADA 6121

Title of the paper: Optimization techniques

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VI
Paper Code	BCADA 6221
Paper Title	AI & DEEP LEARNING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45

Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for Artificial Intelligence and Deep Learning.

COURSE OBJECTIVES:

- To Understand the basic concepts of intelligent agents
- To develop general-purpose problem solving agents and logical reasoning.
- To understand the concepts of Artificial Neural Networks
- To understand CNN of architectures of deep neural networks.
- To learn about applications of deep learning in AI and Data Science

COURSE OUTCOMES:

1. Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings
2. Choose appropriate algorithms for solving given AI problems Understand Smart Objects and IoT Architectures
3. Basics of Artificial Intelligence using deep learning.
4. Apply Convolution Neural Network for image processing.
5. Apply deep learning algorithms for variety applications.

UNIT I: INTELLIGENT AGENTS 9 Hrs.

Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents Problem solving agents – search algorithms – uninformed search strategies

UNIT II: PROBLEM SOLVING 9 Hrs.

Heuristic search strategies – heuristic functions Local search and optimization problems – local search in continuous space – search with nondeterministic actions – search in partially observable environments – online search agents and unknown environments.

UNIT III: DEEP LEARNING ALGORITHMS FOR AI 9 Hrs.

Artificail Neural Netowrks – Linear Associative Networks – Perceptrons -The Backpropagation Algorithm - Hopfield Nets - Boltzmann Machines - Deep RBMs - Variational Autoencoders - Deep Backprop Networks- Autoencoders.

UNIT IV: CONVOLUTIONAL NEURAL NETWORKS 9

Convolution Operation -- Sparse Interactions -- Parameter Sharing -- Equivariance -- Pooling -- Convolution Variants: Strided -- Tiled -- Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions -- Regularization -- Optimizers -- Gradient Computation.

UNIT V: APPLICATIONS OF DEEP LEARNING 9 Hrs.

Detection in chest X-ray images -object detection and classification -RGB and depth image fusion -NLP tasks - dimensionality estimation - time series forecasting -building electric power grid for controllable energy resources - guiding charities in maximizing donations and robotic control in industrial environments.

TEXT BOOKS

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, ``Deep Learning", MIT Press, 2016

REFERENCE BOOKS

1. Stone, James. (2019). Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning, Sebtel Press, United States, 2019.
2. Vance, William , Data Science: A Comprehensive Beginners Guide to Learn the Realms of Data Science (Hardcover - 2020), Joiningthedotstv Limited.
3. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007.
4. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGraw Hill, 2008

BLUE PRINT

Code number: BCADA 6221

Title of the paper: AI & DEEP LEARNING

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20

Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VI
Paper Code	BCADA 6321
Paper Title	AI & IoT
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for Artificial Intelligence and Internet of Things.

COURSE OBJECTIVES:

1. To Understand the basic concepts of intelligent agents
2. To develop general-purpose problem solving agents and logical reasoning.
3. To understand Smart Objects and IoT Architectures
4. To learn about various IOT-related protocols.

COURSE OUTCOMES:

CO1: Explain autonomous agents that make effective decisions in fully informed, partially observable, and adversarial settings

CO2: Choose appropriate algorithms for solving given AI problems Understand Smart Objects and IoT Architectures

CO3: Understand Fundamentals of IoT

CO4: Analyze various IoT protocols
CO5: Design a PoC of an IoT system using Rasperry Pi/Arduino

UNIT I: INTELLIGENT AGENTS **9 Hrs.**

Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents Problem solving agents – search algorithms – uninformed search strategies

UNIT II: PROBLEM SOLVING **9 Hrs.**

Heuristic search strategies – heuristic functions Local search and optimization problems – local search in continuous space – search with nondeterministic actions – search in partially observable environments – online search agents and unknown environments.

UNIT III: FUNDAMENTALS OF IoT **9 Hrs.**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.

UNIT IV: IoT PROTOCOLS **9 Hrs.**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT.

UNIT V DESIGN AND DEVELOPMENT **9 Hrs.**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi.

