Credit Framework for the Bachelor of Computer Applications(DS&AI)-NEP-2020 School of Computer Applications, BBD University, Lucknow

SEMESTER	Discipline Specific Core(DSC) (Major)	Discipline Specific Elective (DSE) (Major)	Generic Elective (GE) (Minor)	Co-Curricular (CC)	Vocational Course(VOC)	Survey/ Seminar/MOOC/ Community Outreach(SSMC)	Value Added Course (VAC)	GP	Total Credit
1	4 Subjects 16 Credits (4+5+5+2 Credits)		1 Subject 3 Credits	1 Subject 3 Credits			2 Credit	1 Credit	25
2	4 Subjects 16 Credits (4+2+5+5 Credits)		1 Subject 3 Credits	1 Subject 3 Credits	1 Subject 2 Credits		2 Credit	1 Credit	27
Early Exit Option-1:Award of UG CERTIFICATE (After 1 Year:52 Credits)									
3	5 Subjects 19 Credits (4+2+5+3+5 Credits)		1 Subject 3 Credits		1Subject 2 Credits		2 Credit	1 Credit	27
4	4 Subjects 16 Credits (4+2+5+5 Credits)	1 Subjects 3 Credits	1 Subject 3 Credits		1 Subject 2 Credits			1 Credit	25
Early Exit Option-2:Award of UG DIPLOMA(After 2 Year:104 Credits)									
5	3 Subjects 14 Credits (4+5+5 Credits)	2 Subjects 6 Credits						1 Credit	21
6	Industrial Training Cum Project 20 Credits							1 Credit	21
Early Exit Option-3:Award of Bachelor of Computer Applications (After 3 Year: 146 Credits)									
7	2 Subjects 6 Credits (3+3 Credits) Dissertation-6 Credits	2 Subjects 7 Credits (3+4 credits)						1 Credit	20
8	2 Subjects 8 Credits (5+3 Credits) Dissertation-II 12 Credits							1 Credit	21
Award of Bachelor of Computer Applications With Research (After 4 Years: 187 Credits)									

Babu Banarasi Das University, Lucknow
School of Computer Applications
Bachelor of Computer Applications(DS&AI)
Evaluation Scheme(w.e.f.AcademicSession2025-26)

SEMESTER I

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN21101	Clean Coding with Python and EDA	3	1	0	40	60	100	4	IBM
DSC	BCADSN21102	Fundamentals of Computer & Programming in 'C'	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN21103	Database Management System	2	1	0	40	60	100	3	
DSC	BCADSN21104	Basic Mathematics	2	0	0	40	60	100	2	
GE		Generic Elective-I	2	1	0	40	60	100	3	
CC		Co-Curricular-I	2	1	0	40	60	100	3	
DSC	BCADSN21151	Programming in 'C' Lab	0	0	4	40	60	100	2	
DSC	BCADSN21152	Database Management System Lab	0	0	4	40	60	100	2	
VAC	UHV11101	Foundation of Universal Human Values	2	0	0	40	60	100	2	
	GPN2101	General Proficiency	0	0	0	100	0	100	1	
Total			**15**	**5**	**8**	**460**	**540**	**1000**	**25**	

SEMESTER II

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN22101	Cloud Application Development	3	1	0	40	60	100	4	IBM
DSC	BCADSN22102	Data Visualization	2	0	0	40	60	100	2	
DSC	BCADSN22103	Operating System	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN22104	Data Structure Using Python	2	1	0	40	60	100	3	
GE		Generic Elective-II	2	1	0	40	60	100	3	
CC		Co-Curricular-II	3	0	0	40	60	100	3	
DSC	BCADSN22151	Data Structure Using Python Lab	0	0	4	40	60	100	2	
DSC	BCADSN22152	Computer Application Lab	0	0	4	40	60	100	2	
VC		Vocational Course-II	2	0	0	40	60	100	2	
VAC	UHV12102	Understanding the Harmony	2	0	0	40	60	100	2	
	GPN2201	General Proficiency	0	0	0	100	0	100	1	
Total			**18**	**4**	**8**	**500**	**600**	**1100**	**27**	

Early Exit Option-1:Award of UG CERTIFICATE(After1Year:52Credits)

SEMESTER III

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN23201	Descriptive Analytics	3	1	0	40	60	100	4	IBM
DSC	BCADSN23202	NoSQL and DBaaS 101	2	0	0	40	60	100	2	
DSC	BCADSN23203	Scala Programming	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN23204	Computer Network	2	1	0	40	60	100	3	
DSC	BCADSN23205	Object Oriented Programming Using Java	2	1	0	40	60	100	3	
GE		Generic Elective-III	2	1	0	40	60	100	3	
DSC	BCADSN23251	Scala Programming Lab	0	0	4	40	60	100	2	
DSC	BCADSN23252	Programming with Java Lab	0	0	4	40	60	100	2	
VC		Vocational Course-III/SSMC	2	0	0	40	60	100	2	
VAC	IKS13201	Indian Knowledge System	2	0	0	40	60	100	2	
	GPN2301	General Proficiency	0	0	0	100	0	100	1	
Total			**17**	**5**	**8**	**500**	**600**	**1100**	**27**	

SEMESTER IV

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN24201	Big Data Fundamentals	3	1	0	40	60	100	4	IBM
DSC	BCADSN24202	Data Science with Python	2	0	0	40	60	100	2	
DSC	BCADSN24203	Artificial Intelligence	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN24204	Basics of Design & Analysis of Algorithms Using Java	2	1	0	40	60	100	3	
GE		Generic Elective-IV	2	1	0	40	60	100	3	
DSE		Discipline Specific Elective-I	2	1	0	40	60	100	3	
DSC	BCADSN24251	Artificial Intelligence Lab	0	0	4	40	60	100	2	
DSC	BCADSN24252	Basics of Design & Analysis of Algorithms Lab Using Java	0	0	4	40	60	100	2	
VC		Vocational Course-IV/SSMC	2	0	0	40	60	100	2	
	GPN2401	General Proficiency	0	0	0	100	0	100	1	
Total			**15**	**5**	**8**	**460**	**540**	**1000**	**25**	

Early Exit Option-2:Award of UG DIPLOMA(After2 Year:104Credits)

SEMESTER V

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN25301	Predictive Analytics	3	1	0	40	60	100	4	IBM
DSC	BCADSN25302	Mobile Application Development	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN25303	Web Development Using Python	2	1	0	40	60	100	3	
DSE		Discipline Specific Elective-II	2	1	0	40	60	100	3	
DSE		Discipline Specific Elective-III	2	1	0	40	60	100	3	
DSC	BCADSN25351	Web Development Using Python Lab	0	0	4	40	60	100	2	
DSC	BCADSN25352	Mobile Application Development Lab	0	0	4	40	60	100	2	
	GPN2501	General Proficiency	0	0	0	100	0	100	1	
Total			**11**	**5**	**8**	**380**	**420**	**800**	**21**	

SEMESTER VI

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN16351	Industrial Training Cum-Project	0	0	0	280	420	700	20	
	GPN2601	General Proficiency	0	0	0	100	0	100	1	
Total			**0**	**0**	**0**	**380**	**420**	**800**	**21**	

Early Exit Option-3:Award of Bachelor of Computer Applications(After3Year:146 Credits)

SEMESTER VII

Course Category	Course Code	Course Title	Period Per Week			Evaluation Scheme			Credits	Mode
			L	T	P	CIA	ESE	Total		
DSC	BCADSN27401	Statistical & Optimization Techniques	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN27402	Research Methodology	2	1	0	40	60	100	3	
DSE		Discipline Specific Elective-IV	3	1	0	40	60	100	4	
DSE		Discipline Specific Elective-V	2	1	0	40	60	100	3	
DSC	BCADSN27452	Dissertation-I	0	0	12	100	200	300	6	
	GPN2701	General Proficiency	0	0	0	100	0	100	1	
Total			**9**	**4**	**12**	**360**	**440**	**800**	**20**	

SEMESTER VIII										
Course Category	**Course Code**	**Course Title**	**Period Per Week**			**Evaluation Scheme**			**Credits**	**Mode**
			L	**T**	**P**	**CIA**	**ESE**	**Total**		
DSC	BCADSN28401	R Programming	2	1	0	40	60	100	3	SCHOOL
DSC	BCADSN28402	Intellectual Property Right	2	1	0	40	60	100	3	
DSC	BCADSN28451	R Programming Lab	0	0	4	40	60	100	2	
DSC	BCADSN28452	Dissertation-II	0	0	28	200	300	500	12	
	GPN2801	General Proficiency	0	0	0	100	0	100	1	
Total			**4**	**2**	**32**	**420**	**480**	**900**	**21**	

Award of Bachelor of Computer Applications With Research(After4Years:187Credits)

DSC	Discipline Specific Core
DSE	Discipline Specific Elective
GE	Generic Elective
VAC	Value Added Course
CC	Co-Curricular
VC	Vocational Course
GP	General Proficiency
L	Lecture
T	Tutorial
P	Practical

Generic Elective-I		
1	BCADSN21111	Discreet Mathematics
2	BCADSN21112	Introduction to Statistical Method
Generic Elective-II		
1	BCADSN22111	Computer Organization
2	BCADSN22112	System Analysis and Design
Generic Elective-III		
1	BCADSN23211	Information & Data Security
2	BCADSN23212	Essential of Data Collection Ethics
Generic Elective-IV		
1	BCADSN24211	Foundation of Deep Learning
2	BCADSN24212	Data Warehousing & Data Mining

Discipline Specific Elective-I		
1	BCADSN24221	Computer Vision
2	BCADSN24222	IOT & Technology
3	BCADSN24223	Soft Computing
Discipline Specific Elective-II		
1	BCADSN25321	Explainable AI(XAI)
2	BCADSN25322	Swarm Intelligence
3	BCADSN25323	Neural Network
Discipline Specific Elective-III		
1	BCADSN25324	Deep Learning
2	BCADSN25325	Bioinformatics& Computational Biology
3	BCADSN25326	Block-chain Technology
Discipline Specific Elective-IV		
1	BCADSN27421	Distributed System
2	BCADSN27422	Ethics For Data Science
3	BCADSN27423	Data Privacy and Laws
Discipline Specific Elective-V		
1	BCADSN27424	Transformers & Large Language Models(LLM)
2	BCADSN27425	Natural Language Processing
3	BCADSN27426	Human Computer Interaction

Note:1.Student may select any subject from Co-Curricular list offered by the University

2.Student may select any subject from Vocational Course list offered by the University

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	I		
Course Name	Clean Coding with Python and EDA				
Code	BCADSN21101				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	The objective of this course is to provide students with a practical understanding of Python Programming. It will dive deep in managing the concept and significance of Data Management and Data Frames, and to understand need and usages of graphical tools and relevant statistical functions, correlations.				
Course Outcomes					
CO1	Develop solutions to simple computational problems using Python programs.				
CO2	Solve problems using conditionals and loops in Python. Develop Python programs by defining functions and calling them.				
CO3	Introduction to NumPy, importance and applications in scientific computing.				
CO4	Pandas Foundation and EDA.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction Of Coding:** What is Bad Code? What is Clean Code? Purpose of Clean Code, Thought of experienced programmers, Meaningful Names, Intention Revealing Names, Make Meaningful Distinctions, Use Pronounceable Names, Avoid Encodings and Mental Mappings, Difference between smart and professional programmer, Class and Method Names, Function Size Matters, Blocks and Indenting, Do only one thing within a function, One level of abstraction per function, Use Descriptive Names, Function Arguments, Advantages of Having Less Arguments, Command Query Separation, Prefer Exceptions to Returning Error Codes.	15	CO1
2	**Python Downloading and installing:** What is Python? Advantages and disadvantages, Downloading and installing, Which version of Python. **Python Programming Concept:** Running Python Scripts, Using the interpreter interactively, Using variables, String types: normal, raw and Unicode, String operators and expressions, Math operators and expressions, Writing to the screen, Reading from the keyboard, Indenting is significant, The if and elif statements, While Loops, Using List, Dictionaries, Using the for statement, Opening, reading and writing a text file, Using Pandas, the python data analysis library and data frames, Grouping, aggregating and applying, merging and joining, Dealing with syntax errors, Exceptions, Handling exceptions with try/exception.	15	CO2
3	**Numpy Foundation:** Introduction to NumPy, importance and applications in scientific computing, Understanding NumPy's speed due to C/Fortran implementation, efficient memory usage and vectorized operations. Understanding NumPy arrays (1D, 2D, multidimensional), array creation techniques using array(), arange(), linspace(), zeros(), ones(), empty(), array indexing, slicing, and iteration, shape manipulation using reshape, ravel, flatten, transpose, stacking arrays using vstack(), hstack(), dstack(), splitting arrays using vsplit(), hsplit(), array_split(), mathematical operations (element-wise, broadcasting, vectorization), statistical operations like	15	CO3

	mean, median, std, sum, max, min, boolean indexing and conditional selection, random number generation using numpy. random, aggregations and axis-wise operations.		
4	**Pandas Foundation and EDA:** Introduction to Pandas and its role in data analysis, understanding Series and DataFrames, creating and accessing data in Series and DataFrames, indexing, slicing, and subsetting, importing/exporting data (CSV, Excel, JSON), handling missing data (NaN), filling or dropping values, renaming columns, type conversion, replacing values, grouping and aggregation with groupby and agg, merging, joining, concatenating datasets, sorting and filtering data, formatting string values, using apply(), map(), and lambda functions in Pandas, Pivot tables in pandas.RE Pattern Matching, Parsing Data, Introduction to Regression, Types of Regression, Use Cases, Exploratory data analysis, Correlation Matrix.	15	CO4

Suggested Readings:

1. “Python Crash Course” by Eric Matthesi
2. "NumPy Beginner's Guide" by Ivan Idris
3. “Python for Data Analysis” by Wes McKinney

Online Resources:

1. https://pandas.pydata.org/docs/user_guide/index.html#user-guide
2. https://numpy.org/doc/stable/user/index.html

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2	2
CO3	2	1	3	2	2		2		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	I		
Course Name	Fundamentals of Computer & Programming in 'C'				
Code	BCADSN21102				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The subject focuses on the fundamentals of Computer and its peripherals with modern technology along with methodology of programming with concepts of C Programming.				
Course Outcomes					
CO1	Demonstrate the knowledge of the basic structure of computers, History of Computer, Hardware, Software, Input / Output devices, Computer languages, Language Translators.				
CO2	Describe the concept of data communication and networks along with the few concepts of modern technology.				
CO3	Learn various constructs of C Language along with programming constructs.				
CO4	Understand the concept of array, structure, functions, and pointers.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Computers:** Introduction to computer, Basics of computers and its operation, History of computer, Capabilities and limitations of computers, Types of computers; **Hardware:** CPU(Architecture & Related Technology); **Storage Devices:** Primary & Secondary; Auxiliary Storage Devices; Cache Memory; Memory Hierarchy; **Software:** Types of software : Application Software and System Software; Input devices; Output Devices; **Operating System:** Functions, Types, Need of Operating System; DOS; Translator: Compiler, Interpreter & Assembler; **Types of Languages:** Machine Language, Assembly Languages, High level Languages; Loader, Linker, Flowchart; **Algorithms:** Introduction, Definition, Characteristics, Limitations.	12 Hrs.	CO1
2	**Introduction to C:** Introduction; Structure of C Program; Writing the first C Program; File used in C Program; Compiling and Executing C Programs; Comments; Data Types, **Tokens:** Keywords, Literals, Identifiers, Variables, Constants; I/O Statements; **Operators:** Types of operators, Precedence and Associativity of operators; Programming Examples; Type Conversion and Type Casting.	10 Hrs.	CO2
3	**Decision Control Statements:** If, If-Else, Nested If, If-Else Ladder, Switch-Case. **Iterative Statements:** For Loop, While Loop, Do-While Loop. **Jump Statement:** Break, Goto and Continue. **Functions:** User-Defined Functions; Function Declaration; Types of Arguments: Actual Arguments, Formal Arguments; Function Definition; Methods to Call a Function: Call by Value, Call by Reference.	11 Hrs.	CO3
4	**Introduction to Array, Structures, Union: Array:** Types of Array: Single Dimension Array, Two-Dimensional Array; Address Calculation of an Element in Array; Insertion and Deletion in an Array.	12 Hrs.	CO4

	Passing Arrays as Parameters; **Pointers:** Declaration of Pointer Variables; Pointer Arithmetic; Pointers and Arrays, Pointer and Character Strings, Array of Pointers, Pointers as Function Arguments; Structure, Union & Enumeration, Storage Classes. **Dynamic Memory Allocation**: Introduction, Library functions – malloc, calloc, realloc and free.		

Suggested Readings:

1. E. Balagurusamy, "Fundamentals of Computers", McGraw Hill Education.
2. Thareja R., "Fundamentals of Computers", Oxford University Press.
3. Peter Norton's, "Introduction to Computers", TMH Publications
4. E. Balagurusamy, "Programming in ANSI C", TMH Publications.
5. Reema Thareja, "Programming in C", OXFORD University Press.
6. Raja Raman. V, "Fundamentals of Computers", PHI Publications, 3rd Edition, 2004.

Online Resources:

1. https://nptel.ac.in/courses/106104128
2. https://archive.nptel.ac.in/courses/106/104/106104128/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2			1	2	2		2	1		1	2	1
CO2	1	3	1		2	3	2		2	1		1	3	1
CO3	3	2	2	3	2	3	2		2	2		3	2	3
CO4	2	3	3	3	3	3	2		2	3		3	3	3

Program	Bachelor of Computer Applications(DS&AI)				
Year	I	**Semester**	I		
Course Name	Database Management System				
Code	BCADSN21103				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	TheobjectiveofthiscourseistointroducethefundamentalconceptsofDBMS, Terminologies of database management system, E-R Modelling, PL/SQL concept, database transactions and concurrency control techniques.				
Course Outcomes					
CO1	Understand the basic concepts of the database and data models.				
CO2	Understand the fundamental concepts ER diagrams and map ER diagrams into Relations.				
CO3	Evaluatethealternativedatabasedesignstodeterminewhichoneisbetter according to selected criteria.				
CO4	Understand the basic concepts/features of database transactions and concurrency control techniques.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Data and information, Concepts of persistent data **Database Management System:** Introduction of DBMS, Evolution of DB & DBMS, Characteristics of the Database Approach, Components of Database System, Database Management System vs. File Management System, Advantages and Disadvantages of DBMS, DBMS Users, DBMS Architecture, Capabilities of good DBMS, Database Schemas and Instances, Classification of Database Management Systems, Database Languages. **Data Models:** Introduction of Data Models: Relational Data Model, Entity Relationship Data Model, Object Based Data Model, Network Data Model, Hierarchical Data Model.	12Hrs.	CO1
2	**Relational Database Management System &Data Modelling:** Introduction to Relational database, Structure of Relational Database, Relational Data Model, Relational model terminology: Relations , Domains, Attributes, Tuples, Relational Constraints, Codd Rule, Entity- Relationship Model: Entity Sets, Entity Types, Attributes, Attributes Types, Relationships, Relationship Types, Keys, Constraints, Entity-Relationship Model: E-R Model Concepts, Notation for E-R Diagram, Mapping Constraints, Extended E-R Features, Reduction of E-R Diagram to Relation. **Relational Algebra:** Concepts of Relational Algebra, Fundamentals Operations: Select, Project, Rename, Union, Set difference, division, Cartesian Product, Additional Relational-Algebra Operations: Set Intersection, Natural Join And Outer Join	12Hrs.	CO1& CO2
3	**SQL and Database Design Theory:** Introduction on SQL: Characteristics of SQL, Advantage of SQL, SQL Data Type and Literals, Types of SQL Commands, SQL Operators and their	11Hrs.	CO3

	Procedure, Queries and Sub Queries, Aggregate Functions, Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus, View. **Functional Dependencies and Normalization:** Informal Design Guidelines for Relation Schemas, Database Anomalies, Functional Dependencies, Armstrong's axioms, Closure of Attribute sets, Normal Forms, First Normal Form, Second Normal Form, Third Normal Forms and Boyce-Codd Normal Forms.		
4	**Transaction Processing & Concurrency Control:** Introduction to Transaction ACID Properties, Transaction State. Transaction logs, Importance of Backups. Database recovery. Causes of failures. Recovery concepts and terminology. **Concurrency Control:** Definition of concurrency, lost update, Dirty read, and incorrect summary problems due to concurrency.	10Hrs.	CO3& CO4

Suggested Readings:

1. Korth, Silbertz, Sudarshan, Database Concepts, McGraw Hill.
2. Elmasri Navathe, Fundamentals of Database Systems, Addison Wesley.
3. Date C.J, An Introduction to Database Systems, Addison Wesley
4. Bipin C. Desai, An Introduction to DatabaseSystems, Galgotia Publications
5. Ramakrishnan, Gehrke,Database Management System, McGraw Hill
6. Ivan Bayross--SQL, PL/SQL: The Programming Language of Oracle, BPP Publication.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105175/
2. https://nptel.ac.in/courses/106104135

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					1			1		1	2	2	1
CO2	1	2	3	1	3	2	1		3	2	2	2	2	2
CO3	1	1	2	3	2	2	2		3	2	2	2	2	3
CO4	2	2	1	2		2	1		1	1		2	1	2

Program	Bachelor of Computer Applications(DS & AI)				
Year	I	**Semester**	I		
Course Name	Basic Mathematics				
Code	BCADSN21104				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	0	0	2
Course Objectives	To introduce the fundamental concepts of mathematics this will help and guide students to understand and make comprehensive rest of the course.				

