BACHELOR OF COMPUTER APPLICATION (BCA)

(NEP 2020)

Detailed syllabi for Students Admitted to KIIT Deemed to be University

ACADEMIC CURRICULA 2025 - 2029

Kalinga Institute of Industrial Technology (KIIT)

Deemed to be University U/S 3 of UGC Act, 1956

SCHOOL OF COMPUTER APPLICATIONS

COURSE STRUCTURE

Bachelor of Computer Application (BCA)
(2025– 2029)
Kalinga Institute of Industrial Technology
(Deemed to be University)

Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956
SCHOOL OF COMPUTER APPLICATIONS

FIRST SEMESTER (AUTUMN)

THEORY							
SL. NO.	**CATEGORY**	**SUBJECT CODE**	**SUBJECT**	**L**	**T**	**P**	**CREDIT**
01	SEC	BC10001	Computer Programming	3	0	0	3
02	CC	BC10003	Introduction to Statistics	3	0	0	3
03	MDC	BC10005	Fundamentals of Accounting	3	0	0	3
04	AEC	BC10007	English Language	3	0	0	3
05	VAC	BC10009	Basics of Information Technology	2	0	0	2
PRACTICAL							
06	SEC	BC19001	Computer Programming Lab	0	0	4	2
07	CC	BC19003	Statistics Lab	0	0	4	2
SESSIONAL							
08	VAC	SY18001	Sports and Yoga	0	0	2	1
TOTAL				-	-	-	**19**

SECOND SEMESTER (SPRING)

THEORY							
SL. NO.	**CATEGORY**	**SUBJECT CODE**	**SUBJECT**	**L**	**T**	**P**	**CREDIT**
01	CC	BC10002	Data Structures	3	0	0	3
02	CC	BC10004	Introduction to Probability	3	0	0	3
03	CC	BC10006	Computer Architecture	3	0	0	3
04	CC	BC10008	Operating Systems	3	0	0	3
05	SEC	BC10010	OOP Using Java	3	0	0	3
06	SEC	BC10012	Web Technologies	2	0	0	2
PRACTICAL							
07	CC	BC19002	Data Structures Lab	0	0	4	2
08	SEC	BC19010	Java Programming Lab	0	0	4	2
09	SEC	BC19012	Web Technologies Lab	0	0	2	1
TOTAL				-	-	-	**22**

THIRD SEMESTER (AUTUMN)

THEORY							
SL. NO.	**CATEGORY**	**SUBJECT CODE**	**SUBJECT**	**L**	**T**	**P**	**CREDIT**
01	CC	BC20001	Database Management Systems	3	0	0	3
02	CC	BC20003	Software Engineering	3	0	0	3
03	CC	BC20005	Discrete Mathematics	3	0	0	3
04	SEC	BC20007	Python Programming	2	0	0	2
05	DSE		Professional Elective –I	2	0	0	2
06	VAC	BC20009	Environmental Science and Sustainability	3	0	0	3
PRACTICAL							
07	CC	BC29001	Database Lab	0	0	4	2
08	SEC	BC29007	Python Programming Lab	0	0	4	2
09	DSE		Professional Elective –I Lab	0	0	2	1
TOTAL				-	-	-	**21**

FOURTH SEMESTER (SPRING)

SL. NO.	**CATEGORY**	**SUBJECT CODE**	**COURSE TITLE**	**L**	**T**	**P**	**CREDIT**
01	CC	BC20002	Entrepreneurship and Startup Ecosystem	2	0	0	2
02	CC	BC20004	Computer Networks	3	0	0	3
03	CC	BC20006	Design and Analysis of Algorithms	3	0	0	3
04	CC	BC20008	Artificial Intelligence	3	0	0	3
05	DSE		Professional Elective –II	2	0	0	2
06	SEC	BC20010	Design Thinking and Innovation	2	0	0	2
PRACTICAL							
01	CC	BC29004	Computer Networks Lab	0	0	4	2
02	CC	BC29008	Artificial Intelligence Lab	0	0	4	2
03	DSE		Professional Elective –II Lab	0	0	2	1
TOTAL				-	-	-	**20**

FIFTH SEMESTER (AUTUMN)

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	DSE		Professional Elective –III	3	0	0	3
02	DSE		Professional Elective –IV	3	0	0	3
03	DSE		Professional Elective –V	3	0	0	3
04	SEC	BC30001	Quantitative Techniques	2	0	0	2
PRACTICAL							
01	DSE		Professional Elective –III Lab	0	0	4	2
02	DSE		Professional Elective –IV Lab	0	0	4	2
03	DSE		Professional Elective –V Lab	0	0	4	2
SESSIONAL							
01	SEC	BC38001	Internship - I	0	0	0	2
TOTAL				-	-	-	**19**