TEXT BOOKS

3. Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

REFERENCE BOOKS

5. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
6. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012 (for Unit 2).

7. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007.
8. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008

BLUE PRINT

Code number: BCADA 6321
Title of the paper: AI & IoT

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VI
Paper Code	BCADA 6421
Paper Title	CLOUD COMPUTING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To understand the concept of cloud computing.
2. To appreciate the evolution of cloud from the existing technologies.
3. To have knowledge on the various issues in cloud computing.
4. To be familiar with the lead players in cloud.
5. To appreciate the emergence of cloud as the next generation computing paradigm.

COURSE OUTCOMES:

On Completion of the course, the students should be able to:

CO1: Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
CO2: Learn the key and enabling technologies that help in the development of cloud.
CO3: Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
CO4: Explain the core issues of cloud computing such as resource management and security and able to install and use current cloud technologies.
CO5: Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

UNIT I: INTRODUCTION 9 Hrs

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning

UNIT II: CLOUD ENABLING TECHNOLOGIES 9 Hrs

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish-Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices – Virtualization Support and Disaster Recovery.

UNIT III: CLOUD ARCHITECTURE, SERVICES AND STORAGE 9 Hrs

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

UNIT IV: RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9 Hrs

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.

UNIT V: CLOUD TECHNOLOGIES AND ADVANCEMENTS 9 Hrs

Hadoop – MapReduce – Virtual Box -- Google App Engine – Programming Environment for Google App Engine — Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.

TEXT BOOKS:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. 2. Rittinghouse, John W., and James F. Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press, 2017.

REFERENCE BOOKS:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata Mcgraw Hill, 2013.

2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach”, Tata Mcgraw Hill, 2009.

3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)”, O'Reilly, 2009.

BLUE PRINT

Code number: BCADA 6321
Title of the paper: AI & IoT

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VI
Paper Code	BCADA6P1
Paper Title	OPTIMIZATION TECHNIQUES LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	VI
Paper Code	BCADA6P2
Paper Title	AI & DEEP LEARNING LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

SEMESTER VII

Semester	VII
Paper Code	BCADA7121

Paper Title	BASICS OF COMPUTER VISION
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1: To review image processing techniques for computer vision.
2: To understand various features and recognition techniques 3: To learn about histogram and binary vision
4: Apply three-dimensional image analysis techniques
5: Study real world applications of computer vision algorithms

COURSE OUTCOMES:

CO1:Explain low level processing of image and transformation techniques applied to images.

CO2: Explain the feature extraction, segmentation and object recognition methods.

CO3: Apply Histogram transform for detection of geometric shapes like line, ellipse and objects.

CO4: Illustrate 3D vision process and motion estimation techniques.

CO5: Understand and learn different Applications

Apply vision techniques to real time applications.

UNIT I: INTRODUCTION 9 Hrs

Image Processing, Computer Vision , What is Computer Vision - Low-level, Mid-level, High-level ; Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

UNIT II: FEATURE EXTRACTION AND FEATURE SEGMENTATION 9 Hrs

Feature Extraction -Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space

Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation -Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation.

UNIT III: IMAGES, HISTOGRAMS, BINARY VISION 9 Hrs

Simple pinhole camera model – Sampling – Quantisation – Colour images – Noise – Smoothing –1D and 3D histograms - Histogram/Image Equalisation - Histogram Comparison - Back-projection - k-means Clustering – Thresholding - Threshold Detection Methods - Variations on Thresholding - Mathematical Morphology – Connectivity.

UNIT IV: 3D VISION AND MOTION 9 Hrs

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion–spline-based motion-optical flow – layered motion.

UNIT V: APPLICATIONS 9 Hrs

Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing , Virtual Reality and Augmented Reality.

TEXT BOOKS:

1. D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.

2. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Verlag London Limited,2011.

REFERENCES:

1. B. K. P. Horn -Robot Vision, McGraw-Hill.

2. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

3. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

4. E. R. Davies, (2012), “Computer & Machine Vision”, Fourth Edition, Academic Press. 5. Concise Computer Vision: An Introduction into Theory and Algorithms, by Reinhard Klette, 2014

BLUE PRINT

Code number: BCADA 7121
Title of the paper: Basics of computer vision

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VII
Paper Code	BCADA7221
Paper Title	NATURAL LANGUAGE PROCESSING
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE DESCRIPTION:

To provide strong foundation for Natural Language Processing.