Course Outcomes	
CO1	Understand the concept of Sequence, Matrices and Determinant.
CO2	Understand the concept of Differentiation and Integration.

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Finite and Infinite Sequences:** Definition, nth term, Sum of n terms of sequence, Arithmetic Progression, Geometric Progression and Harmonic Progression. **Matrices and Determinant:** Definition, Types of matrices, multiplication of matrix by scalar, Sum of matrices, difference of matrices, Product of matrices, Transpose of matrix. **Determinant:** Definition and basics properties.	15	CO1
2	**Differentiation and Integration:** Meaning and geometrical interpretation of derivative, derivatives of simple algebraic and trigonometric function, derivatives of sum/difference, product and quotient of function, **Integration:** Integration as the inverse of differentiation, Integration of algebraic and trigonometric function, Definite Integral.	15	CO2

Suggested Readings:

1. O.P.Malhotra,S.K.Gupta,"Mathematics",S.Chand,2000Edition.
2. Shanti Narain, "Text book of Matrices", S.Chand.

Online Resources:

1. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ma04/
2. https://archive.nptel.ac.in/courses/111/106/111106146/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1		1	1							1	1	1
CO2	1	1	1	2	2	1	1					2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	I		
Course Name	Discrete Mathematics				
Code	BCADSN21111				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The objective is that students will be able to distinguish between the notion of discrete and continuous mathematical structures & will be able to apply fundamental counting algorithms to solve applied problems in the area of computer science.				

Course Outcomes	
CO1	To Perform operations on discrete structures such as sets, functions, relations, and sequences.
CO2	To Solve problems of recurrence relations and generating functions.
CO3	To Verify the correctness of an argument using propositional and predicate logic and truth tables.
CO4	To understand the concept of graph theory.

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Set Theory, Relation & Function:** Set Theory: Definition of Sets, Type of Sets, Venn Diagrams, Operation on Sets, Subsets, Power Set, Cartesian Product, Principle of Inclusion and Exclusion, Multisets; **Relation:** Definition of Relation, Binary Relations, Inverse Relations, Composition of Relations, Properties of Relations, Equivalence Relations, Partial Order Relations, Partial Ordered Set, Hasse Diagram of Poset; **Function:** Definition & Type of Functions, One-to-One Function, Onto Function, Inverse Function, Compositions of Functions .	12	CO1
2	**Discrete Numeric Function and Recurrence Relation:** Numeric Function, Generating Function, Recurrence Relation, Linear Recurrence, Relation with Constant Coefficients, Homogeneous and Particular Solution, Solution by Method of Generating Function.	10	CO2
3	**Fundamentals of Logics:** Proposition, First order Logic, Logical Operation, Truth Values, Compound Proposition, Tautologies & Contradiction, Logical Equivalences, De-Morgan's laws. Predicates, Universal and Existential Quantifiers.	11	CO3
4	**Graph Theory:** Graph: Graph Terminology, Types of Graph: Simple Graph, Complete Graph, Bipartite, Regular and Planar Graph, Euler Graphs, Directed Graph, Hamiltonian Path and Circuits, Graph Coloring, Chromatic Number; **Tree:** Definition of Tree, Spanning Tree, Minimal Spanning Tree, Kruskal's Algorithms, Prim's Algorithms.	12	CO4

Suggested Readings :

1. J. P. Tremblay and R. Manohar, "Discrete Mathematical Structure with Application to Computer Science", TMH, New Delhi, 2000.
2. Kolman, Busby and Ross "Discrete Mathematical Structures" PHI/Pearson., 6th Ed., 2009.
3. Kenneth H. Rosen, "Discrete Mathematics & Applications", TMH, 6th Ed., 2007.
4. C. L. Liu, "Elements of Discrete Mathematics", McGraw Hill Book Company, 2nd Ed., 1985.
5. Narsingh Deo, "Graph Theory", PHI, 24th Indian Print, 2003.

Online Resources :

1. https://archive.nptel.ac.in/courses/106/108/106108227/
2. https://archive.nptel.ac.in/courses/106/103/106103205/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	1	1	1					1	1	2	1
CO2	2	2	1	1	1	1					1		2	1
CO3	2	2	2	2	1	1				1	1		2	2
CO4	3	3	2	2	2	2				1	1	1	2	2

Program	Bachelor of Computer Applications(DS&AI)				
Year	I	**Semester**	I		
Course Name	Introduction to Statistical Method				
Code	BCADSN21112				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	Subjects analyze statistical data graphically using frequency, cumulative frequency distribution, statistical data using central tendency, dispersion, basic probability concept & rules including additive and multiplicative laws.				
Course Outcomes					
CO1	To apply statistical distributions methods for real life problems.				
CO2	To draw & demonstrate valid inferences based on the analysis of statistical data.				
CO3	To Implement the concept of probability.				
CO4	To Implement the concept of conditional probability & Theoretical distribution.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Population, Sample and Data Condensation:** Definition and scope of Statistics, Concept of population simple with illustration, Raw data, attributes and variables, Classification, Frequency distribution, Cumulative frequency distribution. Different Frequency Chart: Histogram, Frequency Curve, Pi-Chart etc; **Measurement of Central Tendency**: Concept of Central Tendency, requirements of a good measures of central tendency; **Types of Central Tendency**: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode for grouped and ungrouped data.	12	CO1
2	**Measures of dispersion:** Concept of dispersion, Absolute and Relative Measures of Dispersion: Range, Quartile, Inter quartile Range, Mean Deviation, Standard Deviation; **Correlation and Regression** : Concept and types of correlation: Karl Pearson's, Spearman's Rank correlation, Linear Regression: Concept and line of best fit(Y on X and X on Y).	11	CO2
3	**Probability and Expected Value:** Experiment, Sample Space, Event, Types of Events, Probability: Classical Approach, Subjective Approach, Axiomatic Approach & Modern Definition; Probability Theorems (Additive, Multiplicative).	10	CO3
4	**Conditional Probability & Theoretical Distribution:** Definition of conditional probability, Bayes's Theorem, Mathematical Expectation ,Random Variable & Probability Distribution of Random Variable, Meaning of Theoretical Distributions, Difference between Theoretical & Observed Frequency Distributions, Binomial Distribution, Properties and Constants Of Binomial Distribution.	12	CO4

Suggested Readings:

1. S. C. Gupta, "Fundamental of Statistics ",Second Edition.
2. Roy D. Yates and David J. Goodman, "Probability and Stochastic Processes-A friendly introduction for Electrical & Computer Engineers, Second Edition.
3. V. K. Rohatgi, "An Introduction to probability and Mathematical Statistics" Wiley Eastern Ltd. New Delhi.
4. Johnson and Kotz, "Distributions in Statistics" ,Houghton and Mifflin ,Vol. I, II and III.

Online Resources:

1. https://archive.nptel.ac.in/courses/111/105/111105077/
2. https://onlinecourses.nptel.ac.in/noc22_cs120/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	1	1			1	2	1	1	1
CO2	2	2	2	2	1									
CO3	3	2	2	3	1									
CO4	2	2	2	2	1	1	1			1	1		1	1

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	I		
Course Name	Programming in 'C' Lab				
Code	BCADSN21151				
Course Type	DSC-Lab	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	To provide the fundamental knowledge about various concepts of 'C' Programming using various constructs like if, if-else, switch case, for loop, do while, etc. and apply code reusability using functions and pointers.				
Course Outcomes					
CO1	Understand various constructs of the C Language along with proper syntax.				
CO2	Develop programs using functions, pointers, structure, union on various topics.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Implementation of Fundamental Data Types. 2. Implementation of Fundamental Operators. 3. Implementation of Conditional Program such as if, switch etc. 4. Implementation of Basic Control Constructs such as For Loop, While Loop, Do While Loop. 5. Implementation of Functions. 6. Implementation of Functions using call by value and call by reference. 7. Implementation of This pointer. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. Implementation of Structures, Union, and Enumeration etc. 2. Implementation of Pointers. 3. Implementation of Pointers as Function Arguments. 4. Implementation of Pointer of Pointer. 5. Implementation of Nested Structure. Note: - Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings:

1. E. Balagurusamy, "Programming in ANSIC", TMH Publications.
2. Reema Thareja, "Programming in C", OXFORD University Press.
3. Peter Norton's, "Introduction to Computers", TMH Publications
4. Kernighan, Ritchie, "The C Programming Language", PHI Publications
5. Yashwant Kanitakar, "Let us C", BPB Publications.

Online Resources:

1. https://nptel.ac.in/courses/106104128
2. https://cse02-iiith.vlabs.ac.in/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	3	2	2	3		1	2	2	1	2	3
CO2			2	3	3								2	3

Program	Bachelor of Computer Applications (DS&AI)				
Year	I	**Semester**	I		
Course Name	Database Management System Lab				
Code	BCADSN21152				
Course Type	DSC-Lab	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	The main objective is students gain knowledge about databases for storing the data and to share the data among different kinds of users for their business operations				
Course Outcomes					
CO1	Develop data base modeling for a problem.				
CO2	Design a data base using normalization.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Creating and Managing Tables a. Creating and Managing Tables b. Including Constraints c. Validations 2. Manipulating Data a. Using INSERT statement. b. Using DELETE statement. c. Using UPDATE statement. 3. SQL Statements–1 a. Writing Basic SQL SELECT Statements b. Restricting and Sorting Data c. Single-Row Functions 4. SQL Statements–2 a. Displaying Data from Multiple Tables b. Aggregating Data Using Group Functions c. Sub queries Note: - Students will also perform all other exercises provided by course instructor.	15	CO1& CO2
2	Using SET operators, Date/Time Functions, GROUPBY clause (advanced features) and advanced sub queries a. Using SET Operators b. Date time Functions c. Enhancements to the GROUP BY Clause d. Advanced Sub queries 2. Creating and Managing other database objects a. Creating Views b. Other Database Objects c. Controlling User Access 3. Using DCL commands a. Creating users b. Authenticating users Note: - Students will also perform all other exercises provided by course instructor.	15	CO1& CO2

Suggested Readings:

1. IvanBayross,"SQL,PL/SQL:TheProgrammingLanguageofOracle",BPPPublication.
2. Connolly&Begg,"DatabaseSystems:APracticalApproachtoDesign,Implementationand Management", Pearson Education.
3. R.S. Despandey,"SQL/PLSQL for Oracle",Dreamtech.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105175/
2. https://nptel.ac.in/courses/106104135

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	3	2	2	3		1	2	2	1	2	3
CO2			2	3	3								2	3

SECOND SEMESTER

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**		**II**	
Course Name	Cloud Application Development				
Code	BCADSN22101				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		**3**	**1**	**0**	**4**
Course Objectives	To learn different cloud computing techniques and concepts for the development of the services with virtualization and hypervisor.				
Course Outcomes					
CO1	Understand Cloud Computing models and methods and deep down into IBM Cloud.				
CO2	Understand and apply DevOps services and Watson API.				
CO3	To develop the cloud application development skills such as REST architecture and JSON.				
CO4	Understand and apply data services and Containerization with IBM Cloud.				

Module	**Course Contents**	**Content Hrs.**	**Mapped CO**
1	Introduction to cloud computing: characteristics of Cloud, benefits of Cloud and the factors contributing to its growth, cloud services models (IaaS, PaaS and SaaS), cloud deployment options (Private, Public, Hybrid). Deep Down into IBM Cloud: What is IBM Cloud? Evolution of IBM Cloud, identify the runtimes and services that IBM Cloud offers, IBM Cloud regions, zones and multi-availability zones, IBM Cloud dashboard, catalog, and documentation features, starter kits and describe the environmental variables that are used with IBM Cloud services, function as a service (FaaS).	15	CO1
2	Introduction to DevOps: Illustration of DevOps, describe the capabilities of IBM Cloud Continuous Delivery, identify the web- based integrated development environment features in IBM Cloud Continuous Delivery. how to use source code management and Issue tracking, learn how to build and deploy applications using DevOps tools on IBM Cloud.	15	CO2
3	REST architecture and Watson APIs: Architecture of Representational State Transfer (REST), representation format of data in REST, advantages of the JavaScript Object Notation (JSON) data format. IBM Watson services on IBM Cloud, Cloudant and NoSql databases.	15	CO3
4	Application with IBM Cloud services: Understand business problems and goals, functional and non-functional requirements. Containerization with Cloud: Introduction to Containers, Dockers and Docker Hub, Container orchestration (Kubernetes) Pods, Deployment, Service and building a cluster by using IBM Cloud.	15	CO4

Suggested Readings:

1. Cloud Computing Concepts and Technologies- Sunil Kumar Manvi, Gopal Shyam
2. The Enterprise Cloud: Best Practices for Transforming Legacy It- James Bond.

Online Resources:

1. https://www.youtube.com/watch?v=EN4fEbcFZ_E
2. https://www.youtube.com/watch?v=1PAy6d16ADQ
3. https://cognitiveclass.ai/courses/cloud computing

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	1	2		1	1	1			1	1		1
CO2	2	1	2	1	2	2	2	1		1			1	2
CO3	1	2	1	3		2	2			2	1	2	1	3
CO4	1	2	3	2	2	2	1			3		2	2	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**		II	
Course Name	Data Visualization				
Code	BCADSN22102				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Python	2	0	0	2
Course Objectives	To effectively visualize and clean data using IBM Watson Studio, focusing on data refinement through Data Refinery and creating customized visualizations using Python libraries Matplotlib and Seaborn, with Pandas for data handling.				
Course Outcomes					
CO1	Understand and apply data visualization techniques and gain knowledge of Watson Studio and Python.				
CO2	Learn to identify suitable data visualization techniques based on specific data requirements, and acquire hands-on experience using Matplotlib and Seaborn libraries to visualize various datasets.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Foundation of Data Visualization:** Introduction to Data Visualization, importance and use cases, understanding types of data (numerical, categorical), basics of Matplotlib and its components (figure, axes, labels, legends), creating basic plots (line plot, bar chart, histogram, pie chart, scatter plot) using matplotlib, customizing plots (colors, markers, line styles, titles, legends, labels), adjusting plot size and layout, saving and exporting plots in various formats.	15	CO1
2	**Data Visualization with Watson Studio and Seaborn:** Introduction to Watson Studio, Adding data to data refinery, Visualization of Data on Watson Studio, comparison between Seaborn and Matplotlib, Multivariate visualizations using pair plots, Basic plots using seaborn, Advanced Visualization Tools (Waffle Charts, Word Clouds), Integration with Pandas, Hands-on practice with real-world datasets using Matplotlib and Seaborn	15	CO2

Suggested Readings:

1. IBM Courseware
2. "Python for Data Analysis" by Wes McKinney
3. "Python Data Science Handbook" by Jake VanderPlas
4. Core Python Programming -Second Edition, R. Nageswara Rao, Dreamtech Press.

Online Resources:

1. https://matplotlib.org/stable/contents.html
2. https://www.w3schools.com/python/matplotlib_intro.asp
3. https://www.youtube.com/watch?v=UO98lJQ3QGI
4. https://www.geeksforgeeks.org/data-visualization-using-matplotlib/
5. https://dataplatform.cloud.ibm.com/docs/content/wsj/getting-started/welcome-main.html
6. https://www.kaggle.com/code/kanncaa1/seaborn-tutorial-for-beginners
7. https://cognitiveclass.ai/courses/data-visualization-python

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	2	3	2		2	1	2	1	1	3	2
CO2	3	2	3	2	2	3		2	2	2	2	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	II		
Course Name	Operating Systems				
Code	BCADSN22103				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To provide a good understanding of the underlying concepts of operating systems.				
Course Outcomes					
CO1	Understand the principles and techniques used to implement processes and threads as well as the different algorithms for process scheduling.				
CO2	Understand the mechanisms used for process synchronization & handling deadlock.				
CO3	Understand the concept of memory management and virtual memory.				
CO4	Understand the file system structure and storage management.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction and Process Management:** Operating System: System Components, System Calls and its types, System Programs; Types of Operating System; Operating System Structure: Simple Structure, Layered Approach, Microkernels, Exokernels; Virtual machine; Introduction to Process: Process States, Process Control Block; Process Scheduling: Scheduling Queues, Schedulers, Context Switch, Scheduling Objectives, Scheduling Criteria; Scheduling Algorithms: First Come First Serve, Shortest Job First, Round Robin, Priority; Multiple-Processor Scheduling; Real-Time Scheduling; Multilevel Feedback Queue Scheduling; Threads.	12	CO1
2	**Process Synchronization and Deadlocks**: Critical- Section Problem; Peterson's Solution; Semaphore: Usage of Semaphore; Classical Problems of Synchronization: Producer Consumer, Readers-Writer, Dining Philosophers; Deadlock System Model; Deadlock Characterization: Necessary Condition, Resource- Allocation graph; Deadlock Handling Methods: Deadlock Prevention, Deadlock Avoidance Mechanisms: Resource Allocation graph Algorithm, Banker's Algorithm, Deadlock Detection and Recovery.	12	CO1 & CO2
3	**Memory Management**: Memory Management Strategies: Address Binding, Logical and Physical Address Space, Dynamic Linking; Swapping; Contiguous and Non- Contiguous Memory Allocation; Paging; Segmentation; Virtual Memory Management Concept; Demand Paging; Page Replacement Policies: Basic Page Replacement, FIFO Page Replacement, LRU Page Replacement, Optimal Page Replacement, Counting Based Page Replacement; Allocation of Frames: Minimum Number of Frames, Allocation Algorithm, Global Versus Local Allocation; Thrashing: Cause of Thrashing, Working Set Model.	11	CO2 & CO4

4	**Storage Management:** File Concept: File Attribute, File Operations, File Types**,** File Structure; File Access Method: Sequential Method, Direct Access Method; Directory Structure; File System Implementation: File System Structure, Allocation Methods**,** Free space Management; Secondary Storage Structure: Disk Structure**,** Disk Scheduling Algorithms**,** Disk Management.	10	CO3 & CO4

Suggested Readings:

1. Abraham Silberschatz and Peter Baer Galvin, "Operating System Concepts", Addison-Wesley.
2. Andrew S. Tanenbaum, "Modern Operating Systems", Prentice Hall.
3. Milan Milankovic, "Operating Systems, Concepts and Design", TMH.
4. William Stallings, "Operating Systems: Internal and Design Principles", PHI.
5. D M Dhamdhere, "Operating System- a Concept based Approach", McGraw Hill Education.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105214/
2. https://onlinecourses.nptel.ac.in

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3					2	2			1	1	3	2	
CO2	3	3		3	2	2	3			2	1	3	2	
CO3	2	2		2		1				2	2	3	2	
CO4	2	1		2	1	2	1			1	1	2	2	

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	Semester	II		
Course Name	Data Structure Using Python				
Code	BCADSN22104				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	This course aims to build foundational knowledge of data structures using Python, including arrays, lists, tuples, sets, and dictionaries. It develops problem-solving skills through functions, recursion, stacks, queues, linked lists, and object-oriented programming. The course also explores trees, graphs, and algorithmic techniques like sorting and searching for efficient data handling.				
Course Outcomes					
CO1	To understand fundamental linear data structures and algorithmic analysis using Python, including arrays, lists, and tuples.				
CO2	To develop problem-solving skills using sets, dictionaries, recursion, stacks, and queues in Python.				
CO3	To understand object-oriented concepts and implement various types of linked lists and their applications in Python.				
CO4	To explore non-linear data structures, sorting/searching algorithms, and graph representations using Python.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Data Structures:** Introduction to Data Structure, Classification of Data Structure: Linear, Non-Linear, Python Specific Data Structure; Operations on Data Structure, Algorithms Analysis, Approach to solve algorithm design problems, Types of Case Analysis, Big-O Notation, Abstract Data Type. **Array:** Creation, array(data_type, value), Basic operations on Array: Adding elements, Accessing elements, Removing elements, Slicing, Searching element, Updating Array; **List:** Creation, list(), Accessing Elements in List, Negative List Indices ,List Slicing[start:end], Updating List, Deleting List Elements, Built-in list class Methods, List operators, List Comprehension, Difference between list & array; **Tuple:** Creation, tuple(),Accessing Elements in Tuple, Updating Tuple, Deleting Tuple Elements Built-in tuple class methods, Indexing & slicing, Operations on tuple, List & Tuple	12	CO1
2	**Set:** Creation, set(), Accessing values in set, Adding items in set, Removing items in set, set operator, Built-in set class methods, Set operations: union(), intersection(), difference(), symmetric_difference(); **Dictionary:** Creation, dict(), Adding values, Replacing values, Retrieving Values, Formatting, Deleting items, Comparing, Built-in dict class methods, Traversing, Nested Dictionary, Traversing Nested Dictionary; 2D Array, Matrix, Map(); **Functions:** Syntax, use of function, return statement, parameters & arguments; **Recursion:** Recursive Definition and Processes, Principles of Recursion, Tower of Hanoi Problem, Recursion Vs. Iteration; **Stack:** Introduction, Implementation of stack in python, Operations on Stacks: Empty, Full, Push & Pop, Applications of stack, Conversion in Infix, Prefix and Postfix Expressions, Evaluation of postfix expression using stack; **Queue:** Introduction, Implementation of Queues in Python, Operations on Queue: Create, Add, Delete, Full and Empty Queue, Circular Queue, Dequeue and Priority Queue	12	CO2