Note: Internship (BC38001) will be initiated in the 4th Semester

SIXTH SEMESTER (SPRING)

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	CC	BC30002	Generative AI	2	0	0	2
02	DSE		Professional Elective –VI	3	0	0	3
03	DSE		Professional Elective –VII	3	0	0	3
04	AEC	BC30004	Soft Skills	2	0	0	2
PRACTICAL							
01	CC	BC39002	Generative AI Lab	0	0	4	2
02	DSE		Professional Elective –VI Lab	0	0	4	2
03	DSE		Professional Elective –VII Lab	0	0	4	2
SESSIONAL							
05	SEC	BC37001	Project	0	0	12	6
TOTAL				-	-	-	**22**

SEVENTH SEMESTER – BCA (HONOURS)

Specialization – AI & ML

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	MDE	BC40001	Social Network Analysis	3	0	0	3
02	CC	BC40003	Optimization Techniques in Machine Learning	3	0	0	3
03	DSE		Professional Elective –VIII	3	0	0	3
04	DSE		Professional Elective –IX	3	0	0	3
PRACTICAL							
01	CC	BC49003	Optimization Techniques Lab	0	0	4	2
02	DSE		Professional Elective –VIII Lab	0	0	4	2
SESSIONAL							
01	SEC	BC48001	Internship - II	0	0	0	4
TOTAL				-	-	-	**20**

Note: Summer Internship (BC48001) will be initiated in the 6th Semester

SEVENTH SEMESTER–BCA (HONOURS)

Specialization–Data Science

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	MDE	BC40005	Advanced Statistical Methods for Data Science	3	0	0	3
02	CC	BC40007	Python for Data Science	3	0	0	3
03	DSE		Professional Elective –VIII	3	0	0	3
04	DSE		Professional Elective –IX	3	0	0	3
PRACTICAL							
01	CC	BC49007	Python for Data Science Lab	0	0	4	2
02	DSE		Professional Elective –VIII Lab	0	0	4	2
SESSIONAL							
01	SEC	BC48001	Internship - II	0	0	0	4
TOTAL				-	-	-	**20**

Note: Summer Internship (BC48001) will be initiated in the 6th Semester

EIGHTH SEMESTER BCA (HONOURS)

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	DSE		Professional Elective –X	3	0	0	3
02	DSE		Professional Elective –XI	3	0	0	3
03	DSE		Professional Elective –XII	2	0	0	2
PRACTICAL							
01	DSE		Professional Elective –X Lab	0	0	4	2
02	DSE		Professional Elective –XI Lab	0	0	4	2
SESSIONAL							
01	SEC	BC48002	Dissertation	0	0	0	8
TOTAL				-	-	-	**20**

SEVENTH SEMESTER BCA– (HONOURS WITH RESEARCH)

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
01	CC	BC40007	Advanced Data Analysis	3	0	0	3
02	CC	RM40009	Research Methodology	3	0	0	3
03	DSE		Professional Elective –VIII	3	1	0	4
05	DSE		Professional Elective –IX	3	1	0	4
PRACTICAL							
01	CC	BC49007	Advanced Data Analysis Lab	0	0	4	2
SESSIONAL							
01	CC	BC48001	Internship - II	0	0	0	4
TOTAL				-	-	-	**20**

Note: Summer Internship (BC48001) will be initiated in the 6th Semester

EIGHTH SEMESTER BCA– (HONOURS WITH RESEARCH)

SL. NO.	CATEGORY	SUBJECT CODE	COURSE TITLE	L	T	P	CREDIT
SESSIONAL							
01	CC	BC48002	Dissertation	0	0	0	20
				-	-	-	
TOTAL				-	-	-	**20**

SPECIALIZATIONS WITH DISCIPLINE-SPECIFIC ELECTIVES (DSE)

DATA SCIENCE (THEORY)

SL. NO.	SEMESTER	SUBJECT CODE	PROFESSIONAL ELECTIVE
1	III	BC20031	Basics of Data Analytics using Spreadsheet
2	1V	BC20032	Data Visualization
3	V	BC30031	Introduction to Data Science
4	V	BC30033	Time Series Analysis
5	V	BC30035	Machine Learning
6	VI	BC30032	Big Data Analytics
7	VI	BC30034	Exploratory Data Analysis
8	VII	BC40031	Business Intelligence & Analytics
9	VII	BC40033	Data Mining & Warehousing
10	VIII	BC40032	Advanced Data Visualization
11	VIII	BC40034	Cloud Computing Data Analytics
12	VIII	BC40036	Data Security & Privacy