COURSE OBJECTIVES:

This course will enable students to:

1. Overview and language modeling
2. Word level and syntactic analysis.
3. Extracting Relations from Text
4. iSTART & Textual Signatures
5. Information Retrieval And Lexical Resources

COURSE OUTCOMES:

CO1: Analyze the natural language text.
CO2: Define the importance of natural language.
CO3: Understand the concepts Text mining.
CO4: Illustrate information retrieval techniques.

UNIT I: OVERVIEW AND LANGUAGE MODELING 9 Hrs.

Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. Language Modeling: Various Grammar- based Language Models-Statistical Language Model.

UNIT II: WORD LEVEL AND SYNTACTIC ANALYSIS 9 Hrs.

Word Level Analysis: Regular Expressions-FiniteState Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis: Context-free GrammarConstituency- Parsing-Probabilistic Parsing.

UNIT III: RELATION EXTRACTION & KNOWLEDGE ROLES 9 Hrs.

Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation.

Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labeling, Learning to Annotate Cases with Knowledge Roles and Evaluations.

UNIT IV: iSTART & TEXTUAL SIGNATURES 9 Hrs.

Evaluating Self-Explanations in iSTART: Word Matching, Latent Semantic Analysis, and Topic Models: Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems, Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures**:** Introduction, Cohesion, Coh-Metrix, Approaches to Analyzing Texts, Latent Semantic Analysis, Predictions, Results of Experiments.

UNIT V: INFORMATION RETRIEVAL AND LEXICAL RESOURCES 9 Hrs.

Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame NetStemmers-POS Tagger- Research Corpora.

TEXT BOOKS

1. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
2. Anne Kao and Stephen R. Poteet (Eds), "Natural LanguageProcessing and Text Mining", Springer-Verlag London Limited 2007.

REFERENCE BOOKS

9. Daniel Jurafsky and James H Martin, "Speech and Language Processing: Anintroduction to Natural Language Processing, Computational Linguistics and SpeechRecognition", 2nd Edition, Prentice Hall, 2008.
10. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummingspublishing company, 1995.
11. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000.

BLUE PRINT

Code number: BCADA 7221
Title of the paper: Natural language processing

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**

Maximum marks for the paper (Excluding bonus question)= 60

Semester	VII
Paper Code	BCADA7P1
Paper Title	BASICS OF COMPUTER VISION LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	VII
Paper Code	BCADA7P2
Paper Title	NATURAL LANGUAGE PROCESSING LAB
Number of teaching hrs per week	4 Hrs
Total number of teaching hrs per semester	60
Number of credits	2

Semester	VII
Paper Code	OE 8

Paper Title	RESEARCH METHODOLOGY
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

This course will enable students to:

1. understand some basic concepts of research and its methodologies
2. identify appropriate research topics
3. select and define appropriate research problem and parameters
4. prepare a project proposal (to undertake a project)
5. organize and conduct research (advanced project) in a more appropriate manner
6. write a research report and thesis

COURSE OUTCOMES:

CO1: **CO2:** Define the importance of natural language.
CO3: Understand the concepts Text mining.
CO4: Illustrate information retrieval techniques.

UNIT I: INTRODUCTION **9 Hrs.**

Meaning of research, Function of Research Meaning of Research - Function of Research – Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

UNIT II: IDENTIFICATION OF RESEARCH PROBLEM **9 Hrs.**

Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem – Source of problems – Personal consideration.

UNITIII: RESEARCH DESIGN **9 Hrs.**

Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design. Different research designs – Basic principles of experimental designs – Computer and internet in designs.

UNITIV: INTERPRETATION AND REPORT WRITING 9 Hrs.

Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report. Types of report – Mechanics of writing a research report – Precautions for writing a research report – Conclusion.