3	**Classes: Defining Classes:** Adding Attributes, Assigning values to an attribute; Self parameters and adding methods to a class, Displaying class attributes and methods, special class attributes, Accessibility, _init_() (Constructor), _del_() (Destructor); **Link Lists:** Linear List concept, Linked List Terminology, Representation of Linked List in Memory, Types of Linked List, Single Linked List, Doubly Linked List, Single Circular Linked list, Circular Doubly Linked List, Operations on Link List: Creation, Traversing, Insert a node(empty list, beginning, middle, end), Delete a node (first, Last, at any position), Traversing node, Searching node, Print list, Count Nodes, Sort Lists, Implementation using Linked List: Stack Queue, Circular Queue, Dequeue, Priority Queue.	11	CO3
4	**Trees:** Introduction to Tree & its Terminology, Binary trees, Types of Binary trees, Representation of Binary Tree, Traversals (Inorder, Preorder, Postorder), Expression Tree, Binary Search Tree, Insertion and Deletion in BST; **Heap:** Min Heap, Max Heap. Graph: Terminology, Representation of Graph: Adjacency Matrix, Incidence Matrix; **Sorting & Searching Techniques:** Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort Sequential/Linear Search, Binary Search.	10	CO4

Suggested Readings:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley
2. Bradley N. Miller, David L. Ranum, "Problem Solving with Algorithms and Data Structures Using Python", Franklin, Beedle & Associates
3. Benjamin Baka, "Python Data Structures and Algorithms", Packt Publishing
4. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles (Python Edition)", CareerMonk Publications

Online Resources:

1. https://archive.nptel.ac.in/courses/106/102/106102064
2. https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		2	1	3	1		1	2	1	3	3	3
CO2	2	2		3	2	3	1		1	2	1	3	3	3
CO3	2	2		3	2	3	1		1	2	1	3	3	3
CO4	2	2		3	2	3	1		1	2	1	3	3	3

Program	Bachelor of Computer Applications (DS &AI)				
Year	I	Semester	II		
Course Name	Computer Organization				
Code	BCADSN22111				
Course Type	GE	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	Develop a comprehensive understanding of Digital Electronics and Computer Organization, focusing on the design and implementation aspects. Enable students to effectively analyze and communicate design challenges in developing processors or other components that meet specific design requirements.				
Course Outcomes					
CO1	Acquire a strong foundation in the vocabulary and fundamental principles of Digital Electronics.				
CO2	Develop a solid understanding of the terminology and fundamental principles of Computer Processors.				
CO3	Gain a comprehensive understanding of the principles governing communication between Input/Output (I/O) devices and Processors.				
CO4	Demonstrate a thorough understanding of the concepts related to storing and retrieving data from memory.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Digital Electronics:** Number System, Boolean Algebra**,** Minimization of Boolean Expressions using K-Map; Logic Gates, Implementations of Logic Functions using Gates; **Combinational Circuits:** Introduction to combinational circuits, Adders & Subtractors; Multiplexer, Decoder; **Sequential Circuit:** Introduction to Flip Flops, Types of Flip flop, Excitation table of Flip flop, Introduction of Registers; Classification of Registers, Introduction of Counter; Synchronous and Asynchronous counter.	12	CO1
2	**Register Transfer Language**: Bus and Memory Transfer; **Micro operations**: Arithmetic, Logical, shift micro- operations; Arithmetic logic shift unit; Timing and control; Instruction codes; Computer instructions, Instructions Format, Instruction Cycle; **Central Processing Unit:** Accumulator based organization; General register organization; Stack organization; Addressing Modes, RISC v/s CISC, Hard wired & micro programmed control Unit.	12	CO2
3	**I/O Organizations:** Introduction to system buses; Input/ output interface; Interrupt and Types of Interrupts, Serial Vs Parallel communications; I/O Processor; Synchronous Data Transfer; Asynchronous Data Transfer methods: Strobe Control, handshaking; Modes of Data Transfer: Programmed I/O, Interrupt initiated I/O. DMA: DMA Controller, DMA Transfer.	11	CO2 & CO3
4	**Memory organizations**: Memory hierarchy; **Main Memory**: RAM Chips, ROM Chips; Concept of address space & Memory Space; Address Mapping; Auxiliary Memory; **Cache memory**: Mapping Techniques: Direct mapping, Associative mapping, Set associative mapping.	10	CO4

Suggested Readings:

1. M. Morris Mano "Digital Logic and Computer Design", 2nd Edition, PHI.
2. P. Raja, "Switching Theory", Fourth Edition, Umesh Publication.
3. M. Morris Mano, "Computer System Architecture", PHI
4. William Stalling, "Computer Organization & Architecture", Pearson Education Asia.

Online Resources:

1. https://www.youtube.com/watch?v=TH9nd-KdVHs
2. https://archive.nptel.ac.in/courses/117/106/117106086/
3. https://archive.nptel.ac.in/courses/106/105/106105163/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	3	2	2				2	1	1	2	2
CO2	2	2	2	2	2	3				3	2	1	3	2
CO3	2	2	1	1	1	1				2	2	2	2	
CO4	2	2	2	2	3	2				2	2	1	3	1

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	**Semester**	II		
Course Name	System Analysis and Design				
Code	BCADSN22112				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To provide the students with the skills to identify business problems which may be solved by technology based solutions and develop design which form the basis for implementing systems as well as strong foundation in system analysis and design concepts.				
Course Outcomes					
CO1	Describe principles, concepts and practice of System Analysis and Design process.				
CO2	To Understand software development life cycle and system documentation.				
CO3	To design appropriate information systems and manage development of systems based on system specification.				
CO4	Manage implementation and maintenance of information systems.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Basic Concept of Systems:** The system: definition and concepts, elements of a system: input, output processor, control, feedback, environment, boundaries and interface, characteristics of a system, types of systems -physical and abstract system, open and closed systems, man-made systems, information and its categories. **Information systems:** MIS, DSS; System analyst: role and need of system analyst, system analyst as an agent of change.	12	CO1
2	**Software Development Life Cycle SDLC**: System Planning and Requirements, initial investigation: Strategic Plan for Information processing, Tools for Planning, Problems in Planning, Need for requirement definition; Information gathering tools: Review of Literature, procedures and forms, On-Site observation, Interviews and Questionnaires; Methodologies, **Feasibility Study:** Economic Feasibility, Organizational Feasibility, Technical Feasibility, Behavioral Feasibility study. **Design:** Decision Tree, Data Dictionary, Decision Table , Data Flow Diagram, Components of a DFD, Zero Level DFD, Context Diagram, Leveling a DFD;	12	CO2
3	**Tools for System Analysis:** Data flow diagram (DFD), logical and physical DFDs, developing DFD, system flowcharts and structured charts, decision trees and decision tables. System design module **specifications:** Module coupling and cohesion, top-down and bottom-up design, logical and physical design and structured design	11	CO3

4	**System Implementation and Maintenance:** Need of system testing, types of system testing, quality assurance; system conversion, conversion methods, procedures and controls, system evaluation and performance, Maintenance activities and issues **System Security and audit:** System security, Security threats, Risk analysis, Control measures, System Audit, Disaster Recovery inning	10	CO4

Suggested Readings

1. Elias Awad — Systems Analysis And Design, Galgotia Publications.
2. V. Rajaraman —Analysis & Design of Information System, PHI.
3. Hussain & Hussain— Information Systems Analysis, Design and Implementation, McGraw Hill

Online Resources

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	1	2		1	1	1			1	1		1
CO2	2	1	2	1	2	2	2	1		1			1	2
CO3	1	2	1	3		2	2			2	1	2	1	3
CO4	1	2	3	2	2	2	1			3		2	2	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	I	Semester	II		
Course Name	Data Structure Using Python Lab				
Code	BCADN22151				
Course Type	DSC	L	T	P	Credit
Pre-Requisite	Python	0	0	4	2
Course Objectives	This course aims to build foundational knowledge of data structures using Python including arrays, lists, tuples, sets, and dictionaries. It develops problem-solving skills through functions, recursion, stacks, queues, linked lists, and object-oriented programming. The course also explores trees, graphs, and algorithmic techniques like sorting and searching for efficient data handling.				
Course Outcomes					
CO1	To implement fundamental linear data structures and algorithmic analysis using Python, including arrays, lists, and tuples, sets, dictionaries, recursion, stacks, and queues in Python.				
CO2	To implement object-oriented concepts and implement various types of linked lists and their applications in Python, non-linear data structures, sorting/searching algorithms, and graph representations using Python.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Implement linear search and binary search on a sorted list. 2. Create a program to insert, delete, and search elements in a 1D array using functions. 3. Write a Python program that demonstrates slicing and updating operations on lists and tuples. 4. Develop a menu-driven program to demonstrate differences between list and array using NumPy. 5. Implement set operations (union, intersection, difference, symmetric difference) without using built-in functions. 6. Create a dictionary to manage a student record system (add, update, delete, search records). 7. Write a recursive function to compute factorial and Fibonacci numbers, and compare with iterative methods. 8. Implement a stack and queue using a list and simulate infix to postfix conversion and evaluation. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. Create a Student class with methods for setting and displaying attributes; use constructor and destructor. 2. Implement a singly linked list with insertion (beginning, middle, end) and deletion operations. 3. Create a circular queue using a linked list with enqueue, dequeue, and display operations. 4. Implement a priority queue using a linked list to manage tasks with different priorities. 5. Implement a binary search tree (BST) with insertion, deletion, and inorder traversal. 6. Create a min-heap and max-heap using a list and perform heap sort. 7. Implement graph representation using adjacency list and perform BFS and DFS traversals. 8. Compare the performance of various sorting algorithms (bubble, selection, quick, merge) on a given list. Note: - Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley
2. Bradley N. Miller, David L. Ranum, "Problem Solving with Algorithms and Data Structures Using Python", Franklin, Beedle & Associates
3. Benjamin Baka, "Python Data Structures and Algorithms", Packt Publishing
4. Narasimha Karumanchi, "Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles (Python Edition)", CareerMonk Publications

Online Resources:

1. https://archive.nptel.ac.in/courses/106/102/106102064
2. https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		2	2	3	1		1	2	1	3	3	3
CO2	2	2		3	2	3	1		1	2	1	3	3	3

Program	Bachelor of Computer Applications				
Year	I	**Semester**	II		
Course Name	Computer Application Lab				
Code	BCADSN22152				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	The course objective of Microsoft Office is to provide users with a comprehensive understanding of the various tools and features available in the word processing software, spreadsheet software, presentation software and database management software.				
Course Outcomes					
CO1	Create, edit, save, and print documents. Include lists and tables in it. Format text and to use styles, add a graphic to a document, manipulate documents using functions such as find and replace; cut, copy, replace.				
CO2	Create, edit, save, and print, format presentations. Add a graphic to a presentation. Create and manipulate simple slide shows with outlines and notes. Use design layouts and templates for presentations.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	1. Microsoft Word: a. Creating and formatting a professional-looking resume. b. Designing a newsletter with multiple columns, images, and hyperlinks. c. Creating a table of contents and incorporating footnotes in a research paper. 2. Microsoft Excel: a. Creating a budget spreadsheet with formulas for calculating expenses, income, and savings. b. Analyzing sales data using charts and graphs to identify trends and patterns. c. Building a loan amortization schedule to understand repayment plans. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	3. Microsoft PowerPoint: a. Designing an engaging presentation on a historical event or a scientific concept. b. Creating an interactive slideshow with hyperlinks and custom animations. c. Using advanced features like slide transitions, embedded videos, and audio narration. 4. Microsoft Access: a. Creating a database to manage inventory for a small business. b. Designing a student database system to track grades, attendance, and courses. c. Building a customer relationship management (CRM) database to store and analyze customer data.	15	CO2

	Note: - Students will also perform all other exercises provided by course instructor.		

Suggested Readings:

1. McFedries, P. “Automating Microsoft Office 2019 Work with VBA”, Wiley, 2019.
2. Walkenbach, J., “Excel VBA Programming for Dummies”, Dummies, 2020.
3. Machado, M., “PowerShell for Office 365”, Apress, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106106092

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2		2	2	2	2		1	1	2	2	2	1
CO2	2	2		2	2	2	2		1	1	2	2	1	1

THIRD SEMESTER

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	Descriptive Analytics				
Code	BCADSN23201				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	Understand how analytics provided a solution to industries using real case studies. To learn the importance of analytics and how it's transforming the world today. Describe a reporting application, its interface, and the different report types and prompts. Learn the implementation of conditional formatting and different layout to work on.				
Course Outcomes					
CO1	To understand and implement the concept of configuring and using IBM Cognitive Analytics Tool.				
CO2	Understand how a business analysis software works, and its architecture				
CO3	Introduction to Power BI & Basic Data Analysis.				
CO4	Advanced Power BI & Data Insights.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Changing business with data insight Overview:** Understand how analytics is transforming the world, Understand the profound impact of analytics in business decisions, Understand what is analytics and how it works, Understand why business analytics has become important in various industries, Understand the history of analytics and how it has changed today, Understand how to analyze unstructured data, Understand how analytics is making the world smarter, Understand where the future of analytics lies, Explain why successful enterprises need business analytics, Understand how business analytics can help turn data into insight, Understand how predictive analytics is transforming all types of organizations, Explain how analytics supports retail companies, Understand how analytics can reduce crime rates and accidents, Explain the use of analytics in law enforcement and insurance companies, Understand how analytics can affect the future of education, Predictive Analytics Modeler, Big Data Developer, Data Warehouse Developer.	15	CO1
2	**IBM Cognos Analytics for Consumers:** Introduction to IBM Cognos Analytics – Reporting What is IBM Cognos Analytics – Reporting, Explore the environment, Examine the side panel, Explore authoring templates, Generate the report, Create list reports Examine list reports, Group data, Format list columns, Include list headers and footers Focus reports using filters Create filters, Filter your data with advanced detail filters, Create crosstab reports Create a crosstab report, Add measures to crosstab reports, Data sources for crosstabs,Design a Cognos prompt report for sales analysis and build a dashboard for customer insights visualization.	15	CO2

3	**Introduction to Power BI & Basic Data Analysis:** Covers Power BI basics, including interface, data import and transformation, basic DAX, visualizations, relationships, and publishing reports for sharing insights.	15	CO3
4	**Advanced Power BI & Data Insights:** Focuses on advanced data modeling, time intelligence, complex DAX functions, performance optimization, interactive dashboards, Row-Leve Security, and integration with Power Apps and Power Automate.	15	CO4

Suggested Readings:

1. he Definitive Guide to DAX" by Marco Russo and Alberto Ferrari
2. Power BI Cookbook" by Brett Powell
3. IBM Courseware

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc24_cs65/preview
2. https://learn.microsoft.com/en-us/training/powerplatform/power-bi

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2	2
CO3	2	1	3	2	2		2		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	NO SQL and Dbaas 101				
Code	BCADSN23202				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	0	0	2
Course Objectives	Students will understand fundamental concepts of a number of different NOSQL products. Students will also learn various CRUD operations and the querying mechanisms in NOSQL. Students will also comprehend with advanced topics. Use the MongoDB tools to develop and deploy your applications. Implement Java/ Python / PHP web application for a real world problem with MongoDB.				
Course Outcomes					
CO1	Define, compare and use the four types of NoSQL Databases (Document-oriented, Key Value Pairs, Column-oriented and Graph).				
CO2	Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.				
CO3	Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.				
CO4	Demonstrate an understanding of the detailed architecture; define objects, load data, query data and performance tune Key-Value Pair NoSQL databases.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	Definition of NOSQL, History of NOSQL and different NOSQL Products, Why NoSQL, NoSQL vs SQL, Interfacing and Interacting with NOSQL, Installing and Setting up MongoDB (Local + MongoDB Atlas)	7	CO1
2	MongoDB with Python (Using Pymongo library), Exploring: Mongo Shell and Compass, Data Model Design (Embedded Data Models and Normalized Data Models), Data types, Querying NOSQL stores, Modifying Data Stores and Managing Evolution MongoDB Use Cases, Understanding the NOSQL architecture, CRUD Operations, Operators (Comparison, logic, Evaluation, etc.)	8	CO2
3	NOSQL in cloud, Using MongoDB for Big Data Applications, Migrating from RDBMS to NOSQL, Query for All Documents in a Collection, Query by a Top-Level Field	7	CO3
4	Batch Processing, Data Aggregation Pipeline, Indexing, Join Concept (lookup in mongodb), Bucketing, Replication via Replica Sets, Query by a Field in an Embedded Document, Query by a Field in an Array, Specify Conditions with Operators, Combine Condition, Auto-Sharding, Shard Keys, Horizontal Scalability	8	CO4

Suggested Readings:

1. IBM Courseware
2. David Hows, "The definitive guide to MongoDB", 2nd edition, Apress Publication, 2009, 8132230485.
3. Shakuntala Gupta Edward, "Practical Mongo DB ", Second edition, Apress Publications, 2016, ISBN 1484206487

Online Resources:

1. https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-cs33/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2	2
CO3	2	1	3	2	2		2		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	Scala Programming				
Code	BCADSN23203				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The course equips students with a strong foundation in Scala programming, covering object-oriented and functional paradigms, enabling them to develop scalable, modular, and concurrent applications with modern development tools.				
Course Outcomes					
CO1	To understand Scala syntax, control structures, functions, and basic programming constructs for developing simple applications.				
CO2	To Apply object-oriented concepts using Scala's classes, traits, and access control to build modular and reusable code.				
CO3	To utilize Scala's collections and functional programming features like higher-order functions and pattern matching for efficient data processing.				
CO4	To implement advanced Scala features including concurrency, file handling, and project structuring to develop and manage real-world applications.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Basics of Scala Programming:** Introduction to Scala, History and features of Scala, Setting up the Scala environment (REPL, IDEs), Differences between Scala and Java, Variables and data types, Operators and expressions, Conditional statements (if-else, match-case), Loops (for, while, do-while), Functions and methods, Default and named arguments, Recursive functions, Immutable and mutable variables.	12	CO1
2	**Object-Oriented Programming in Scala:** Classes and objects, Primary and auxiliary constructors, Inheritance and polymorphism, Abstract classes, Traits and multiple inheritance, Method overriding, Access modifiers (private, protected, public), Companion objects, Case classes, Object equality and comparison.	12	CO2
3	**Collections and Functional Programming:** Immutable and mutable collections, Lists, Sets, Maps, Tuples, Arrays, Higher-order functions (map, filter, reduce, fold, flatMap), Anonymous functions (lambdas), Closures, Currying, Pattern matching, Option, Some and None, Working with iterators and streams, Lazy evaluation.	10	CO3
4	**Advanced Scala Features and Project Work:** File handling (reading and writing files), Exception handling, Implicit parameters and conversions, Futures and Promises for concurrency, SBT (Scala Build Tool) basics, Modular programming and packages, Creating and running Scala projects, Final mini project integrating OOP and functional programming concepts.	11	CO4

Suggested Readings:

2. Martin Odersky, Lex Spoon, Bill Venners, "Programming in Scala", Artima Press
3. Dean Wampler, Alex Payne, "Programming Scala", O'Reilly Media
4. Jason Swartz, "Learning Scala", O'Reilly Media
5. Slava Schmidt, "Scala Cookbook", O'Reilly Media

Online Resources:

1. https://www.coursera.org/learn/scala-functional-programming
2. https://ocw.mit.edu/courses/6-821-programming-languages-fall-2002/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		1	1	1	1		1	2	1	1	2	1
CO2	2	2		2	1	2	2		3	3	2	2	3	3
CO3	2	2		2	2	3	3		2	3	2	3	2	2
CO4	1	2		2	3	2	3		2	2	2	3	2	2

Program	Bachelor of Computer Applications (DS& AI)				
Year	II	**Semester**		III	
Course Name	Computer Network				
Code	BCADSN23204				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To introduce basic elements of communication system. To understand channels, techniques and devices used to transmit data between distant locations through different devices. To introduce the functions of different layers of reference model. Understand different protocols and network components.				
Course Outcomes					
CO1	To describe and analyze the hardware, software, and various components of a communication network.				
CO2	Able to explain networking protocols models and devices with their hierarchical relationship. Compare protocol models and select appropriate protocols for a particular design.				
CO3	Able to classify networks, transferring of data, address of data packets, analyzing performance, and understanding concepts of data connection and transfer.				
CO4	Able to Identify infrastructure components and their roles they serve, and design infrastructure including devices, topologies, protocols, systems software, management and security.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Computer Network:** Definition; Goals and Application of Computer Network; Types of Networks, Types of Topologies, Centralized, Distributed and Collaborative; Type of Data Communication System: Wired and Wireless communication. Introduction to Internet, Intranet, Extranet, VPNS. Bandwidth, Band.	12	CO1
2	**Network Architecture:** Monolithic v/s Layered Approach; Design Issues of Layered approach; Services, Interfaces, Standards and Protocols; ISO- OSI Reference Model and TCP/IP Model; Multiplexing: FDM, TDM, WDM; **Switching:** Circuit, Message, Packet; PSTN & ISDN: Narrowband and Broadband. **Subnet Communication:** Concept of Subnet & Host-to-Host Communication; Intermediate Devices: Repeaters and Regenerators, Hub, Switch, Router, Gateway. **Physical Layer:** Design Issues, Services, Protocols.	12	CO2
3	**Data Link Layer:** Framing, Error Control- CRC, Checksum, Flow Control-Hamming Code; LLC and MAC Sub- layer; DLL Protocols: Stop-and-wait Protocol, Sliding Window Protocols, Go-Back-N protocol, LAN Protocols: IEEE protocol. Network Layer: Routing, Congestion Control, Internetworking; Routing Algorithms: Distance Vector Routing, Link State; IP Addressing: IPV4 & IPV6, Firewalls.	11	CO3
4	**Transport Layer:** Connection Management, Multiplexing, Segmentation and Reassembly Host- to-Host Flow Control, Acknowledge and Error Control; Transport Protocol: Connection-oriented TCP and Connection-less UDP. **Session Layer** Logical Session Management, Token Management; Synchronization. **Presentation Layer:** Data Presentation, Introduction to Compression Encryption. **Application Layer:**	10	CO4

	HTTP, HTTPS, Internet Browser, FTP, Telnet, DNS, Email System.		