DATA SCIENCE (LAB)

SL. NO.	SEMESTER	SUBJECT CODE	PROFESSIONAL ELECTIVE LAB
1	III	BC29031	Basics of Data Analytics using Spreadsheet
2	1V	BC29032	Data Visualization
3	V	BC39031	Introduction to Data Science
4	V	BC39033	Time Series Analysis
5	V	BC39035	Machine Learning
6	VI	BC39032	Big Data Analytics
7	VI	BC39034	Exploratory Data Analysis
8	VII	BC49031	Business Intelligence & Analytics
9	VIII	BC49032	Advanced Data Visualization
10	VIII	BC49034	Cloud Computing Data Analytics

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (THEORY)

SL. NO.	SEMESTER	SUBJECT CODE	PROFESSIONAL ELECTIVE
1	III	BC20041	Feature Engineering
2	1V	BC20042	Introduction to ML
3	V	BC30041	Artificial Neural Networks
4	V	BC30043	Image Processing
5	V	BC30045	Natural Language Processing
6	VI	BC30042	Computer Vision
7	VI	BC30044	Predictive Analysis
8	VII	BC40041	Explainable AI
9	VII	BC40043	Evolutionary Algorithm
10	VIII	BC40042	Reinforcement Learning
11	VIII	BC40044	Digital Signal Processing
12	VIII	BC40046	Security aspects of ML

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (LAB)

SL. NO.	SEMESTER	SUBJECT CODE	PROFESSIONAL ELECTIVE LAB
1	III	BC29041	Feature Engineering
2	1V	BC29042	Introduction to ML
3	V	BC39041	Artificial Neural Networks
4	V	BC39043	Image Processing
5	V	BC39045	Natural Language Processing
6	VI	BC39042	Computer Vision
7	VI	BC39044	Predictive Analysis
8	VII	BC49041	Explainable AI
9	VIII	BC49042	Reinforcement Learning
10	VIII	BC49044	Digital Signal Processing

FIRST SEMESTER (AUTUMN)

BC10001 COMPUTER PROGRAMMING CREDITS: 3

UNIT - I

Programming Process: Steps in developing of a program, data flow diagram, decision table, algorithm development, flowchart, pseudo code, testing and debugging.
Fundamentals of C Languages: Character set, identifiers and keywords, constants, types of C constants, rules for constructing integer, real and character constants, variables, data types, rules for constructing variables.
Operators and Expressions: C instructions, arithmetic operators, relational operators, logical operators, assignment operators, type conversion in assignments, hierarchy of operations, standard and formatted statements, structure of a C program, compilation and execution.

UNIT - II

Decision Control Structure: Decision making with if-statement, if-else and nested if else.
Loop Control Structure: While and do-while, for loop and Nested loops.
Case Control Structure: Decision using switch, break, continue and goto statements.
Functions: Library functions and user defined functions, global and local variables, function declaration, calling and definition of function, methods of parameter passing to functions, recursion and storage classes in C.

UNIT - III

Arrays: Introduction, Array declaration, accessing values in an array, initializing values in an array, Single and Two-Dimensional Arrays, Initializing a 2-Dimensional Array, Memory Map of a 2-Dimensional Array, Passing array elements to a function, Call by value and call by reference, Arrays of characters, Searching the elements in an array, Matrices in arrays, Passing an Entire Array to a Function.
Pointers: Pointer declaration, Address operator "&", Indirection operator "*", Pointer and arrays, Pointers and 2-Dimensional Arrays, Pointer to an Array, Passing 2-D array to a Function.
Dynamic Memory Allocation: malloc(), calloc(), realloc(), free() functions.

UNIT – IV

String Manipulation: Declaring and Initializing string variables, Reading and writing strings, String Handling functions (strlen(), strcpy(), strcmp(), strcat()).
Structures and Unions: Declaration of structures, Structure Initialization, Accessing structure members, Arrays of structure.
Files Handling: Introduction, Opening and Closing files, Basic I/O operation on files.