UNIT V: STATISTICAL TECHNIQUES AND TOOLS 9 Hrs.

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation - Regression – Multiple Regression. Sampling distribution – Standard error – Concept of point and interval estimation – Level of significance – Degree of freedom – Analysis of variance – One way and two way classified data – 'F'-test.

REFERENCE BOOKS:

1. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976.

2. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008.

3. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.

4. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011.

5. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi,1999.

6. Statistical Methods , G.W. Snedecor and W.G. Cochrans, Lowa state University Press,1967. PAPER II : ADVANCED PHYSI

BLUE PRINT

Code number: BCADA 7321
Title of the paper: Research methodology

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10

Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

SEMESTER VIII

Semester	VIII
Paper Code	BCADA8121
Paper Title	SPEECH PROCESSING AND ANALYTICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To understand the need for morphological processing and their representation
2. To know about the various techniques used for speech synthesis and recognition
3. To appreciate the syntax analysis and parsing that is essential for natural language processing
4. To learn about the various representations of semantics and discourse
5. To have knowledge about the applications of natural language processing

COURSE OUTCOMES:

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

CO1: Identify the different linguistic components of natural language
CO2: Design a morphological analyser for a given natural language
CO3: Decide on the appropriate parsing techniques necessary for a given language and application
CO4: Design new tagset and a tagger for a given natural language
CO5: Design applications involving natural language

UNIT I: SPEECH PROCESSING **9 Hrs.**

Phonetics –Articulatory Phonetics -Phonological Categories -Acoustic Phonetics and Signals -Speech Synthesis –Text Normalization –Phonetic and Acoustic Analysis -Diphone Waveform synthesis – Evaluation-Automatic Speech Recognition –Architecture -Hidden Markov Model to Speech -MFCC vectors -Acoustic Likelihood Computation -Evaluation. Triphones –Discriminative Training -Modeling Variation. Computational Phonology- Finite-State Phonology –Computational Optimality Theory - Syllabification -Learning Phonology and Morphology

UNIT II: SPEECH ANALYSIS **9 Hrs.**

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths

UNIT III: SPEECH MODELING **9 Hrs.**

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV: SPEECH RECOGNITION **9 Hrs.**

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word units; Applications and present status.

UNIT V: SPEECH SYNTHESIS **9 Hrs.**

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

REFERENCE BOOKS

1. Jurafsky and Martin, “Speech and Language Processing”, Pearson Prentice Hall, Second Edition, 2008.
2. Lawrence Rabinerand Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003

3. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
4. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education.
5. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons, 1999.
6. Ben gold and Nelson Morgan, “Speech and audio signal processing”, processing and perception of speech and music, Wiley- India Edition, 2006 Edition.
7. Frederick Jelinek, “Statistical Methods of Speech Recognition”, MIT Press

BLUE PRINT

Code number: BCADA 8121

Title of the paper: Speech processing and analytics

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VIII
Paper Code	BCADA8221
Paper Title	COGNITIVE SCIENCE AND ANALYTICS
Number of teaching hrs per week	3 Hrs

Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To explain cognitive computing and design principles.
2. To distinguish between NLP and cognitive computing.
3. To apply advanced analytics to cognitive computing.
4. To discuss application of cognitive computing in business.
5. To illustrate various applications of cognitive computing.

COURSE OUTCOMES:

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

CO1: Explain cognitive computing and design principles.

CO2: Distinguish between NLP and cognitive computing.

CO3: Apply advanced analytics to cognitive computing.

CO4: Discuss application of cognitive computing in business.

CO5: Illustrate various applications of cognitive computing.

UNIT I: FOUNDATION & DESIGN PRINCIPLES 9 Hrs

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition. Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation and visualization services.

UNIT II: NLP IN COGNITIVE SYSTEM 9 Hrs

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, semantic web, Applying Natural language technologies to Business problems.

Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations.

UNIT III: BIG DATA Vs COGNITIVE COMPUTING 9 Hrs

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data.

Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, using advanced analytics to create value, Impact of open source tools on advanced analytics.