Suggested Readings:

1. W.Stallings, “Data and Computer Communication”, Pearson Education.
2. A.S.Tanenbaum, “Computer Network”, Pearson Education.
3. BehrouzA.Forouzan,“DataCommunicationandNetworking”,TataMcGrawHill.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105183

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	1s	2		1		2	1	1	2	2	2
CO2	2	2	2	1	2	1	1		2	1	1	2	2	2
CO3	2	1	3	1	2		1		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS& AI)				
Year	II	**Semester**	III		
Course Name	Object Oriented Programming Using Java				
Code	BCADSN23205				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The main objective of this subject is to introduce the fundamental concepts of object-oriented Programming, show competence in the use of the Java programming language in the development of small to medium-sized application programs that demonstrate professionally acceptable coding and performance standard.				
Course Outcomes					
CO1	To understand the concept of object-oriented programming and implement it in Java.				
CO2	To understand building blocks of OOPs language, class, objects and method etc.				
CO3	Able to understand inheritance, package and interfaces concepts.				
CO4	To implement multithreading in object-oriented programs and designing GUI using AWT Control and event handling.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Java:** Evolution of Java, Features of Java, Byte Code and Java virtual machine, JDK, Structure of Simple Java Program, Compiling and Interpreting Applications; Java Tokens: Java Character set, Keyword and Identifiers; Data Types, Operators and Expression; Control Statements, Looping; **Array and String:** Single and Multidimensional Arrays, String Class, StringBuffer Class, Operations on String, Command Line Argument, and Use of Wrapper Class.	12	CO1
2	**Classes, Objects & Methods:** Class, Object, Object Reference Methods in Java, Method Overloading, Constructor, Constructor Overloading, Passing and Returning Object from method; new Operator; this & Static Keyword; finalize() method; Visibility modifiers; Nested Class; Inner Class.	10	CO2
3	**Inheritance and Polymorphism:** Inheritance in Java, Types of Inheritance, Member Access Rule, Use of this and Super Keyword, Abstract class, Dynamic Method Dispatch, Use of final Keyword; **Package & Interface:** Defining and Importing Packages, Defining and Implementing Interfaces, Extending Interfaces; **I/O STREAM:** Concept of Streams, Streams Classes: Byte and Character Stream, Reading Console input & Writing Console output.	11	CO3
4	**Exception Handling:** Exception Type, Usage of try, catch, throw, throws and finally Keywords, Creating Own Exception Classes; **Multi-Threading:** Concept of Thread, Thread Life Cycle, Creating Thread Using Thread Class and Runnable Interface, Thread Priority; **AWT Control:** The AWT Class Hierarchy, User Interface Components: Labels, Button, Text Components, Check Box, Check Box group, Choice, List Box, Panels, Working with Frame Class, Fonts and Layout Manager; **Event Handling:** Events, Event Sources, Event Listeners, EDM, Handling Mouse and Keyboard Events.	12	CO4

Suggested Readings:

1. Herbert Schild, “The Complete Reference, Java 2”, TMH.
2. R. Krishnamoorthy & S. Prabhu, “Internet and Java Programming”, New Age International Publishers.
3. E. Balaguruswamy, “Programming with Java A Primer”, TMH.
4. Udit Agrawal, “Internet and Java Programming”, Dhanpat Rai & Co.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105191/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1		1	2	1	2		3	1	2	2	2	2
CO2	2	1		1	2	3	3		1			2	2	2
CO3	1	2		2	2	2	2		2	1	1	1	2	2
CO4	2	3		2	1	3	2		2		2	1	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	Information & Data Security				
Code	BCADSN23211				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	In this course, student will systematically study the fundamental principles of computer system security, including access control, security policies, software vulnerabilities, web security and various authentication mechanisms.				
Course Outcomes					
CO1	To understand the basics of information security.				
CO2	To learn about how to maintain the information and data security i.e., confidentiality, integrity and availability.				
CO3	Understanding the basic concept of security policies.				
CO4	The student will be able to understand the basics of security, policies, cryptographic algorithms, and its issues along with its countermeasures				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Information Security:** Principles, CIA (Confidentiality, Integrity, Availability), Aspects of Information Security, Need for Security, Goals of Information Security, Features of a Good Security Policy, Security Attacks, Virus, DoS, Worms, Spyware, Ransomware, Security Services and Mechanisms, Security Standards.	12	CO1
2	**Principles of Security**: Steganography, Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Types of Substitution Techniques, Transposition Techniques, Types of Transposition Techniques, Block Cipher Principles, Block Cipher Modes of Operation, Encryption and Decryption, Data Encryption Standard (DES) Algorithm, Strength of DES.	12	CO2
3	**Introduction to Security Policies:** Confidentiality, Integrity, Availability and Hybrid Policies, Academic Computer Security Policy: General University Policies, Information Risk Management, Risk Mitigation, Risk Handling Strategies and Risk Assessment, Information Classification – Guidelines, Types, Criteria for data Classification, Data Classification procedures, Classification Controls.	11	CO3
4	**Authentication:** Basics of Authentication, One Factor Authentication, Two Factor Authentication, Multi Factor Authentication, Passwords: Attacking a Password System, Countering Password Guessing, Biometrics: Fingerprints, Faces, Voices, Eyes and Combinations, Access Control, Types of Access Control.	10	CO4

Suggested Readings:

1. Matt Bishop, “Introduction to Computer Security”, Addition Wesley.
2. William Stallings, “Computer Security: Principles and Practices”, Pearson Education
3. Timothy Morey Andrew Burt, Thomas C. Redman, Christine Moorman “Customer Data and Privacy: The Insights You Need from Harvard Business”, Harward Business Press.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106146/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	1	1		1	2		1			1		1
CO2	1	2	1	1	1	1	2		1			1	1	2
CO3		1	2	2		1	1		1	1	1	1		1
CO4	2	2	3	2	2	2	3		3	2	3	2	2	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	Essential Of Data Collection Ethics				
Code	BCADSN23212				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To provide participants with the adequate knowledge of the techniques of data collection and ethics.				
Course Outcomes					
CO1	To understand the basic concept of data collection and their methods.				
CO2	To understand the principle of data collection ethics.				
CO3	To understand the essential of data collection ethics.				
CO4	To understand the case studies of data collection ethics.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Fundamentals of data collection**: Definition and concept Data collection, Data collection method, Type of data collection method; **Primary data collection method**: Quantitative Data Collection Methods-Time series analysis, Smoothing technique, Barometric method, Qualitative Data Collection Methods-Survey, Interviews, Group discussion, questionnaire; **Secondary data collection method**: Publish data, Unpublish data, Internal sources of data collection, External Sources of data collection.	12	CO1
2	**Data ethics**: Concept of Data Ethics, Importance of Data ethics, Data Ethics guidelines for individuals and organization, Data Security, Challenges for implementing data ethics, Ethical frameworks- Informed consent, Privacy and Confidentiality, Bias and Fairness, Overview of data protection laws (GDPR (EU), HIPAA (USA), CCPA (California), PDPB (India), Institutional Review Boards (IRBs) and their role.	11	CO2
3	**Data collection ethics:** Introduction of data collection ethics, 5C's of data collection ethics-Consent, Clarity, Consistency, Control, Consequences; Responsible data handling, Ethics issue in specific context. **Principle of data collection ethics**: Privacy, Consent, Transparency, Fairness, Accountability. Ethical considerations in automated data scraping and surveillance, Internet of Things (IoT) and passive data collection, Ethics of social media data collection	12	CO3
4	**Case Studies and Practical Applications**: Ethical audit and data collection policies in organizations, Historical cases of unethical data collection, Facebook Emotional Contagion Study, Cambridge Analytical Data Scandal, Google Street WIFI Data Collection, The Volkswagen (VW) emissions scandal	10	CO4

Suggested Readings:

1. Data Collection: Methods, Ethical Issues and Future Directions by Susan Elswick, Nova Science Pub Inc.
2. Data Science Ethics: Concepts Techniques and Cautionary Tales by David Martens, Oxford University Press.
3. Ethics of Data and Analytics Concepts and Cases by Kirsten Martin, Auerbach Publications (T&F).

Online Resources:

1. https://www.simplilearn.com/what-is-data-collection-article
2. https://searchworks.stanford.edu/view/13045465

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	1	1		1	2		1			1		1
CO2	1	2	1	1	1	1	2		1			1	1	2
CO3		1	2	2		1	1		1	1	1	1		1
CO4	2	2	3	2	2	2	3		3	2	3	2	2	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	III		
Course Name	Scala Programming Lab				
Code	BCADSN23151				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	This course aims to develop proficiency in Scala programming by focusing on core concepts like object-oriented and functional programming, concurrency, and collections, empowering students to design and implement real-world applications efficiently.				
Course Outcomes					
CO1	To implement fundamental Scala concepts, including syntax, data types, control structures, recursion, and object-oriented principles, enabling students to develop functional and object-oriented programs.				
CO2	To implement Scala's collections, higher-order functions, concurrency, file handling, and SBT, empowering students to build real-world projects integrating both functional and object-oriented paradigms.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Write a program to check if a given number is prime. 2. Implement a simple calculator that performs addition, subtraction, multiplication, and division. 3. Create a recursive function to calculate the factorial of a number. 4. Implement a program to generate the Fibonacci sequence up to a given number. 5. Create a class Person with name and age attributes and a method to display the details. 6. Implement inheritance by creating a subclass Employee that extends Person and adds salary as an attribute. 7. Create a Shape trait and implement it in Circle and Rectangle classes to calculate area. 8. Implement a case class Book and use pattern matching to print details based on its properties. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. Write a function that accepts a list of integers and returns a new list with only even numbers. 2. Implement a program to merge two lists and sort the result. 3. Create a program to find the sum of elements in a list of integers using fold and reduce. 4. Write a function to calculate the factorial of a number using currying. 5. Implement a program to read and write to a file. 6. Create a program that handles custom exceptions for invalid inputs (e.g., division by zero). 7. Implement a simple multi-threaded program using Futures to calculate the sum of two lists concurrently. 8. Build a small Scala project using SBT (Scala Build Tool) that handles basic arithmetic operations. Note: - Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings:

1. Martin Odersky, Lex Spoon, Bill Venners, "Programming in Scala", Artima Press
2. Dean Wampler, Alex Payne, "Programming Scala", O'Reilly Media
3. Jason Swartz, "Learning Scala", O'Reilly Media
4. Slava Schmidt, "Scala Cookbook", O'Reilly Media

Online Resources:

1. https://www.coursera.org/learn/scala-functional-programming
2. https://ocw.mit.edu/courses/6-821-programming-languages-fall-2002/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		2	2	3	1		1	2	1	3	3	3
CO2	2	2		3	2	3	1		1	2	1	3	3	3

Program	Bachelor of Computer Applications				
Year	II	**Semester**	III		
Course Name	Programming with java Lab				
Code	BCAN23252				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	To implement the basic concepts of object-oriented using classes and objects inheritance, interface, packages, exception handling techniques and multithreading and to design streams and efficient user interface design techniques using GUI.				
Course Outcomes					
CO1	Able to use the syntax and semantics of java programming language and basic concepts of OOP using the concepts of inheritance, polymorphism, interfaces and packages.				
CO2	Able to apply the concepts of Multithreading and Exception handling to develop efficient and error free codes and to design event driven GUI and web related applications which mimic the real word scenarios.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Implementation of a simple Java Program, Interpreting & Compiling. 2. Implementation of control, such as Loops etc. 3. Implementation of Single and Multidimensional Array. 4. Implementation of String class and String Operations. 5. Implementation of Classes and Objects. 6. Implementation of Method in Java. 7. Implementation of Constructor overloading. 8. Implementation of Access Modifier. 9. Implementation of static and this keyword. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. Implementation of Inheritance in Java 2. Implementation of Super Keyword. 3. Implementation of Abstract class and final Keyword. 4. Defining and Importing Packages. 5. Defining and Implementing Interface. 6. Implementation of I/O Stream. 7. Implementation of Exception Handling 8. Handling of Multiple Threads. 9. Implementation of AWT Control. 10. Implementation of Event Handling. Note: - Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings:

1. Herbert Schild, “The Complete Reference, Java 2”, TMH.
2. R Krishnamoorthy & S. Prabhu, “Internet and Java Programming”, New Age International Publishers.
3. E. Balaguruswamy, “Programming with Java A Primer”, TMH.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105191/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1			2	1	1					1	2	1
CO2	2	2		1	2	1	2		2	2	1	3	2	2

FOURTH SEMESTER

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	IV		
Course Name	Big Data Fundamentals				
Code	BCADSN24201				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	To provide an overview of an exciting growing field of big data analytics. To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability. To enable students to have skills that will help them to solve complex real-world problems in for decision support.				
Course Outcomes					
CO1	Develop an understanding of the complete open-source Hadoop ecosystem and its near term future direction				
CO2	Understand the functions and features of HDP				
CO3	Implement big data processing and querying using open source tools of Hadoop Ecosystem				
CO4	Demonstrate how Apache Spark fits into the big data architecture.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Big Data:** Explain what Big Data is, Describe the complete open source Hadoop ecosystem and its near-term future directions, Describe the major challenges of data, Explain how the growth of interconnected devices contributes big data, List real-life examples of Big Data, List the types of Big Data, Identify Big Data use cases, Describe the evolution from traditional data processing to big data processing Introduction to RDBMS With DDL, DML, DCL Commands, HDFS commands. Explain the basic need for a big data strategy in terms of parallel reading of large data files and internode network speed in a cluster, Describe the nature of the Hadoop Distributed File System (HDFS), Explain the function of NameNode and DataNode in a Hadoop cluster, Explain how files are stored and blocks (splits) are replicated.	15	CO1
2	**Introduction to Hortonworks Data Platform (HDP):** Describe the functions and features of HDP, List the IBM added value components, Describe the purpose and benefits of each added value component. Explain the purpose of Apache Ambari in the HDP stack, Describe the overall architecture of Ambari and its relation to other services and components of a Hadoop cluster.	15	CO2
3	**Storing and querying data:** Hive introduction, architecture, bucketing, partitioning of data using hive, joins, internal and external tables pig introduction. HBase data storage model, DDL, DML commands Sqoop import data in Hadoop, Hive and Hbase, import all tables and export data	15	CO3

4	**Data processing with different Hadoop Tools:** Describe the MapReduce programming model, Describe Hadoop v1 and MapReduce v1 and list their limitations, Describe Apache Hadoop v2 and YARN, Compare Hadoop v2 and YARN with Hadoop v1, Explain the nature and purpose of Apache Spark in the Hadoop ecosystem, Describe the architecture and list the components of the Apache Spark unified stack, Describe the role of a Resilient Distributed Dataset (RDD), Explain the principles of Apache Spark programming, List and describe the Apache Spark libraries, Start and use Apache Spark Scala and Python shells. Introduction of map reduce with java/python code.	15	CO4

Suggested Readings:

1. IBM Courseware
2. Alex Holmes, "Hadoop in Practice", Dreamtech Press
3. Shankarmani, "Bigdata Analytics", Wiley

Online Resources:

1. Big Data Computing - Course (nptel.ac.in)

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2		2	2		2		2	1	2	2	2	2
CO2	2	2		3	2	1	2		2	1	1	2	2	2
CO3	2	1		2	2		2		2	1		2	2	2
CO4	2				2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
	II	**Semester**		IV	
Course Name	Data Science with Python				
Code	BCADSN24202				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	0	0	2
Course Objectives	To acquire technical expertise using popular open source analytics frameworks for Data Science. To understand the scientific method for Data Science, use cases, and the Data science team Key roles. To define the Demonstrate knowledge of statistical data analysis techniques utilized in business decision making. To learn how to Use data mining software to solve real-world problems.				
Course Outcomes					
CO1	Understand the scientific method for the Classification and mathematical.				
CO2	Data Science life cycle revolve around using some techniques and other Analytical methods to produce insights and predictions from data to achieve a business objective.				
CO3	Applying and analyzing, is the process of determining which features might be useful in training a model, and then creating those features by transforming raw data found in log files and other sources.				
CO4	Understand Data engineering and data modeling practices using machine learning and Building and create role-playing challenge-based scenarios to propose real-world solutions.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Statistics with python:** Descriptive Statistic, Mean, median, mode, variance, standard deviation, Data distribution, skewness, kurtosis, inferential, Statistics ,Probability distributions(normal, binomial, Poisson) Hypothesis testing (t-test, chi-square, ANOVA) Confidence intervals, p-values Correlation & Regression, Pearson correlation Simple linear regression with Python Practical Using scipy. stats and stats models for statistical analysis	8	CO1
2	**Supervised Machine Learning:** Regression and Classification analysis, Algorithms- Linear regression, Logistic regression, Support Vector Machine, KNN, Naïve Bayes, Decision tree, Random forest, Model evaluation techniques- MAE, MSE, RMSE, R-squared, Adjusted R-squared, Confusion Matrix, Accuracy, Precision, Recall, F-score and AUC-ROC curve.	8	CO2
3	**Unsupervised Learning Techniques:** Use cases of unsupervised learning. Clustering, K-Means Clustering, Hierarchical Clustering, Agglomerative clustering, Divisive clustering, Density-Based clustering, PCA, Distance Matrices, Euclidean Distance, Manhattan Distance Introduction to Reinforcement Learning Key Terminology: Agent, Environment, State, Action, The Learning Task, Markov Decision process, Q learning, The Q function, Algorithm for Learning Q	7	CO3

4	**Artificial Neural Network:** Motivation, Neural Network Representation, Perceptron, Training Rule, Activation Functions and types of Activation Functions, Introduction to Gradient Descent and Delta Rule. Feed Forward Neural Network, Back Propagation Network: Overview, Back Propagation Algorithm. **Project:-** Machine learning project – Spam mail classifier using Naïve Bayes algorithm.	7	CO4

Suggested Readings:

1. IBM Courseware
2. Joseph K. Blitzstein and Jessica Hwang, "Introduction to Probability"
3. Wes McKinney "Introduction to Machine Learning with Python: A Guide for Data Scientists"

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_cs60/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2	2
CO3	2	1	3	2	2		2		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	IV		
Course Name	Artificial Intelligence				
Code	BCADSN24203				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The course aims to provide a comprehensive introduction to Artificial Intelligence, covering intelligent agents, search algorithms, planning, knowledge representation, and learning in Artificial Intelligence.				