Reference Books

1. *Reema Thareja, Computer Fundamentals and Programming in C, 2nd Edition, Oxford University Press, 2016.*
2. *Ashok N Kamthane: Programming in C, 2nd Edition, Pearson Edition Publication, 2011.*
3. *P. Dey, M. Ghosh, Programming in C, 2nd Edition, Oxford University Press, 2013.*
4. *K. R. Venugopal, S. R. Prasad, Mastering C, MGH, 2007.*
5. *R.S. Bichkar, Programming with C, University Press, 2012.*
6. *E Balagurusamy, Programming in ANSI C, 8thEdition, MGH, 2019.*
7. *A.K. Sharma, Computer Fundamentals and Programming in C,2nd Edition, Universities press, 2018.*

COURSE OUTCOMES

On taking the 'Computer Programming'course the students will be able to:

CO1: Design correct programs to solve problems.
CO2: Compare various programming, and apply the concept of decision structures, loops and functions.
CO3: Solve basic programming problems using a variety of skills and strategies.
CO4: Use pseudo-code and visual modelling to prepare clear and accurate program documentation and models.
CO5: Examine working programs to identify their structures.
CO6: Apply appropriate techniques to create entry-level programs from models.

BC10003 INTRODUCTION TO STATISTICS CREDITS: 3

UNIT - I

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and Sample Data: quantitative and qualitative, attributes, variables, scales of measurement

nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

UNIT - II

Measures of Central Tendency: Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections.

UNIT - III

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation, simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

UNIT – IV

Index Numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Chain index numbers, conversion of fixed based to chain-based index numbers and vice-versa, Consumer price index numbers.

Reference Books

1. *Allan G. Bluman, Elementary Statistics: a step-by-step approach, 10th Edition, McGraw Hill, 2018.*
2. *F. J. Gravetter&L.B. Wallnau, Statistics for The Behavioral Sciences, 10th Edition, Cengage, 2016.*
3. *R.Peck, C. Olsen,Jay L. Devore, Introduction to Statistics and Data Analysis, Brooks/Cole, 4th edition, 2010.*
4. *P.N.Arora, Comprehensive Statistical Methods, 4th Edition, S. Chand, 2014.*
5. *S.C. Gupta &V.K.Kapoor, Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, 2020.*
6. *D.N. Elhance, V. Elhance& B.M. Aggarwal, Fundamentals of Statistics, 60th Edition, Kitab Mahal Publishers, 2020.*
7. *Speigel, David P. Lindstrom,Schaums Easy Outline of Statistics,2nd Edition, MGH, 2020.*

COURSE OUTCOMES

On taking the 'Introduction to Statistics' course the students will be able to:

CO1: Define and use the basic terminology of statistics

CO2: Analyse and compare different sets of data

CO3: Classify the data by means of diagrams and graph

CO4: Recall the meanings of statistical terms

CO5: Explain the statistical concepts of central tendency, dispersion skewness, Kurtosis & index numbers

CO6: Calculate and interpret the various measures of central tendency, dispersion skewness, Kurtosis & index numbers.

BC10005 FUNDAMENTALS OF ACCOUNTING CREDITS: 3

UNIT - I

Basic concepts ofaccounting: An Overview of Accounting, Concepts to be observed at the recording stage, Systems of Book -Keeping, Classification of Accounts, Rules of Debit and Credit, Accounting Process.

UNIT - II

Theaccounting process: Objective, Introduction, Journal, Ledger, Trial Balance, Opening Entry.

UNIT - III

Cash book and bank reconciliation: Objective, Introduction, Sub-division of Journal, Cash Book, Bank Reconciliation Statement, Petty Cash Book, OTHER SUBSIDIARY BOOKS.

UNIT – IV

Financial Statements: Meaning and Components of Financial statements, Preparation of FinancialStatements, Trading Account, Profit and loss Account, Meaning and Purpose of Balance Sheet, Format of Balance Sheet; Steps for preparation of Balance Sheet.

Reference Books

1. *Financial Accounting, S.N. Maheshwari, Vikas Publication House Pvt. Ltd., New Delhi.*
2. *Financial Accounting, Ashis Bhattacharya, prentice-Hall India Publication.*
3. *Harold Bierman Jr. and Allan R. Drebin,Financial Accounting, An Introduction,B. Saunders Company, Philadelphion, London.*
4. *Maheshwari, S.N., Introduction to Accounting, Vikas Publishing House,NewDelhi.*
5. *Patil V. A. and J.S. Korlahalli, Principles and Practice ofAccounting, R. Chand& Co., New Delhi.*

COURSE OUTCOMES

On taking the 'Fundamentals of Accounting' course,the students will be able to:

CO1: Understand the concept of entrepreneur and entrepreneurship.
CO2: Develop a start-up Enterprise and Analyze start-up capital requirement by analyzing legal factors.
CO3: Analyse the business environment of a start-up and Access growth stages in new venture and reasons for scaling ventures.
CO4: Evaluate financial stability and decide on expansion possibilities.
CO5: Know the importance of venture capital and angel investment.
CO6: Understanding a team and leadership styles and Networking and collaboration.