UNIT IV: COGNITIVE COMPUTING IN BUSINESS 9 Hrs

The Business Implications of Cognitive Computing: Preparing for change, advantages of new disruptive models, knowledge meaning to business, difference with a cognitive systems approach, meshing data together differently, using business knowledge to plan for the future, answering business questions in new ways, building business specific solutions, making cognitive computing a reality, cognitive application changing the market- IBM Watson as a cognitive system.

UNIT V: APPLICATIONS 9 Hrs

The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing- Building a cognitive health care application- Smarter Cities-Cognitive Computing in Government.

REFERENCE BOOKS:

1. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive computing and Big Data Analytics” , Wiley, 2015.

2. Vijay Raghvan, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and Applications“, by Elsevier publications, North Holland Publication, 1st Edition, 2016.

3. Bernadette Sharp (Author), Florence Sedes (Author), Wieslaw Lubaszewski (Author), Cognitive Approach to Natural Language Processing Hardcover, First Edition May 2017.

4. Arun Kumar Sangaiah, Arunkumar Thangavelu, et al., Cognitive Computing for Big Data Systems Over IoT: Frameworks, Tools and Applications: Lecture Notes on Data Engineering and Communications Technologies 1st edition 2018

5. Min Chen and Kai Hwang, Big-Data Analytics for Cloud, IoT and Cognitive Computing Wiley Publication, 1st Edition, 2017.

6. Mallick, Pradeep Kumar, Borah, Samarjeet," Emerging Trends and Applications in Cognitive Computing”, IGI Global Publishers, 2019.

BLUE PRINT

Code number: BCADA 8221

Title of the paper: Cognitive science and analytics

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VIII
Paper Code	OSE 3
Paper Title	AI AND ROBOTICS
Number of teaching hrs per week	3 Hrs
Total number of teaching hrs per semester	45
Number of credits	3

COURSE OBJECTIVES:

1. To study the Robot Locomotion and types of robots.
2. To explore the kinematic models and constraints
3. To Learn sensors of robots and image processing for robotics.
4. To understand the methods for mobile robot Localization
5. To study the Path planning and Navigation of Robots.

COURSE OUTCOMES:

After the completion of this course, students will be able to:

CO1: Explain the types of Robots

CO2: Narrate the kinematics of Robots

CO3: Implement image processing algorithms

CO4: Devise Localization algorithms

CO5: Devise Path planning methods for navigation

UNIT I: ROBOT LOCOMOTION **9 Hrs**

Introduction to AI and Robotics – robot locomotion – legged mobile robots – wheeled mobile robots – aerial mobile robots.

UNIT II:MOBILE ROBOT KINEMATICS **9 Hrs**

Kinematic models and constraints – mobile robot maneuverability – mobile robot workspace – advanced kinematics – motion control.

UNIT III: ROBOT PERCEPTION **9 Hrs**

Sensors for mobile robots – computer vision for robots – image processing for robotics – place recognition – range data.

UNIT IV: MOBILE ROBOT LOCALIZATION **9 Hrs**

Introduction to localization – noise and aliasing – localization-based navigation – belief representation – map representation – probabilistic map-based localization – autonomous map building.

UNIT V: ROBOT PLANNING AND NAVIGATION **9 Hrs**

Planning and navigation – planning and reacting – path planning – obstacle avoidance – navigation architectures.

TEXT BOOKS:

1. R. Siegwart, I. R. Nourbaksh, and D. Scarramuzza, “Introduction to Autonomous Mobile Robots”, Second Edition, MIT Press, 2011.

2. Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020.

BLUE PRINT

Code number: OSE 3

Title of the paper: AI and robotics

Chapter	Number of Hours	Total marks for which the questions are to be asked (including bonus questions
Unit I	9	10
Unit II	9	20
Unit III	9	20
Unit IV	9	20
Unit V	9	10
TOTAL	**45**	**80**
Maximum marks for the paper (Excluding bonus question)= 60		

Semester	VII
Paper Code	BCADA8P1
Paper Title	RESEARCH PROJECT
Number of teaching hrs per week	6 Hrs

Total number of teaching hrs per semester	90
Number of credits	3