Course Outcomes	
CO1	Understand the concept, scope, foundation, and various applications of Artificial Intelligence.
CO2	Learn and familiarize with different Searching Techniques in Artificial Intelligence.
CO3	Learn and familiarize with the basic concepts of Planning in AI, Reasoning techniques such as propositional and Predicate logic and their roles in designing Logical Agents.
CO4	Develop conceptual skills in knowledge representation and reasoning systems, Handling uncertainties, learning in the AI System.

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to AI:** Overview, Scope, Foundations, Applications, Techniques, and Issues of Artificial Intelligence. **Intelligent Agents:** Agent and its Environment; Concept of a Rationality: Omniscience, Learning and autonomy; Structure of Agents: Simple Reflex, Model-Based, Goal Based, Utility Based Agents.	12	CO1
2	**Introduction to Search:** Introduction to search algorithm and search space in artificial intelligence, Searching for solutions; **Uninformed search strategies:** Introduction to Depth-First, Introduction to Breadth-first search, **Informed search strategies:** Hill Climbing; Adversarial Search: Minimax Algorithm.	11	CO2
3	**Logical Agents:** Knowledge based Agent, Logic, Propositional Logic, Agents Based on Propositional Logic, Introduction to First Order Logic and Inference. **Planning:** Classical Planning, Algorithms for Planning as State Space Search, Time Schedule and Resources, Hierarchical Planning, Planning in Nondeterministic Domains, Multi-agent Planning.	12	CO3
4	**Knowledge Representation:** Ontological Engineering, Categories and Objects, Events, Reasoning Systems, Reasoning with default information; Acting under Uncertainty, Basic Probability Notation, Probabilistic Reasoning, Bayes Rule. **Learning:** Learning from Observations, Inductive Learning, Knowledge in Learning, Explanation-based Learning. **Case Studies:** MYCIN: Overview, Domain, and features.	10	CO4

Suggested Readings:

1. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach" (3rd ed.), Pearson Education, 2011.
2. Elaine Rich and Kelvin Knight, "Artificial Intelligence", Tata McGraw Hill, 2002.
3. Eugene Charniak and Drew McDermott, "Introduction to Artificial Intelligence", Pearson Education, 2009.
4. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Prentice Hall of India, 2006.
5. George F. Luger, "Artificial Intelligence, Structures and Strategies for Complex Solving", Pearson Education, 5th Edition, 2010.

Online Resources:

1. https://www.youtube.com/watch?v=pKeVMlkFpRc
2. https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-artificial-intelligence

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	1	2	1	3	1	1	1	1	1	2	2	2
CO2	2	2	2	2	1	3		1	1	2	1	2	2	2
CO3	3	2	1	2	1	3		1	2	2	1	2	2	2
CO4	3	3	1	3	1	3		1	2	2	1	3	2	2

Program	Bachelor of Computer Applications(Data Science & Artificial Intelligence)				
Year	II	Semester	IV		
Course Name	Basics of Design & Analysis of Algorithms Using Java				
Code	BCADSN24204				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	To know the importance of studying the complexity of a given algorithm and various design techniques. Utilizing data structures and/or algorithmic design techniques in solving new problems. Understanding basic computability concepts and the complexity.				
Course Outcomes					
CO1	Able to Argue the correctness of algorithms using inductive proofs and analyze worst-case running times of algorithms using asymptotic analysis.				
CO2	Able to explain important algorithmic design paradigms (divide-and-conquer, greedy method) and apply when an algorithmic design situation calls for it.				
CO3	Able to explain important algorithmic design paradigms (dynamic-programming and Backtracking) and apply when an algorithmic design situation calls for it.				
CO4	Able to Explain the major graph algorithms and Employ graphs to model engineering problems, when appropriate.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Basic Concepts of Algorithms**: Definition of algorithm; Characteristic of algorithm; Pseudo Codes & Time Complexity of Basic Control Structures; Time and Space Complexity of Insertion Sort; Selection Sort; Heap Sort; Bubble Sort; Asymptotic Notations (Growth of Functions).	12	CO1
2	**Divide and conquer**: Binary Search, Maximum & Minimum, Merge Sort, Quick Sort, Strassen's matrix multiplication; **Greedy Method**: General method, Knapsack Problem, Travelling Salesman problem, Job Sequencing with deadline, Optimal Storage on tapes, Huffman Codes, An Activity Selection Problem.	12	CO2
3	**Dynamic Programming**: Assembly Line Scheduling, Matrix Chain Multiplications, Longest Common Subsequence; **Backtracking**: General method, N Queens Problem, Sum of subsets, Hamiltonian Circuit Problem.	10	CO3
4	**Branch & Bound**: Introduction, Live Node, Dead Node and Bounding Functions, Knapsack Problem, Assignment Problem; **Analysis of Graph Algorithms**: Elementary Graph Algorithms, Multistage Graphs, Minimum Spanning Trees: Kruskal's & Prim's Algorithm, Single Source Shortest Path: Dijkstra's & Bellman Ford.	11	CO4

Suggested Readings

1. Thomas H. Coremen, "Introduction to Algorithms", MIT Press.
2. Horowitz & Sahani, "Fundamentals of Algorithms", Galgotia Publications.
3. Aho, Ullman, "Design & Analysis of Computer Algorithms", Pearson.
4. Johnsonbaugh, "Algorithms", Pearson.
5. Bressard, "Fundamentals of Algorithms", PHI.

Online Resources

1. https://archive.nptel.ac.in/courses/106/106/106106131/.
2. ttps://onlinecourses.nptel.ac.in/noc19_cs47/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		2		3	1		1	2	1	3	3	3
CO2	2	2		3		3	1		1	2	1	3	3	3
CO3	2	2		3		3	1		1	2	1	3	3	3
CO4	2	2		3		3	1		1	2	1	3	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	IV		
Course Name	Foundation of Deep Learning				
Code	BCADSN24211				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	This course aims at teaching supervised, unsupervised and reinforcement deep learning methods which helps to develop state-of-the-art artificial intelligence applications.				
Course Outcomes					
CO1	To explain the fundamentals of deep learning, artificial neural network.				
CO2	To articulate different problem of model improvement, imbalance data problem, and CNN.				
CO3	To understand object detection and image segmentation.				
CO4	To understand generative learning, its application, and deep reinforcement learning.				

Module	**Course Contents**		**Mapped CO**
1	**Introduction:** Deep Learning & its applications, Machine Learning, features, weights, loss function, cost function; **Artificial Neural Network** (ANN): forward propagation, Backpropagation, Stochastic Gradient Descent, Batch gradient descent, mini batch gradient descent, Optimizers, Momentum, training-validation testing set, evaluation measures, accuracy, precision, f-measure.	12	CO1
2	**Model Improvement**: Overfitting vs underfitting, Bias vs Variance, Regularization: L1, L2 regularization, Dropout, Early stopping, Data normalization, Batch normalization, Hyper parameter Tuning; **Imbalance data problem**: Data augmentation in image, Cropping, Flipping, Rotation, Brightness, Contrast, Color augmentation, Saturation, Convolutional Neural Networks; CNN architectures; convolution, striding, padding, pooling.	12	CO2
3	**Object Detection**: setup problem and cost function, well known datasets, Evaluation measure, Average precision, Mean average precession, Two stage detector, single stage detector, RCNN, Fast RCNN; **Image Segmentation**: setup problem and cost function, various dataset, Semantic segmentation, Instance segmentation.	11	CO3
4	**Generative Learning (GL)**: Variational auto-encoders, Generative Adversarial Neural Networks, GL Applications, Image generation, font generation, video generation, anime face/celebrity face generation, **Deep Reinforcement Learning**; Markov decision Processing, Deep Q Learning, exploration vs exploitation, Value iteration vs policy iteration, RL Applications.	10	CO4

Suggested Readings:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, and Yoshua Bengio, “Deep learning”, Cambridge, MIT press.
2. Aston Zhang, Zack C. Lipton, Mu Li, and Alex J. Smola, “Dive into Deep Learning”, Corwin.
3. Nithin Bu duma, Nikhil Bu duma, Joe Papa "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", Shroff/O'Reilly.
4. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, "Deep Learning Using Python", Wiley.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106184
2. https://nptel.ac.in/courses/106106184

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1	1	1	1			1	1	1	2	1
CO2	2	2	2	2	1	2	1		1	1	1	2	2	
CO3	2	2	2	1	2	2				2	2	1	2	2
CO4	2	2	2	1	1	2	1			2	1	1	1	2

Program	Bachelor of Computer Applications(DS& AI)				
Year	II	**Semester**	IV		
Course Name	Data Warehousing & Data Mining				
Code	BCADSN24212				
Course Type	GE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	This course provides an in-depth exploration of data mining and data warehousing techniques, methodologies, and applications. Students will learn how to extract valuable insights from large datasets, design and implement data warehouses, and apply data mining algorithms for knowledge discovery.				
Course Outcomes					
CO1	To understand the basic concept Data Warehousing and Data Mining.				
CO2	To understand the concept of pre-processing, OLAP and Frequent pattern Mining.				
CO3	To understand the concept of Classification.				
CO4	To understand the concept of Clustering.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Data Mining and Data Warehousing:** Overview of data mining and knowledge discovery process Role and importance of data warehouses, Key concepts and components of data mining and data warehousing; **Multi-Dimensional Data Model:** Introduction, Elements, steps in dimensional modeling, Multi-Dimensional Schema; **Data Warehouse Architecture:** The 3-Tier Data Warehouse Architecture, The Bus Architecture.	12	CO1
2	**Data Preprocessing:** Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and discretization; **Data Warehouse Modeling:** Data Cube, Typical OLAP Operations, Role of Concept Hierarchies, OLAP Server Architectures; **Mining Frequent Patterns:** Basic concepts Frequent Item set mining method: the Apriori Algorithm, Generating Association Rules from frequent itemsets, FP Growth Algorithm.	12	CO2
3	**Classification:** General Approach to solving classification problems, Classification by decision Tree Induction: Attribute selection measure, Tree pruning, Bayesian Classification: Bayes' Theorem; Rule based classification, Model Evaluation and Selection.	10	CO3
4	**Cluster Analysis:** Cluster Analysis, Partitioning Methods: K-means clustering; Hierarchical Methods: BIRCH clustering; Density Based Methods: DBSCAN; Grid Based Clustering Outlier Analysis; **Data Mining Ethics and Privacy:** Ethical considerations in data mining, Privacy-preserving data mining techniques.	11	CO4

SuggestedReadings:

1. JiaweiHanandMichelineKamber,"DataMiningConceptsandTechniques",Elsevier.
2. Pang-NingTan,MichaelSteinbachandVipinKumar,"IntroductiontoDataMining",PHI
3. MaxBramer, "Principles of Data Mining", Springer.
4. Arun K Pujari,"Data Mining Techniques", University Press.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105174/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	1	1	2	2	1		1	1	1	2	3	1
CO2	2	2	1	1	2	2	1		1	3	1	2	3	1
CO3	3	3	2	3	3	3	1		1	3	1	3	3	3
CO4	3	3	2	3	3	3	1		2	3	1	3	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**	IV		
Course Name	Computer Vision				
Code	BCADSN24221				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	This course introduces students to the fundamental concepts, techniques, and applications of computer vision. Students will learn how computers can be programmed to interpret and understand visual information from digital images and videos. Topics covered include image formation, image processing, feature extraction, object recognition, and deep learning approaches to computer vision.				
Course Outcomes					
CO1	Understand the basic principles and challenges of computer vision.				
CO2	Apply image processing techniques for image enhancement, filtering, and segmentation.				
CO3	Extract meaningful features from images for pattern recognition and object detection.				
CO4	Implement algorithms for image classification, object recognition, and scene understanding. Analyze and evaluate the performance of computer vision systems.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Computer Vision**, Definition and scope of computer vision, Applications of computer vision in real-world scenarios, Challenges and limitations in computer vision Image processing and low-level vision, Image sampling, interpolation, transformations Linear filters and edges, Feature extraction, Optical flow and feature tracking.	12	CO1
2	**Image**: Image Formation and Representation, Digital image fundamentals, Image formation process, Color models and color spaces, Image Processing Techniques, Image enhancement, Image filtering and convolution, Image segmentation and thresholding Grouping and fitting, Least squares fitting, robust fitting, RANSAC, Alignment, image stitching.	12	CO2
3	**Geometric vision:** Image geometric vision and formation, Camera models, Light, shading and color, Camera calibration, Epipolar geometry, Two-view and multi-view stereo, Structure from motion, Morphological operations, Point and edge detection.	11	CO3
4	**Image classification:** Recognition and beyond, Statistical learning framework, Deep learning, Object detection, Segmentation; **Deep Learning** for Computer Vision, Introduction to deep learning and neural networks.	10	CO4

Suggested Readings:

1. Richard Szeliski ,"Computer Vision: Algorithms and Applications", Springer.
2. David A. Forsyth and Jean Ponce , "Computer Vision: A Modern Approach", Pearson.
3. Rajalingappaa Shanmugamani , "Deep Learning for Computer Vision", Packt publisher

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105216/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					1			1		1	2	2	1
CO2	1	2	2	1	2	2	1		2	2	2	2	2	2
CO3	1	1	2	1	1	2	2		2	2	2	2	2	3
CO4	2	2	1	2		1	1		1	1		2	1	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	**Semester**		IV	
Course Name	Internet of Things				
Code	BCADSN24222				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To study fundamental concepts of IoT, roles of sensors and hardware in IoT. To learn different Wireless Technologies, protocols for IoT and understand the role of IoT in various domains of Industry.				
Course Outcomes					
CO1	To understand the various concepts, terminologies and architecture of IoT systems.				
CO2	To understand the use of sensors, actuators and IoT supported hardware for design of IoT system.				
CO3	To understand and apply various wireless technology and protocols for design of IoT systems.				
CO4	To understand the various security aspects for IoT system.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of IoT:** Concepts and Definition of IoT, Characteristics, Conceptual Framework, Architectural view, technology behind IoT, M2M Communication; **Design Principles for Connected Devices:** IoT/M2M systems layers and design standardization, Application of IoT.	12	CO1
2	**Hardware for IoT:** Sensors, Digital sensors, actuators, radio frequency identification (RFID) technology, wireless sensor networks, participatory sensing technology; **Embedded Platforms for IoT:** Embedded computing basics, Overview of IoT supported Hardware platforms such as Arduino, Net Arduino, and Raspberry pi.	12	CO2
3	**Wireless Technologies for IoT:** IEEE 802.15.4, Bluetooth, Wi-Fi, Zigbee, RFID, HART, LoRaWAN, NFCZ-Wave, Z-Wave; **IP Based Protocols for IoT:** IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT.	10	CO3
4	**Overview of IoT Security:** Introduction Securing the Internet of Things, Architecture, Requirements, Security Protocols for IoT Access Networks, Attack, Defense, and Network Robustness of Internet of Things; **Case Studies/Industrial Applications:** Home Automation, Smart Cities, Smart Parking, Agriculture and Health Sector, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.	11	CO4

Suggested Readings

1. Sudip Misra, Anandarup Mukherjee, Arijit Roy "Introduction to IoT" Cambridge University Press; First Edition.
2. Arsheep Bahga, Vijay Madisetti," Internet of Things: A Hands-On Approach", Orient Blackswan Private Limited - New Delhi; First Edition.
3. Raj Kamal, Internet of Things Architecture and Design Principles, McGraw Hill; Standard Edition.
4. Vibha Soni, "IoT for Beginners: Explore IoT Architecture, Working Principles, IoT Devices, and Various Real IoT Projects", BPB Publications.

Online Resources

1. https://archive.nptel.ac.in/courses/106/105/106105166/
2. https://kp.kiit.ac.in/pdf_files/06/SM_6th-Sem_Cse_Internet-of-Things.pdf

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	1	1	1			2	1	1	1	1	1
CO2	2	1	3	1	1	2	1		1	3	1	2	2	1
CO3	1	3	3	2	3	2			1	2	1	2	3	1
CO4	3	3	1	1	1	1	1	1	3	1	3	2	1	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	Semester		IV	
Course Name	Soft Computing				
Code	BCADSN24223				
Course Type	DSE	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	The main objective of the soft computing techniques to improve data analysis solution is to strengthen the dialogue between the statistics and soft computing research communities in order to cross pollinate both fields and generate mutual improvement activities.				
Course Outcomes					
CO1	To understand how soft computing and ANN approach influences various modern developments.				
CO2	To understand learning rule and activation function.				
CO3	To understand different types of Fuzzy System used in real world.				
CO4	To understand type II fuzzy set and genetic algorithms.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Soft Computing, Differences between Soft Computing and Hard Computing, Requirements of Soft Computing, Applications of Soft Computing; Introduction to Artificial Intelligence, Models of Artificial Neural Network, Feed forward artificial neural networks, Perceptron and Multilayer Perceptron neural networks, Radial basis function artificial neural networks, Recurrent neural networks, Modular neural networks.	12	CO1
2	**Learning Rules and Various Activation Functions**, Hebbian Learning Rule, Perception Learning Rule, Delta Learning Rule, Widrow, Hoff Learning Rule, Correlation Learning Rule, Winner take All Learning Rule, Associative Memories**.**	11	CO2
3	**Introduction to Fuzzy System:** Fuzzy System, Fuzzy Logic, Fuzzy Sets and Crisp Sets, Evolution of Fuzzy System, Fuzzy Set Operations, Fuzzy to Crisp Conversion, Inference in Fuzzy Logic, Fuzzy Rule Base, Fuzzy Knowledge Base, Fuzzyfication and Defuzzyfication**.**	12	CO3
4	**Type II Fuzzy Set:** Need of Type II Fuzzy Set, Type II Fuzzy Set, Generalized Type II Fuzzy Set, Interval Type II Fuzzy Set, Fuzzy System; Genetic Algorithm, Basic Concept, Working Principle of Genetic Algorithm, Flow Chart of Genetic Algorithm, Genetic Representation (Encoding), Initialization and Selection.	10	CO4

Suggested Readings

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications” Prentice Hall of India
2. N.P.Padhy,”Artificial Intelligence and Intelligent Systems” Oxford University Press
3. Siman Haykin,”Neural Netowrks” Prentice Hall of India

Online Resources

1. https://archive.nptel.ac.in/courses/106/105/106105173/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	2	1		1	2		1	2	3	2	2	2
CO2	2	1	2	1		2	1		1	3	2	2	2	1
CO3	2	2	2	2		2	1		2	2	2	2	2	2
CO4	2	2	3	2	2	2	1		2	2	2	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	II	Semester	IV		
Course Name	Artificial Intelligence Lab				
Code	BCADSN24251				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		0	0	4	2
Course Objectives	To understand and implement fundamental Artificial intelligence algorithms such as search techniques, game playing (e.g., Minimax), and basic logic reasoning.				
Course Outcomes					
CO1	To understand the Basic Concepts of Artificial intelligence and its tools such as Python/MATLAB.				
CO2	Implement and compare various Artificial intelligence searching Algorithms.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Installation and working on various A.I tools such as Python 2. Write a program to print the multiplication table for the given number? 3. Write a program to check whether the given number is prime or not? 4. Write program to implement Simple Calculator program? 5. Write a program to generate Calendar for the given month and year? 6. Write a program to Illustrate Different Set Operations? 7. Write a program to implement simple Chat bot? 8. Write a program to Implement of Towers of Hanoi Problem. Note: Students will also perform all other exercises provided by course instructor	15	CO1
2	1. Write a Program to Implement Breadth First Search 2. Write a Program to Implement Depth First Search. 3. Write a program to implement Hill Climbing Algorithm 4. Write a program to implement Mini-Max Algorithm. 5. Write a program to implement Tic-Tac-Toe game. 6. Write a program to implement Bayes Rule. Note: Students will also perform all other exercises provided by course instructor	15	CO2

Suggested Readings

1. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, “Artificial Intelligence”
2. Stuart Russell & Peter Norvig,“Artificial Intelligence: A Modern Approach”
3. Patrick D. Smith,“Hands-On Artificial Intelligence with Python”

Online Resources

1. https://onlinecourses.nptel.ac.in/noc24_ge47/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2		2	1	2		1			2	1	1
CO2	2		2		2	2	2		1			2	1	1

Program	Bachelor of Computer Applications(Data Science & Artificial Intelligence)				
Year	II	**Semester**	IV		
Course Name	Basics of Design & Analysis of Algorithms Lab Using Java				
Code	BCAN24252				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	This course will enable students to Design and implement various algorithms in JAVA and Employ various design strategies for problem solving.				
Course Outcomes					
CO1	Design algorithms using appropriate design Techniques (brute force, reedy, Dynamic programming, etc.				
CO2	Implement a variety of algorithms such as sorting, graph related, combinatorial, etc., in Java language.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Sort a given set of n Integers Using Bubble Sort, Insertion Sort and Selection Sort. 2. Sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. complexity analysis: worst case, average case and best case. 3. Sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. 4. Implement in Java, the 0/1 Knapsack problem using (a) Dynamic Programming method (b) Greedy method. Note: - Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm. Write the program in Java. 2. Find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm. 3. Find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm 4. Design and implement in Java to find a subset of a given set S = {Sl, S2,. ...,Sn} of n positive integers whose SUM is equal to a given positive integer d. 5. Design and implement in Java to find all Hamiltonian Cycles in a connected undirected Graph G of n vertices using backtracking principle. Note: - Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings:

1. Thomas H. Coremen, “Introduction to Algorithms”, MIT Press.
2. Horowitz & Sahani, “Fundamentals of Algorithms”, Galgotia Publications.
3. Aho, Ullman, “Design & Analysis of Computer Algorithms”, Pearson.
4. Johnsonbaugh, “Algorithms”, Pearson.
5. Bressard, “Fundamentals of Algorithms”, PHI.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106131/.
2. ttps://onlinecourses.nptel.ac.in/noc19_cs47/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		2		3	1		1	2	1	3	3	3
CO2	2	2		3		3	1		1	2	1	3	3	3

FIFTH SEMESTER

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Predictive Analytics				
Code	BCADSN25301				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	Understand how analytics provided a solution to industries using real case studies. 1 To provide an overview of an exciting field of Predictive Analytics. To introduce the tools required For the Predictive Analytics. Review and explore data to look at data distributions and to identify data problems, including missing values. To enable students to have skills that will help them to solve complex real-world problems for decision support.				
Course Outcomes					
CO1	Understand and critically apply the concepts and methods of Business analytics				
CO2	Understand and apply IBM SPSS Modeler in Data Mining, what kinds of data can be mined, what kinds of patterns can be mined.				
CO3	Applying and analyzing how to use functions, deal with missing values, use advanced field operations, handle sequence data and improve efficiency.				
CO4	To evaluate the Model on the basis of different Predictive Methods. Building and create advanced analytical model that leverage historical data to uncover real time insights to predict future events..				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	ANALYTICS OVERVIEW Definition of business Analytics with rea time examples, How Predictive analytics: Transforming data into future insights, Analytics trends: Past, Present & Future, Towards a Predictive enterprise.	15	CO1
2	IBM SPSS MODELER & DATA MINING What is a Data Mining applications, Strategy for data mining: CRISP-DM, Identify nodes and streams, The framework of a Data – mining project, Brief the unit of analysis, Explain the type of dialog box.	15	CO2
3	UNIT OF ANALYSIS Concepts of Unit of analysis (Distinct, Aggregate, SetToFlag), Integrate data, CLEM Expression, Role of Relationship between two fields, Identifying the modeling objective.	15	CO3
4	ADVANCED DATA PREPARATION WITH IBM SPSS MODELER Functions to enrich data, Method to transform data, Cross record functions, Sampling, Partitioning and sampling data, Improving Efficiency. PROJECT Predicting using IBM SPSS Modeler & IBM Watson with real Case studies.	15	CO4

Suggested Readings:

1. IBM Courseware
2. Predictive Analytics Mesmerizing & fascinating by ERIC SIEGEL

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc24_cs65/preview
2. https://learn.microsoft.com/en-us/training/powerplatform/power-bi

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2	2
CO3	2	1	3	2	2		2		2	1		2	2	2
CO4	2		2		2	2	1		1		1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Mobile Application Development				
Code	BCADSN25302				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The capabilities and limitations of mobile platforms that affect application development and deployment. The technology and business trends impacting mobile application development. The characterization and architecture of mobile applications. The techniques for deploying and testing mobile applications, and for enhancing their performance and scalability.				
Course Outcomes					
CO1	To understand the basic concepts of Mobile application development				
CO2	Able to design and develop user interfaces for the Android platforms.				
CO3	Able to design and develop mobile applications using Components.				
CO4	Able to design and develop mobile applications using a chosen application development framework.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction:** introduction to android, history and versions of android, android API, Various mobile platforms, android architecture, android runtime, Dalvik virtual machine, features of android, introduction and installation of eclipse and ADT plugin and/or introduction and installation of android studio, requirements and installation of android SDK, SDK manager, emulator, AVD, android virtual device manager, Google play account, installing android app from google play, APK file.	12	CO1
2	**Development Environment**: Setting up Development Environment, Installing Packages using SDK Manager, Android Project Structure, Creating Hello Android App, deploy it on USB-connected Android device, setting up an Emulator, Android Tool Repository, Manifest File, Activity Life Cycle and its methods, Logcat, Components of an Android App: Activity, Service, Broadcast Receiver, Content Provider.	10	CO2
3	**Layout**: Constraint Layout ,Linear Layout, Relative Layout, Scroll View: Vertical, Horizontal Layout, Table Layout, Frame Layout, **Views**: Text view, Edit Text, Button, Check Box, Radio Button, Image View, Grid View, Web View, Video View, Toast, Rating Bar, Seek Bar, Date Picker.	12	CO3
4	**Intent**, Types of Intents**; Fragments**: Lifecycle, Methods **Service**: Features of Service, Android platform service, Defining new service, Service Lifecycle, Permission, example of service. **Android Menu:** Option, context, popup Menu; Data persistence using SQLite. Internal and External Storage.	11	CO4

Suggested Readings:

1. Michael Burton, Donn Felker, "Android Application Development for Dummies", Dummies.
2. Pradeep Kothari, " Android Application Development (with Kitkat Support)", Kogent Learning Solutions Inc.
3. W. Frank Ableson, Robi Sen, Et. Al., " Android in Action", Manning.
4. Charlie Collins, Michael Galpin, Et. Al., " Android in Practice", Manning.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106156/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2				2	1	2		1			2	1	1
CO2	2				2	2	2		1			2	1	1
CO3	2	2		2	3	2	3		2	2	2	2	2	2
CO4	2	2		2	2	2	3		3	2	2	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Web Application Development Using Python				
Code	BCADSN25303				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The main objective of this subject is to introduce the fundamental concepts of web application development using HTML, DHTML, CSS, JavaScript & Django, show competence in the use of the Python programming language in the development of small to medium-sized web application programs that demonstrate professionally acceptable coding and performance standard.				
Course Outcomes					
CO1	Understand the basic concept of HTML and application in web designing.				
CO2	Students develop static and dynamic website using HTML and CSS.				
CO3	Understanding the basic concept of Java Script and its application.				
CO4	Design and Develop web applications using Django framework & MySQL.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Basics of Web Designing:** Introduction to Web (www), Uniform Resource Locator (URL), Hypertext Transfer Protocol (HTTP), Introduction to Internet, Web Browsers, Web Clients, Web Servers; **Introduction to HTML:** HTML tags and its attributes; Text Formatting tags; Various types of Lists: Ordered, Unordered, Definition lists; **Table tags:** Methods to Create Tables, Attributes of table tag, Col span and Row span; Frame tags and its Attributes; **Form tag:** Creation of Forms, Textbox, Radio Button, Hidden; Image, Anchor Tag; **Links to External Documents:** Inter-page and Intra-page linking.	12	CO1
2	**DHTML and CSS:** Introduction to DHTML: Uses of DHTML, Features of DHTML, Components of Dynamic HTML, Advantages and disadvantage of DHTML; **CSS (Cascading Style Sheet):** Font Attributes, Color and Background Attributes Text Attributes, Border, Margin related Attributes, List Attributes; Types of Style Sheet-Inline, External and Embedded; CSSP (Cascading Style Sheet Positioning); Document Object Model; JSSS (JavaScript assisted Style Sheet); Browser objects; DHTML Events.	10	CO2
3	**Introduction to JavaScript:** Advantages and disadvantages of JavaScript, Type of JavaScript, Data Types, Creating Variables and JavaScript Array; **Operators and Expressions:** Arithmetic , Logical, Comparison, String and Conditional Operators; J**avaScript Programming Constructs:** Conditional checking, Loops; **Functions in JavaScript:** Built in Functions and User Defined Functions; **Dialog Boxes:** Alert , Confirm and Prompt Dialog Box; **JavaScript Document Object Model (DOM):** Object hierarchy in DOM, Event Handling; **Form Object:** Form Object's Methods and Properties, Text Element, Button Element; Other Built in Objects in JavaScript, String, Math and Date Object; Writing Client Side Validations from HTML Form Elements.	11	CO3

4	**Introduction to MySQL:** Installation & working with MySQL, Basics of Database & Table, Data Types in MySQL, Creating Table in MySQL. Writing selects, insert, update and delete SQL queries in MySQL. **Django Framework**: Introduction; Installation; Apps Life Cycle; Admin Interface; Creating Views; URL mapping; Template System; **Django Model**: Model Relationship, Querying Models & Connecting to MySQL database; **Django Forms:** Understand the process of building, Handling, Submitting & Validating HTML forms using Django; Web application using Django framework, deployment.	12	CO4

Suggested Readings:

1. Xavier, C, "Web Technology and Design", New Age International Publications.
2. Bayross Ivan," HTML, DHTML. JavaScript, and PHP", BPB Publications.
3. Samuel Dauzon, Aidas Bendoraitis, Arun Ravindran ,"Django: Web Development with Python", packt publications
4. O'Reilly , "Web Development with Django Cookbook", 2016, Packt Publishing

Online Resources:

1. https://archive.nptel.ac.in/courses/106/105/106105191/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1		1	2	1	2		3	1	2	2	2	2
CO2	2	1		1	2	3	3		1			2	2	2
CO3	1	2		2	2	2	2		2	1	1	1	2	2
CO4	2	3		2	1	3	2		2		2	1	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Explainable AI (XAI)				
Code	BCADSN25321				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The course aims to introduce students to the principles of Explainable AI (XAI) and its importance in building transparent and accountable AI systems. It will equip students with both theoretical knowledge and practical skills in model interpretability techniques, including post-hoc explanations. Students will also explore real-world applications and the ethical implications of XAI.				
Course Outcomes					
CO1	To understand the foundational concepts, importance, and motivation behind Explainable AI.				
CO2	To understand and interpret model-agnostic explanation techniques like LIME and SHAP.				
CO3	To Gain hands-on experience in explaining deep learning models using techniques like Grad-CAM and Integrated Gradients.				
CO4	To analyze real-world applications of XAI and understand ethical challenges and future trends.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Explainable AI:** Motivation for Explainable AI: Trust, Transparency, Ethics, Black-box vs. White-box models, Regulatory and societal needs for explainability (e.g., GDPR, AI Act), Human-centered AI and interpretability, Overview of interpretability techniques	12	CO1
2	**Interpretable Models and Post-hoc Explanations:** Interpretable models: Linear Regression, Decision Trees, Rule-based systems; Post-hoc model-agnostic techniques: LIME (Local Interpretable Model-agnostic Explanations); SHAP (SHapley Additive exPlanations):Partial Dependence Plots (PDP), Accumulated Local Effects (ALE), Feature importance methods	12	CO2
3	**Explainability in Deep Learning:** Challenges of explaining neural networks, Saliency maps and visualization techniques, Grad-CAM, Integrated Gradients, Occlusion, Layer-wise relevance propagation (LRP), Explaining NLP models (e.g., attention mechanisms, LIME for text)	11	CO3
4	**Applications, Case Studies, and Ethical Considerations:** Explainability in healthcare, finance, autonomous systems, Case studies: XAI in credit scoring, medical diagnostics, Fairness, bias detection, accountability in AI, Human-AI interaction and explanations, Future directions in XAI	10	CO4

Suggested Readings:

1. Ribeiro, M.T., "Why Should I Trust You? Explaining the Predictions of Any Classifier", ACM.
2. Lundberg, S.M., and Lee, S.I., "A Unified Approach to Interpreting Model Predictions", Advances in Neural Information Processing Systems.
3. Chen, J., Song, L., and Lafferty, J., "Learning to Explain: An Information-Theoretic Perspective on Model Interpretation", Proceedings of the 31st International Conference on Machine Learning.

Online Resources:

1. https://eecs.berkeley.edu/courses/cs-294-deep-learning-and-interpretability/
2. https://introtodeeplearning.com/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		1	1	1	1		1	2	1	1	2	1
CO2	2	2		2	1	2	2		3	3	2	2	3	3
CO3	2	2		2	2	3	3		2	3	2	3	2	2
CO4	1	2		2	3	2	3		2	2	2	3	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Swarm Intelligence				
Code	BCADSN25322				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The course provides an understanding of swarm intelligence concepts and algorithms like PSO, ACO, ABC, and Firefly. Students will apply these techniques to optimization problems, explore multi-objective optimization, and integrate swarm intelligence with hybrid approaches for improved performance.				
Course Outcomes					
CO1	To understand swarm intelligence, its key concepts, and how it compares to evolutionary computation.				
CO2	To understand application of PSO and ACO to solve optimization problems and understand their underlying mathematical formulations.				
CO3	To learn the core principles, algorithms, and applications of Artificial Bee Colony (ABC), Firefly, and Bat algorithms in optimization tasks.				
CO4	To apply swarm intelligence techniques to multi-objective optimization problems and integrate them with other optimization methods for enhanced performance.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Swarm Intelligence & Evolutionary Computation:** Overview, Definition, origin, and motivation, Examples from nature: Ant colonies, bird flocking, fish schooling, etc., Relationship with Artificial Intelligence (AI); Key Concepts in Swarm Intelligence: Emergent behaviour, Self-organization and decentralized control; Applications of Swarm Intelligence: Robotics, optimization, network design, and more; Introduction to Evolutionary Algorithms: Genetic Algorithms (GA), Differential Evolution (DE), Evolution Strategies (ES); Swarm Intelligence vs. Evolutionary Computation: Comparing natural systems and evolutionary processes	10	CO1
2	**Particle Swarm Optimization (PSO) & Ant Colony Optimization (ACO):** Biological inspiration (flocking behavior of birds), Basic working principles of PSO, Mathematical formulation for PSO: Velocity, position updates, and particle interactions, Applications of PSO in continuous optimization problems; Ant Colony Optimization (ACO): Inspiration from ant foraging behaviour, Pheromone modeling and the concept of artificial ants, Mathematical formulation of ACO, ACO applications in discrete optimization problems (e.g., Traveling Salesman Problem, routing)	12	CO2
3	**Other Swarm Intelligence Algorithms:** Artificial Bee Colony (ABC) Algorithm, Inspiration from bee foraging behaviour, Mathematical formulation: Solution representation and fitness function, Applications of ABC in optimization problems, resource allocation; Firefly Algorithm: Inspiration from firefly flashing behaviour, Attraction mechanism based on light intensity, Mathematical formulation of Firefly Algorithm, Applications in function optimization and engineering design; Bat Algorithm: Inspiration from bat echolocation and hunting behaviour, Mathematical formulation: Frequency tuning and	11	CO3

	position updates, Applications of Bat Algorithm in global optimization and parameter tuning		
4	**Swarm Intelligence in Multi-Objective Optimization & Hybrid Approaches:** Introduction to multi-objective optimization: Pareto-optimal solutions, Multi-Objective Particle Swarm Optimization (MOPSO), Non-dominated Sorting Genetic Algorithm (NSGA-II), Applications in environmental management, resource distribution, and trade-off problems; Hybrid Approaches in Swarm Intelligence: Combining Swarm Intelligence with other optimization techniques (e.g., hybrid PSO with genetic algorithms), Benefits of hybridization: Improved convergence and performance, Applications in complex real-world problems	12	CO4

Suggested Readings

1. Aboul Ella Hassanien, et al., "Swarm Intelligence: Fundamentals, Models, and Applications", Springer
2. R. C. Eberhart, Y. Shi, "Particle Swarm Optimization", Morgan Kaufmann
3. Marco Dorigo, Thomas Stützle, "Ant Colony Optimization", MIT Press

Online Resources

1. https://www.coursera.org/learn/swarm-intelligence
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-spring-2010/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		1	1	1	1		1	2	1	1	2	1
CO2	2	2		2	1	2	2		3	3	2	2	3	3
CO3	2	2		2	2	3	3		2	3	2	3	2	2
CO4	1	2		2	3	2	3		2	2	2	3	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**		V	
Course Name	Neural Network				
Code	BCADSN25323				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	Introduce the fundamental concepts of Neural Network. Equip students with the learning process of ANN, RNN and CNN. Students will get the basic understanding of neural network fundamentals.				
Course Outcomes					
CO1	To understand how human brain works and how ANN mimics that.				
CO2	To understand ANN architecture and perceptron.				
CO3	To understand RNN, RNN types, architecture and LSTM.				
CO4	To understand CNN, CNN architecture, its layers and learning.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Biological Neural Network**: Neurons and Synapses; How the Brain Learns; Neural Networks: Structure and working, Fundamentals, History of neural networks, characteristics of neural networks terminology; neural network architecture, Multilayer Neural Networks. Concept of Learning, Types of Learning, Learning Rules; Hebbian Learning Rule;	12	CO1
2	**Artificial Neural Networks (ANN)**: Artificial Neuron and its models, McCulloch-Pitts model, Perceptron, Single Layer Perceptron, Multi- Layer Perceptron; Adaline model; Neural Network Architectures, Single Layer Feedforward Network, Multilayer Feedforward Network, Recurrent Networks, Various Activation Functions; Artificial Neural Networks applications;	11	CO2
3	**Recurrent Neural Network (RNN):** Introduction to RNN, Types Of RNN, Recurrent Neural Network Architecture, Applications of RNN in real world; Vanishing Gradient Problem; Introduction to Long Short-Term Memory (LSTM) LSTM Architecture, Forget gate, input gate, output gate, LSTM vs RNN; Gated Recurrent Unit (GRU); Bi-RNN; Introduction to Neural Machine Translation (NMT) and Transformer Models (BERT, T5, GPT)	12	CO3
4	**Convolution Neural Network (CNN)**: Introduction to CNN, CNN architecture, Working of Convolutional Layers, Layers of CNN, Merits of CNN, Demerits of CNN, Applications; Image Classification using CNN; Semantic Segmentation; Hyperparameter Optimization; A brief idea about ResNet, EfficientNet, DenseNet, Inception Network, Xception;	10	CO4

Suggested Readings

1. B.Yegnanarayana, “Artificial Neural Networks”, Prentice Hall of India.
2. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, Prentice Hall of India.
3. Siman Haykin,”Neural Networks”, Prentice Hall of India.

Online Resources

1. https://archive.nptel.ac.in/courses/117/105/117105084/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2		2	1	1		1			2	1	1
CO2	2				2	2			1				1	1
CO3	2	2		2	1	2	1			2	2		2	2
CO4	2	2	3	2	2	2				2	2		1	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Deep Learning				
Code	BCADSN25324				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	This course aims at teaching supervised, unsupervised and reinforcement deep learning methods which helps to develop state-of-the-art artificial intelligence applications.				
Course Outcomes					
CO1	To explain the fundamentals of deep learning, artificial neural network.				
CO2	To articulate different problem of model improvement, imbalance data problem, and CNN.				
CO3	To understand object detection and image segmentation.				
CO4	To understand generative learning, its application, and deep reinforcement learning.				

Module	**Course Contents**		**Mapped CO**
1	**Introduction:** Deep Learning & its applications, Machine Learning, features, weights, loss function, cost function; **Artificial Neural Network** (ANN): forward propagation, Backpropagation, Stochastic Gradient Descent, Batch gradient descent, mini batch gradient descent, Optimizers, Momentum, training-validation testing set, evaluation measures, accuracy, precision, f-measure.	12	CO1
2	**Model Improvement**: Overfitting vs underfitting, Bias vs Variance, Regularization: L1, L2 regularization, Dropout, Early stopping, Data normalization, Batch normalization, Hyper parameter Tuning; **Imbalance data problem**: Data augmentation in image, Cropping, Flipping, Rotation, Brightness, Contrast, Color augmentation, Saturation, Convolutional Neural Networks; CNN architectures; convolution, striding, padding, pooling.	12	CO2
3	**Object Detection**: setup problem and cost function, well known datasets, Evaluation measure, Average precision, Mean average precession, Two stage detector, single stage detector, RCNN, Fast RCNN; **Image Segmentation**: setup problem and cost function, various dataset, Semantic segmentation, Instance segmentation.	11	CO3
4	**Generative Learning (GL)**: Variational auto-encoders, Generative Adversarial Neural Networks, GL Applications, Image generation, font generation, video generation, anime face/celebrity face generation, **Deep Reinforcement Learning**; Markov decision Processing, Deep Q Learning, exploration vs exploitation, Value iteration vs policy iteration, RL Applications.	10	CO4

Suggested Readings:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, and Yoshua Bengio, “Deep learning”, Cambridge, MIT press.
2. Aston Zhang, Zack C. Lipton, Mu Li, and Alex J. Smola, “Dive into Deep Learning”, Corwin.
3. Nithin Bu duma, Nikhil Bu duma, Joe Papa "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", Shroff/O'Reilly.
4. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, "Deep Learning Using Python", Wiley.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106184
2. https://nptel.ac.in/courses/106106184

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1	1	1	1			1	1	1	2	1
CO2	2	2	2	2	1	2	1		1	1	1	2	2	
CO3	2	2	2	1	2	2				2	2	1	2	2
CO4	2	2	2	1	1	2	1			2	1	1	1	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Bioinformatics & Computational Biology				
Code	BCADSN25325				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The course provides foundational knowledge in bioinformatics and computational biology, enabling students to analyze biological data, understand molecular structures, apply computational tools, and interpret genomic, proteomic, and systems-level biological information for research and innovation.				
Course Outcomes					
CO1	To understand the fundamental concepts of bioinformatics, including biological data types, databases, and basic computational tools used in biological analysis.				
CO2	To gain proficiency in sequence alignment techniques, including pairwise and multiple alignments, and apply them to comparative genomics.				
CO3	To learn to analyze and visualize protein structures, predict protein functions, and understand structural bioinformatics databases.				
CO4	To learn how to analyze gene expression, metabolic pathways, and apply data mining and machine learning techniques to large-scale biological data				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Bioinformatics and Computational Biology:** Overview of Bioinformatics and Computational Biology, Definitions, scope, and applications, Importance in modern biology and healthcare; Biological Data Types: Nucleotides, proteins, and sequences, Genome, transcriptome, and proteome data; Data Representation and Databases: Sequence data formats (FASTA, GenBank), Major bioinformatics databases (NCBI, EMBL, UniProt); Basic Computational Biology Concepts: Algorithms and data structures in bioinformatics, Introduction to programming for biological data	12	CO1
2	**Sequence Alignment and Comparative Genomics:** Pairwise Sequence Alignment, Dot Matrix, Needleman-Wunsch, Smith-Waterman algorithms, Scoring systems and gap penalties, Multiple Sequence Alignment, ClustalW, MUSCLE, MAFFT, Applications and challenges in MSA, Genomic Comparisons, Comparative genomics and evolution, Whole genome alignment and synteny analysis, Tools for Sequence Alignment, BLAST, FASTA, and other alignment tools	12	CO2
3	**Structural Bioinformatics:** Protein Structure, Primary, secondary, tertiary, and quaternary structures, Protein folding and stability, Molecular Visualization, Tools like PyMOL, Chimera, and RasMol, Visualizing protein-protein interactions, Protein Function Prediction, Homology modeling, docking, and prediction methods, Fold recognition and structural alignment, Structural Databases, Protein Data Bank (PDB), SCOP, CATH	11	CO3
4	**Systems Biology and Data Analysis:** Gene Expression Analysis, Microarrays, RNA-Seq, and gene expression profiling, Bioinformatics tools for transcriptomics, Metabolomics and Pathway Analysis, Introduction to metabolic pathways, Tools for metabolic network analysis (KEGG, Reactome), Systems Biology Concepts, Biological networks and systems-level analysis, Modeling and simulation of biological processes, Data	10	CO4

	Mining and Machine Learning in Bioinformatics, Data mining techniques for biological data, Introduction to machine learning applications in genomics		

Suggested Readings

1. Alfred V. Aho, Jeffrey D. Ullman, "Foundations of Computer Science", W.H. Freeman and Company.
2. Leslie C. Dunn, Theodora W. Smith, "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", Springer.
3. Arthur M. Lesk, "Introduction to Bioinformatics", Oxford University Press.

Online Resources

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-047j-introduction-to-computational-biology-fall-2006/
2. https://www.coursera.org/learn/bioinformatics

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		1	1	1	1		1	2	1	1	2	1
CO2	2	2		2	1	2	2		3	3	2	2	3	3
CO3	2	2		2	2	3	3		2	3	2	3	2	2
CO4	1	2		2	3	2	3		2	2	2	3	2	2

Program	Bachelor of Computer Applications				
Year	III	**Semester**	V		
Course Name	Blockchain Technology				
Code	BCADSN25326				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	To Gain a comprehensive understanding of Blockchain and Distributed Ledger Technologies, covering fundamental concepts and functionalities. Delve into Alternative Blockchains to grasp the workings of Distributed Ledger Technology beyond conventional paradigms				
Course Outcomes					
CO1	Students will learn fundamental concepts of Blockchain and Distributed Ledger Technologies				
CO2	To acquire the insights into Blockchain functionality.				
CO3	To explore Blockchain implementation through Bitcoin and Merkle Root etc.				
CO4	To get knowledge about Distributed Ledger Technology in Alternative Blockchains.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Blockchain and Distributed Ledger Fundamentals**: Blockchain, Growth of Blockchain technology Cryptographic basics for cryptocurrency: signature schemes, encryption schemes; Categories of Blockchain: Public Blockchain, Private Blockchain, Permissioned Ledger, Tokenized Blockchain, Tokenless Blockchain.	10	CO1
2	**Blockchain Functionality:** Distributed identity and Digital identification: Public and private keys, Decentralized network, Permissioned distributed Ledger, Digital identification and wallets; Blockchain data structure and security: Double spending, Network consensus, Sybil attacks, Block rewards and miners, Forks and consensus chain, Sharding based consensus algorithms to prevent attack, Finality, Limitation of proof-of-work, Alternatives to Proof of Work.	12	CO2
3	**Blockchain Implementation:** Bitcoin and Merkle Root; Eventual Consistency and Bitcoin; Byzantine Fault Tolerance and Bitcoin; Bitcoin block-size; Bitcoin Mining; Blockchain Collaborative Implementations: Hyperledger, Corda; Ethereum's ERC 20 and token explosion; Blockchain and full ecosystem decentralization: Smart contract, Decentralized autonomous organization (DAO), Decentralized applications.	12	CO3
4	**Distributed Ledger Technology in Alternative Blockchain:** Blockchain Governance Challenges: Bitcoin Blocksize Debate, The Ethereum DAO Fork, Ethereum's Move to PoS and Scaling Challenges; Blockchain Technical Challenges: Denial-of-Service Attacks, Security in Smart Contracts, Ripple, Stellar; Decentralized Network manager: Tezos.	11	CO4

Suggested Readings

1. Iyer, Kedar, et al., "Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions", McGraw-Hill Education.
2. Wattenhofer, R., "Distributed Ledger Technology: The Science of the Blockchain, Create Space Independent Publishing Platform.
3. Mark Gates, "Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money, CreateSpace Independent Publishing Platform,
4. Bahga, Vijay Madisetti, "Block chain Applications: A Hands-On Approach", Arshdeep Bahga.

Online Resources

1. https://nptel.ac.in/courses/106105184/.

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1	2	1			1	1		1	2	
CO2	2	2	2	1	2	1			1	1		1	2	1
CO3	2	1	2	1	2	2			1	1	1	1	1	1
CO4	2	2	2	1	1	2			1	1	1	1	2	1

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Web Application Development Using Python Lab				
Code	BCADSN25351				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	To understand the various concepts of HTML, DHTML, JavaScript, Python, Django Framework and their usage and implementation.				

Course Outcomes	
CO1	Understand and implement concept of HTML, DHTML and CSS concepts.
CO2	Understand and implement concepts of Django Framework to develop Web Applications.

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	1. Implementation of List Tags in HTML. 2. Implementation of Table Tag in HTML. 3. Implementation of Frameset Tag in HTML. 4. Implementation of different Form Tags in HTML. 5. Implementation of Cascading Style Sheet in Web Pages. 6. Implementation of Class Concept in DHTML. 7. Implementation of DHTML Events. 8. Implementation of CSS positioning. 9. Implementation CSS tables and links. 10. Implementation of CSS navigation bar. **Note: -** Students will also perform all other exercises provided by course instructor.	15	CO1
2	1. Implementation of basic variables in Java Script. 2. Implementation of User Defined Functions in Java Script. 3. Implementation of Form validation in Java Script. 4. Develop JavaScript to implement the decision making and looping statements. 5. Perform the specified string manipulation operation on the given String(s). 6. Use JavaScript to implement form events to solve the given problem. 7. Installing Django and creating projects. 8. Creating templates. 9. Adding administration panel to project. 10. Interacting with database and models. 11. Implementation of advanced views and URLconfs. **Note: -** Students will also perform all other exercises provided by course instructor.	15	CO2

Suggested Readings

- Xavier, C, “Web Technology and Design”, New Age International Publications.
- Bayross Ivan,” HTML, DHTML. JavaScript, and PHP”, BPB Publications.

2. Achyut S Godbole and Atul Kahate, “Web Technologies”, Tata McGraw Hill.
3. Samuel Dauzon, Aidas Bendoraitis, Arun Ravindran, ”Django: Web Development with Python”, packt publications
4. O’Reilly , ”Web Development with Django Cookbook”, 2016, Packt Publishing

Online Resources

1. https://archive.nptel.ac.in/courses/106/105/106105191/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	2	2	2	3	3		1	2		3	3	3
CO2	2	1	2	2	2	3	1		1	2		3	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	III	**Semester**	V		
Course Name	Mobile Application Development Lab				
Code	BCADSN25352				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	The capabilities and limitations of mobile platforms that affect application development and deployment. The technology and business trends impacting mobile application development. The characterization and architecture of mobile applications. The techniques for deploying and testing mobile applications, and for enhancing their performance and scalability.				
Course Outcomes					
CO1	To understand the basic concepts of Mobile application development Design and Develop user interfaces for the Android platforms.				
CO2	Able to designing and develop mobile applications using a chosen application development framework.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	1. Demonstrate the installation of Android Studio, including setting up the Android SDK, SDK Manager, and AVD (Android Virtual Device). Provide screenshots of each step. 2. Install additional SDK packages using SDK Manager. Set up and configure a new Android Virtual Device (AVD) with custom specifications. Launch and test it. 3. Create a basic "Hello Android" app using Android Studio. Deploy the app on both an emulator and a USB-connected Android device. 4. Edit the AndroidManifest.xml file to include necessary permissions and activity declarations. Explain how changes in the manifest affect the application. 5. Create an Android app that logs each lifecycle method (e.g., onCreate(), onStart(), onResume(), etc.) using Logcat. 6. Creating an application that displays message based on the screen orientation. Note: Students will also perform all other exercises provided by course instructor	15	CO1
2	7. Create an Android app using at least three different layouts: ConstraintLayout, LinearLayout (vertical and horizontal), and RelativeLayout. Show how each layout affects component positioning with screenshots.. 8. Develop a form with multiple fields and buttons using a Vertical ScrollView and place a Horizontal ScrollView inside it. Demonstrate the scrolling behavior and explain its use cases 9. Design a UI that uses the following views: TextView, EditText, Button, CheckBox, RadioButton, ImageView and	15	CO2

	SeekBar. Capture and display the user input on a button click. 10. Create an app that uses a VideoView to play a video from local storage or a URL and a WebView to load a webpage. 11. Develop an application that makes use of Notification Manager. 12. Build an app that stores and retrieves student information (e.g., name, roll number, grade) using SQLite. Implement insert, update, delete, and fetch operations using UI controls. 13. Create a sample application with login module (check user name and password) On successful login change Textview "Login Successful". On login fail alert using Toast "login fail" 14. Create an app to write and read text files using internal and external storage. 15. Develop a Mobile application for simple needs (Mini Project) Note: Students will also perform all other exercises provided by course instructor.		

Suggested Readings:

1. Michael Burton, Donn Felker, "Android Application Development for Dummies", Dummies.
2. Pradeep Kothari, " Android Application Development (with Kitkat Support)", Kogent Learning Solutions Inc.
3. W. Frank Ableson, Robi Sen, Et. Al., " Android in Action", Manning.
4. Charlie Collins, Michael Galpin, Et. Al., " Android in Practice", Manning.

Online Resources:

1. https://archive.nptel.ac.in/courses/106/106/106106156/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2			2	1	2		1			2	1	1
CO2	2	2			2	2	2		1			2	1	1

Seventh Semester

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	Semester	VII		
Course Name	Statistical & Optimization Techniques				
Code	BCADSN27401				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	The course provides a holistic understanding of statistical analysis, optimization, logistics, and project management. Students will learn to interpret data, solve optimization problems, manage logistics efficiently, and plan projects effectively, preparing them for analytical roles in diverse industries.				

Course Outcomes	
CO1	Gain proficiency in basic statistical analysis and interpretation.
CO2	To understand Master problem-solving techniques for linear programming and optimization.
CO3	Develop skills to solve transportation and assignment problems efficiently.
CO4	Apply inventory management and job sequencing principles effectively in real-World scenarios.

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Statistics:** Introduction, Review of Basic Statistics; Different **Frequency Chart:** Histogram, Frequency Curve, Pi-Chart etc.; **Measurement of Central Tendency:** Mean, Median, Mode; **Measures of dispersion:** Absolute Measure of Dispersion, Range, Inter Quartile Range; **Relative Measure of Dispersion:** Mean Deviation, Standard Deviation.	10	CO1
2	**Linear Programming Problem**: Introduction to LPP, Components of LPP, Formulation of LPP, Graphical Solution of LPP, Slack and Surplus Variable, Basic Feasible Solution, Unbounded Solution, Optimal Solution, Simplex Method, Artificial Variables, Two-Phase Method, Big-M Method, Duality, Dual Simplex Method, Revised Simplex Method, Problem of Degeneracy.	12	CO2
3	**Transportation Problem:** Introduction, Basic Feasible Solution of TP, North-West Corner Method, Matrix Minima Method, Row Minima Method, Column Minima Method, Vogal's Approximation Method, Degeneracy in TP, Loops in TP, Optimal Solution, Unbalanced TP. **Assignment Problem:** Introduction and Application of AP, Hungarian Algorithm for AP, Unbalanced AP.	10	CO3
4	**Inventory Management:** Introduction, Types of Inventories, Costs Involved in Inventory Decisions, Economic Order Quantity (EOQ), Determination of EOQ, EOQ Model without Shortage and with Shortage, Inventory Model with Price-Break, Replacement Problem; **Job Sequencing:** Introduction, N-Jobs Two Machines, N-Jobs Three Machines, N-Jobs M Machines; **CPM and PERT:** Introduction, Application of CPM/PERT, Network Diagram, Floats, Critical Path, Project Evaluation and Review Technique (PERT).	12	CO4

Suggested Readings:

1. Gillet B.E., "Introduction to Operation Research, Computer Oriented Algorithmic approach", Tata McGraw Hill Publising Co. Ltd. New Delhi.
2. P.K. Gupta & D.S. Hira, "Operations Research", S.Chand & Co.
3. J.K. Sharma, "Operations Research: Theory and Applications", Mac Millan.
4. S.D. Sharma, "Operations Research", Kedar Nath Ram Nath, Meerut (UP).

Online Resources:

1. http://www.digimat.in/nptel/courses/video/111105039/L21.html
2. https://www.digimat.in/nptel/courses/video/111105077/L25.html

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	2	1			1	1		2	1	1
CO2	1	2	1	2	2	1			1	1		2	1	1
CO3	1	2	2	2	1	1	1		1	2		2	1	
CO4	2	2	2	3	2	1	1		1	2		2	1	1

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	Semester	VII		
Course Name	Research Methodology				
Code	BCADSN27402				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	The course aims to develop research aptitude skills among the learners and to enable them to prepare a research report. To identify the relevance and role of research and differentiating between different kinds of research available, data models, data handling and analysis.				
Course Outcomes					
CO1	To Understand the basic concepts of research and Outlining the significance of research and research methodology.				
CO2	To Formulate research process for solving the business related problems. To develop ability to determine qualitative and quantitative methods of collection of data and sampling				
CO3	Able to examining the concept of measurement, sampling and hypothesis testing. Reconcile various types of charts, diagrams and statistical techniques used to analyze data.				
CO4	Able to prepare and present an effective research report.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Research Methodology:** Scope, Purpose, Need, Functions and Application of research; Types of research, Criteria of research. **Process of Research:** Steps of research process, Unit of Analysis: Individual, and organizational, Group and data series; Concept, Construct, Attributes, Variable and Hypotheses. **Research Design:** Various Methods of Research Design, Review of literature; Planning research: Preparing the Research Proposal, Elements of Research Proposal, Evaluating Research Proposal; Problem identification and formulation; Research design; Applications of Research.	12	CO1
2	**Data Collection:** Primary and Secondary source of data; Qualitative Vs Quantitative data; Methods of Data Collection; **Sampling theory with applications:** types of sampling, steps in sampling, sampling and non-sampling error: sample size, advantage and limitations of sampling; Precautions in Preparation of Questionnaire, Collection of Data, Significance and Reliability of Questionnaire.	11	CO2
3	**Research Modelling:** Field study, laboratory study, survey method, observational method, existing data based research; Scaling techniques. **Data Handling and Analysis:** Coding, Editing and Tabulation of Data, Measurement Scales. Various Kinds of Charts and Diagrams Used in Data Analysis: Line, Bar and Pie, Histogram Graphs and their Significance; Basics of Hypothesis and hypothesis testing.	12	CO3

4	**Report/ Thesis Writing:** Pre writing consideration; Formulation of research projects/ proposals; Format of Report; Presentation of Research report; Review articles, bibliography norm & plagiarism.	10	CO4

Suggested Readings:

1. C. R. Kothari, "Research Methodology Methods &Techniques", New Age International Publishers.
2. Cooper, "Donald R and Schindler" Business Research Methods, Tata McGraw Hill.
3. Naresh Malhotra, "Market Research", Pearson Education.
4. Kumar, Ranjit, "Methodology: A Step by Step guide for Beginners", Pearson Education

Online References:

1. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	1	2	1	2	2	-	1	2	1	2	-	1
CO2	1	1	1	1	1	2	2	-	1	2	1	1	-	3
CO3	1	1	1	1	1	2	1	-	1	2	1	1	-	3
CO4	2	3	3	2	2	2	2	-	3	3	1	2	1	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VII		
Course Name	Distributed System				
Code	BCADSN27421				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	To explain fundamental principles and models underlying the Distributed Systems and to understand the various practical-system like problems e.g. Global State and Time, Mutual Exclusion, Deadlock Detection, Failure Recovery, Authentication etc.				
Course Outcomes					
CO1	Identify various design and operational issues of Distributed Systems like Concept of Distributed Object, Indirect Inter-process Communication in Distributed System; Logical Clocks.				
CO2	Understand the working of various Algorithms required in modeling various functional aspects and designing the distributed systems.				
CO3	To know about distributed resource management and Shared Memory Techniques.				
CO4	Have knowledge of Fault Tolerance, Synchronization and Deadlock.				

Module		**Contact Hrs.**	**Mapped CO**
1	**Characterization of Distributed Systems**: Introduction, Examples of distributed Systems, Resource sharing and the Web Challenges. Architectural models, Fundamental Models; **Theoretical Foundation for Distributed System**: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks, Lamport's & vectors logical clocks. Concepts in Message Passing Systems: causal order, total order, total causal order, Techniques for Message Ordering, Causal ordering of messages, global state, and termination detection.	15	CO1
2	**Distributed Mutual Exclusion**: Classification of distributed mutual exclusion, requirement of mutual exclusion theorem, Token based and non-token-based algorithms, performance metric for distributed mutual exclusion algorithms; **Distributed Deadlock Detection**: system model, resource Vs communication deadlocks, deadlock prevention, avoidance, detection & resolution, centralized dead lock detection, distributed dead lock detection, path pushing algorithms, edge chasing algorithms.	15	CO2
3	**Agreement Protocols**: Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, consensus problem, Interactive consistency Problem, Solution to Byzantine Agreement problem, Application of Agreement problem, Atomic Commit in Distributed Database system; **Distributed Resource Management**: Issues in distributed File Systems, Mechanism for building distributed file systems, Design issues in Distributed Shared Memory, Algorithm for Implementation of Distributed Shared Memory.	15	CO3

4	**Failure Recovery in Distributed Systems**: Concepts in Backward and Forward recovery, Recovery in Concurrent systems, Obtaining consistent Checkpoints, Recovery in Distributed Database Systems. Fault Tolerance: Issues in Fault Tolerance, Commit Protocols, Voting protocols, Dynamic voting protocols; **Transactions and Concurrency Control**: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, comparison of methods for concurrency control; **Distributed Transactions**: Flat and nested distributed transactions, Atomic commit protocols, concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery.	15	CO4

Suggested Readings:

1. Singhal & Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill.
2. Ramakrishna, Gehrke," Database Management Systems", McGraw Hill.
3. Vijay K. Garg, "Elements of Distributed Computing", Wiley Publications.
4. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson Education.
5. Tenanuanbaum, Steen, "Distributed Systems", PHI Publication.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs87/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	3	2	2	3	1		2	2	1	2	2	3
CO2	1	1	3	2	2	3	1		2	2	1	2	2	3
CO3	1	1	3	2	2	3	1		2	2	1	2	2	2
CO4	1	1	3	2	2	3	1		2	2	1	2	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	Semester	VII		
Course Name	Ethics for Data Science				
Code	BCADSN27422				
Course Type	DSE	L	T	P	Credit
Pre-Requisite		3	1	0	4
Course Objectives	This course examines ethical considerations in the practice of data science, focusing on the responsible collection, use, and dissemination of data. Students will explore ethical frameworks, case studies, and real-world applications to develop a deeper understanding of the ethical challenges and responsibilities faced by data scientists.				
Course Outcomes					
CO1	To understand key ethical principles and frameworks relevant to data science.				
CO2	To Identify ethical issues related to data collection, storage, analysis and dissemination.				
CO3	To apply ethical reasoning to evaluate data science practices and decision-making.				
CO4	To develop strategies for addressing ethical dilemmas in data science.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Ethics and Data Science;** Overview of ethical principles and theories, Ethical considerations in data science, Ethical frameworks, utilitarianism, deontology; virtue ethics, and consequentialism, Applying ethical frameworks to data science.	15	CO1
2	**Data Collection and Privacy**: Informed consent and data privacy laws, Data anonymization and de-identification, Bias and Fairness. Types of bias in data collection and analysis, Mitigating bias in algorithms and decision-making, Transparency and Accountability.	15	CO2
3	**Explainability and interpretability in Machine Learning**: Ethical responsibilities of data scientists, Social Impacts of Data Science, Surveillance, discrimination, and social justice, Data ethics, Data ethics in healthcare, finance, and other industries.	15	CO3
4	**Case Studies**: Ethical dilemmas in data science, Analyzing and discussing real-world cases, Responsible Data Science, Best practices for ethical data science. Developing an ethical data science framework.	15	CO4

Suggested Readings:

1. Davis, Kord, “Ethics of Big Data”, O'reilly.
2. Cathy O'Neil, “Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy”, Crown Publishing Group.
3. David Martens, "Data Science Ethics: Concepts, Techniques, and Cautionary Tales", Oxford University Press

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_hs55/preview
2. https://archive.nptel.ac.in/noc/courses/noc17/SEM1/noc17-hs05/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	2		2	1	2		1			2	1	1
CO2	1	1			2		1		1			2	1	1
CO3		2	2	2	1				2	2	2	2	2	2
CO4	1	2	3	2	2	2	3		3	2	2	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VII		
Course Name	Data Privacy and Laws				
Code	BCADSN27423				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		3	1	0	4
Course Objectives	This course will examine fundamentals of data privacy include data confidentiality, data security, limitation in data collection and use, transparency in data usage, and compliance with the appropriate data privacy laws.				
Course Outcomes					
CO1	To understand the basic concept of digital age privacy concepts and theories.				
CO2	To understand the basic concept of privacy implications of modern digital technology.				
CO3	To understand the basic rules and frameworks for data privacy in the age of technology.				
CO4	To understand the basic concept of various data privacy acts and IT Acts.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction Data Privacy**: Fundamental Concepts, Definitions, Data Privacy Attacks, Types of Attacks, Phishing, Ransomware, SQL Injection, DoS, DDoS, Password Attack, Malicious Insiders, Access Control Models: Role Based Access Control, Rule Based Access Control. Privacy Policies: Introduction, General Data Protection Regulation (GDPR), California Privacy Right Act (CPRA), Personal Information Protection and Electronic Documents Act (PIPEDA) Privacy in Different Domains-Medical, Financial, etc.	15	CO1
2	**Concepts of Security:** Basic Components of Security, Principles of Security, Encryption and Decryption, Authentication: Introduction, 1FA Authentication, 2FA Authentication, MFA Authentication, Security Standards, Types of Security Standards, Security Services, Importance of Security Services, Security Mechanism, Encipherment, Digital Signatures, Authentication Exchange, Notarization.	15	CO2
3	**Introduction to Cryptography:** Definition, Symmetric and Asymmetric Cryptography, Steganography, Types of Steganography, Plain Text and Cipher Text, Conventional Encryption Techniques: Substitution Techniques, Types of Substitution Techniques, Transposition Techniques, Types of Transposition Techniques, Modern Technique, Block Ciphers Block Cipher Principles, Block Cipher Modes of Operation Data Encryption Standard (DES), Triple DES, Strength of DES, Advance Encryption Standard.	15	CO3
4	**Data Privacy Law:** Cyber-crime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cyber-crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and social media, Cyber Laws of other countries, Case Studies.	15	CO4

Suggested Readings:

1. Matt Bishop, “Introduction to Computer Security”, Addition Wesley.
2. William Stallings, “Computer Security: Principles and Practices”, Pearson.
3. Timothy Morey Andrew Burt, Thomas C. Redman, Christine Moorman “Customer Data and Privacy: The Insights You Need” Harvard Business Press.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc24_cs121/preview

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2		2	1	2		1			2	1	1
CO2	2		2		2	2	2		1			2	1	1
CO3	2	2	2	2	3	2	3		2	2	2	2	2	2
CO4	2	2	3	2	2	2	3		3	2	2	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VII		
Course Name	Transformers & Large Language Models				
Code	BCADSN27424				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The objective of this course is to explore the architecture, training, and applications of Transformers and Large Language Models (LLMs) in modern NLP and gain hands-on experience with models like BERT and GPT, while addressing real-world challenges such as scaling, prompting, and ethical deployment.				
Course Outcomes					
CO1	To understand the foundational NLP concepts and explore how Transformer architecture overcomes the limitations of traditional models.				
CO2	To understand transfer learning in NLP and apply encoder-based models like BERT for downstream language tasks.				
CO3	To understand GPT-style models and learn the principles and challenges of training and scaling large language models.				
CO4	To understand effective prompt strategies and critically evaluate ethical and safety concerns in deploying LLMs.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to NLP and the Transformer Revolution:** NLP Overview and traditional methods: Bag-of-Words, Word2Vec, Recurrent models: RNNs, LSTMs, Limitations of sequential architectures; Transformer Architecture: Self-Attention and Scaled Dot-Product Attention, Multi-Head Attention, Positional Encoding, Encoder-Decoder structure, Layer Normalization, Residual Connections	12	CO1
2	**Pretraining and Encoder-Based Models:** Transfer Learning in NLP, Pretraining tasks: MLM, CLM, NSP; **BERT and Its Variants:** BERT, RoBERTa, ALBERT architectures, Tokenization techniques: WordPiece, Byte-Pair Encoding, Fine-tuning for classification, QA, NER tasks.	10	CO2
3	**Decoder Models and Scaling LLMs:** GPT Models: GPT-1, GPT-2, GPT-3 architectures, Autoregressive training, text generation; Training Large Language Models: Data collection and preprocessing, Tokenization and vocabulary handling, Training infrastructure and compute challenges, Optimization algorithms: Adam, Adafactor	11	CO3
4	**Prompting, Ethics, and Responsible AI:** Prompt Engineering and Instruction Tuning: Crafting effective prompts, Chain-of-thought prompting, Instruction tuning, RLHF; Ethics and Safety: Bias, fairness, and hallucination in LLMs, OpenAI alignment techniques, Content moderation and model robustness, Case Study: Ethical considerations in a real-world LLM application	12	CO4

Suggested Readings:

1. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly Media.
2. Palash Goyal, Sumit Pandey, and Karan Jain, "Deep Learning for Natural Language Processing", Apress.
3. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", Pearson Education (3rd Edition, draft available online).
4. Denis Rothman, "Transformers for Natural Language Processing", Packt Publishing.

Online Resources:

2. https://web.stanford.edu/class/cs224n/
3. https://github.com/cmu-multicomp/llm-course

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1		1	1	1	1		1	2	1	1	2	1
CO2	2	2		2	1	2	2		3	3	2	2	3	3
CO3	2	2		2	2	3	3		2	3	2	3	2	2
CO4	1	2		2	3	2	3		2	2	2	3	2	2

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	Semester	VII		
Course Name	Natural Language Processing				
Code	BCADSN27425				
Course Type	DSE	L	T	P	Credit
Pre-Requisite	Artificial Intelligence and Automata	2	1	0	3
Course Objectives	To understand the algorithms available for the processing of linguistic information and computational properties of natural languages. To conceive basic knowledge on various morphological, syntactic and semantic NLP tasks.				

Course Outcomes	
CO1	Introduce the basic concepts of NLP, its applications, syntax, semantics, discourse & pragmatics of natural language.
CO2	Demonstrate the understanding of Language Modeling and Neural Networks Basics.
CO3	Discover the linguistic and statistical features relevance to the basic NLP task in context to parts-of-speech tagging.
CO4	Understanding of parsing and semantic analysis.

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to NLP**: NLP – introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts-of-speech and Formal Grammar of English.	10	CO1
2	**Language Modeling:** N-gram and Neural Language Models Language Modeling with N-gram, Simple N-gram models, Smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, application of neural language model in NLP system development.	12	CO2
3	**Parts-of-speech Tagging:** Basic concepts; Tag set; Early approaches: Rule based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model.	11	CO3
4	**Parsing**: Basic concepts: top down and bottom up parsing, tree bank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs; **Semantics**: Vector Semantics; Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis; Embedding from prediction: Skip-gram and CBOW; Concept of Word Sense; Introduction to WordNet.	12	CO4

Suggested Readings:

1. Jurafsky D. and Martin J. H., "Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Upper Saddle River, NJ: Prentice-Hall
2. Yoav G., "A Primer on Neural Network Models for Natural Language Processing", AI Access Foundation.
3. Vajjala S., Gupta A. and Surana H., "Practical Natural Language Processing", O'Reilly.

Online Resources:

1. https://elearn.nptel.ac.in/shop/nptel/applied-natural-language-processing/?v=c86ee0d9d7ed
2. https://www.coursera.org/learn/machine-learning-and-nlp-basics

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2		2	1	2	1			1			2	1	1
CO2	2		2	1	2	2			1			2	1	1
CO3	2	2	2	1	3	2			2	2	1	2	2	2
CO4	2	2	3	2	2	2	1		3	2	1	2	3	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VII		
Course Name	Human Computer Interaction				
Code	BCADSN27426				
Course Type	DSE	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	Understand the fundamentals of Human computer interaction. Develop user empathy and preferences through user research, design principles of interactive systems that are usable, efficient, and satisfying for users. The skills to design user interfaces, interaction patterns, and visual design. Explore emerging trends and technologies in Human computer interaction, student to think constructively and analytically about how to design and evaluate interactive technologies.				
Course Outcomes					
CO1	To understand and analyze the common methods in the user cantered design process and the appropriateness of individual methods for a given problem.				
CO2	To apply, adapt and extend classic design standards, guidelines, and patterns.				
CO3	To employ selected design methods and evaluation methods at a basic level of competence. Build prototypes at varying levels of fidelity, from paper prototypes to functional, interactive prototypes.				
CO4	To demonstrate sufficient theory of human computer interaction, experimental methodology and inferential statistics to engage with the contemporary research literature in interface technology and design.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Importance of user Interface definition, importance of good design. Benefits of good design, A brief history of Screen design. The graphical user interface popularity of graphics; **Concept of direct manipulation**: graphical system, Characteristics, Web user, Interface popularity, Principles of user interface.	10	CO1
2	**Design process:** Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, understanding business junctions; **Screen Designing:** Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow.	11	CO2
3	**Visually pleasing composition**: amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design; **Windows:** New and Navigation schemes selection of window, selection of devices based and screen based controls. Components, text and messages, Icons and increases multimedia, colors, uses problems, choosing colors.	12	CO3
4	**HCI in the software process**: The software life cycle, Usability engineering, Iterative design, and prototyping Design; Focus prototyping in practice design rationale; Design rules; principles to support usability standards; Golden rules; **heuristics HCI patterns Evaluation techniques**: Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles Multi modal interaction.	12	CO4

Suggested Readings:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, Prentice Hall.
2. Jonathan Lazar Jinjuan, Heidi Feng, Harry Hochheiser, “Research Methods in Human Computer Interaction”, Wiley.
3. Ben Shneiderman, and Catherine Plaisant, “Designing the User Interface: Strategies for Effective Human-Computer Interaction”, Addison-Wesley Publishing Co.
4. Samit Bhattacharya, “Human-Computer Interaction: User-Centric Computing for Design”, McGraw Hill

Online Resources:

1. https://archive.nptel.ac.in/courses/106/103/106103115/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	2		1	1	1				1	1	2	1
CO2		2	2		1	2	1		1		1	1	2	1
CO3	1	2	2	1	1	2				2	1	1	2	2
CO4		2	2	1	1	2	1			2	1	1	1	2

Eighth Semester

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VIII		
Course Name	R Programming				
Code	BCADSN28401				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		2	1	0	3
Course Objectives	The objective is to provide fundamental understanding of R Programming/R Studio. Also able to understand needs and usages of graphical tools and statistical functions, correlations, and other R Programming related aspects				
Course Outcomes					
CO1	Able to understand R Programming/RStudio, commands, conditional and Iterative statements.				
CO2	Able to identify and manage data Structures, Utilizing inbuilt functions and custom functions using R Programming				
CO3	Able to identify and manage and implementation of Data management and data frames, reading and writing data in files.				
CO4	Able to understand the implementation of statistical functions, handling data with graphical tools.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of R Programming:** Basic fundamentals of R Programming, installation and use of Base-R/RStudio software, data editing, and use of R as a calculator, Writing R scripts in an editor, Vector and scalar, missing data and logical operators, Conditional executions and iterative statements/loops.	10	CO1
2	**Data Structures and Functions:** Data management with sequences. Data management with repeats, sorting, ordering, and lists, Vector indexing, factors, Data management with strings, display and formatting, inbuilt function support, creating custom functions.	11	CO2
3	**Matrices and Data Frames:** Creating matrices and Data frames, Matrices and dataframe functions, slicing data frame, combining slicing with functions, data management with display paste, split, find and replacement, manipulations with alphabets, evaluation of strings, data frames. Advanced Data frames manipulations, import of external data in various file formats.	12	CO3
4	**Plots and Statistical function:** Graphics and plots, Colors, plotting arguments, Scatterplot, Histogram, Barplot, pirateplot, Low level plotting functions, Saving plot to pdf, jpg, png file formats, statistical functions (linear and nonlinear modeling, classical statistical tests, time-series analysis, classification, clustering) for central tendency, variation, skewness and kurtosis, handling of bivarite data through graphics, correlations, Data persistency, Hypothesis test (T Test, Correlations Test, Chi Square Test).	12	CO4

Suggested Readings:

1. Christian Heumann, Michael Schomaker and Shalabh “Introduction to Statistics and Data Analysis - With Exercises, Solutions and Applications in R” Springer.
2. Pierre Lafaye de Micheaux, Remy Drouilhet, Benoit Liquet “The R Software-Fundamentals of Programming and Statistical Analysis” Springer.
3. Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters “A Beginner's Guide to R (Use R)” Springer.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ma33/preview
2. https://home.iitk.ac.in/~shalab/sprs.htm

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					1								
CO2	2	1				1				1				
CO3	2	2		1	1	2				1		1		
CO4	2	2		1	1	2				1		1	1	

Program	Bachelor of Computer Applications (DS &AI)				
Year	IV	Semester	VIII		
Course Name	Intellectual Property Right				
Code	BCADSN28402				
Course Type	DSC	L	T	P	Credit
Pre-Requisite		2	1	0	3
Course Objectives	This course introduces the student to the basics of Intellectual Property Rights, Copy Right Laws, Trade Marks and Issues related to Patents. The overall idea of the course is to help and encourage the student for startups and innovations.				

Course Outcomes	
CO1	To understand the need of intellectual property rights.
CO2	To understand the concepts Patent and Copyrights.
CO3	To understand the concept of Trade Mark and Design.
CO4	To understand the Geographical indications and Plant Variety Protection.

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction and the need for intellectual property right (IPR):** Meaning, nature and basic concepts of intellectual property, Types of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design; IPR in India: Genesis and development, IPR in abroad, Introduction to TRIPS and WTO, Introduction to IT Act.	10	CO1
2	**PATENT:** Objectives, Rights, Patent Acts 1970 and its amendments. Procedure of obtaining patents, working of patent, Industrial Application: Non-Patentable Subject Matter, Registration Procedure, Rights and duties of Patentees, Infringement, Restoration of lapsed Patents, Surrender and Revocation of Patents; **Copyright:** Definition &Types of Copyright, Registration procedure, Assignment & license, Terms of Copyright, Piracy, Infringement, Remedies, Copyrights with special reference to software.	12	CO2
3	**Trademarks:** Concept of Trademarks, Types of trademarks: brand names, logos, signatures, symbols, well-known marks, certification marks and service marks, Non-Registrable Trademarks, Registration of Trademarks, Rights of holder, assignment and licensing of marks Trademark Infringement, Remedies & Penalties - Trademarks registry and appellate board; **Design:** meaning and concept of novel and original, Procedure for registration, effect of registration and term of protection.	12	CO3
4	**Geographical indication:** Concept of GI, Procedure for registration, effect of registration and term of protection; **Plant Variety Protection**: Concept of Plant variety protection, Procedure for registration, effect of registration and term of protection. India`s New National IP Policy, Govt. of India step towards Promoting IPR, Govt. Schemes in IPR – Career Opportunities in IPR.	11	CO4

Suggested Readings:

1. Neeraj, P., & Khusdeep, D. , "Intellectual Property Rights. India", IN: PHI learning Private Limited.
2. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
3. Nityananda, K.V. , Intellectual Property Rights: Protection and Management. India, In: Cengage Learning India Private Limited.

Online Resources:

1. https://www.uspto.gov/
2. http://cipam.gov.in/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1		1			1	1			2	1	2	1	1
CO2	1	2	1	1	2	1	2		2	3	1	2	2	2
CO3	1	2	3	1	2	1	2		2	3	1	2	2	2
CO4	1	2	2	1	2	1	1	2	1	2	2	2	2	3

Program	Bachelor of Computer Applications (DS & AI)				
Year	IV	**Semester**	VIII		
Course Name	R Programming Lab				
Code	BCADSN28451				
Course Type	DSC	**L**	**T**	**P**	**Credit**
Pre-Requisite		0	0	4	2
Course Objectives	The objective of this course is to provide students with a practical understanding of R Programming/RStudio. It will dive deep in managing the concept and significance of Data Management and Data Frames, and to understand need and usages of graphical tools and relevant statistical functions, correlations.				
Course Outcomes					
CO1	Able to work on RStudio and learn basics of R Programming, control & iterative, matrix, list, vector manipulations, inbuilt and custom Functions				
CO2	Able to Use data management through excel file, CSV File, Graphical tools and statistical functions.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	1. Introduction to R and RStudio, Working with commands and variables 2. Implementation of various Data Structures in R (Vectors, Matrices, lists, data frames) 3. Implementation of various Control Structure (If-else statements, loops) 4. Implementations and usage of various inbuilt functions, writing custom functions and apply family functions in R Programming 5. Performing data manipulation with dplyr and tidyr packages 6. Performing Data visualization with ggplot2 for creating plots, scatter plots, histogram, box plots, customizing plots with themes, colors and labels 7. Introduction to Statistical Analysis in R Programming, Implementation of basic regression analysis. 8. Implementations of various inferential statistics (T-tests, ANOVA, Correlation) 9. Implementation of importing and exporting data to and from sources (CSV, Excel, database etc) 10. Introductions and demonstrate the use of readr and readxl packages. Note: Students will also perform all other exercises provided by course Instructor.	15	CO1
	1. Creating and managing R Packages 2. Introduction to Probability and its implementation in R Programming 3. Simulation and Implementation of the Normal Curve using R Programming 4. Simulating and implementation of Measures of Central Tendency and Dispersion 5. Simulating and implementation Standard Deviations,	15	CO2

2	Standard Scores and the Normal Distribution 6. Simulating and implementation Hypothesis Testing: Testing the Significance of the Difference Between Two Means 7. Simulating and implementation Hypothesis testing: One and Two-tailed Tests 8. Simulating and implementation Bivariate Statistics for Nominal Data 9. Simulating and implementation Bivariate Statistics for Ordinal Data 10. Simulating and implementation Bivariate Statistics for Interval / Ratio Data Note: Students will also perform all other exercises provided by course Instructor.		

Suggested Readings:

1. Christian Heumann, Michael Schomaker and Shalabh "Introduction to Statistics and Data Analysis - With Exercises, Solutions and Applications in R" Springer.
2. Pierre Lafaye de Micheaux, Remy Drouilhet, Benoit Liquet "The R Software-Fundamentals of Programming and Statistical Analysis" Springer.
3. Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters "A Beginner's Guide to R (Use R)" Springer.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ma33/preview
2. https://home.iitk.ac.in/~shalab/sprs.htm

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2					1								
CO2	2	1				1				1				