BC10007 ENGLISH LANGUAGE CREDITS: 3

UNIT – I

Fundamental Units: Clauses and Phrases, Sentence Structure, Vocabulary, Idioms, Phrases and Phrasal Verbs, Reading Comprehension.

UNIT - II

Sounds of English: Pronunciation practice for non-native sounds, Challenges faced by non-native speakers, strong and weak forms, Stress, Pitch and Intonation.

UNIT - III

Strengthening Usage: Parts of Speech, Subject-Verb Agreement, Tense basics, Articles, Prepositions, Punctuation and Consistency errors.

UNIT - IV

Spoken Language: Thinking in English, Variation in Speed, Body Language, Rhythm, Pausing and phrasing, Situational Conversations, Role Play & other fluency boosters.

Reference Books

1. *Kumar, Sreehari and Savithri, Essential English, Orient Black Swan, 2011.*
2. *John Seely, Oxford Guide to Writing & Speaking, OUP, 2013.*
3. *J D O' Connor, Better English Pronunciation, Cambridge, 1980.*
4. *John Eastwood, Oxford Practice Grammar, OUP, 2016.*
5. *Raman and Sharma, Technical Communication, OUP, 2015.*

COURSE OUTCOMES

On taking the 'English Language course the students will be able to:

CO1: Students will be able to utilize grammatical concepts to enhance reading comprehension

CO2: Students will develop heightened awareness of English phonetics, to improve pronunciation and overcome common challenges faced by non-native speakers.

CO3: Students will demonstrate improved fluency and clarity in spoken English.

CO4: Students will expand their vocabulary and gain proficiency to enhance both written andspoken communication.

CO5: Students will be able to identify and correct common grammatical and punctuation errors.

CO6: Students will be able to engage in natural and effective communication.

BC10009 BASICS OF INFORMATION TECHNOLOG CREDITS: 2

UNIT - I

Introduction & Evolution of Digital Systems: Role & Significance of Digital Technology. Information & Communication Technology & Tools. Computer System & it's working, Software and its types. Operating Systems: Types and Functions. Problem Solving: Algorithms and Flowcharts.

UNIT -II

Communication Systems: Principles, Model & Transmission Media. Computer Networks & Internet: Concepts & Applications, WWW, Web Browsers, Search Engines, Messaging, Email, Social Networking.

Computer Based Information System: Significance & Types. E-commerce & Digital Marketing: Basic Concepts, Benefits & Challenges.

UNIT - III

Digital India & e-Governance: Initiatives, Infrastructure, Services and Empowerment. Digital Financial Tools: Unified Payment Interface, Aadhar Enabled Payment System, USSD, Credit / Debit Cards, e-Wallets, Internet Banking, NEFT/RTGS and IMPS, Online Bill Payments and PoS.
Cyber Security: Threats, Significance, Challenges, Precautions, Safety Measures, & Tools, legal and ethical perspectives.

UNIT-IV

Emerging Technologies &Their Applications: Overview of Cloud Computing, Big Data, Internet of Things, Virtual Reality, Blockchain & Cryptocurrency, Robotics, Machine Learning & Artificial Intelligence, 3-D Printing. Digital Signatures.

Reference Books

1. *V. Rajaraman, Introduction to Information Technology, 3rd Edition, PHI, 2018.*
2. *E Balagurusamy, Fundamentals of Computers, Tata Mc GrawHill,2009.*
3. *Behrouz A. Forouzan, Data Communications and Networking,4th Edition, McGraw Hill, 2017.*
4. *Pramod Kumar, Anuradha Tomar, R. Sharmila, Emerging Technologies in Computing Theory, Practice and Advances, Chapman and Hall/CRC Imprint, 2021.*
5. *Buvya, Broberg, and Goscinski, Cloud Computing- Principals and Paradigms, Wiley, 2013.*
6. *Russel and Norving, Artificial Intelligence- A Modern Approach, 4th Edition, Pearson Education, 2022.*
7. *Samuel Greengard, Internet of Things, MIT Press, 2021.*

COURSE OUTCOMES

On taking the 'Basics of Information Technology' course, the students will be able to:

CO1: Comprehend the digital landscape.
CO2: Recognize the importance of digital technologies, financial instruments, and e-commerce platforms.
CO3: Have a knowledge of communication networks.
CO4: Be familiar with e-governance frameworks and the Digital India program.
CO5: Understand the practical applications of digital technology.
CO6: Understand current computer science trends and their potential applications

PRACTICAL

BC19001 COMPUTER PROGRAMMING LAB CREDITS: 2

List of Experiments:

1. Practice and write programs on simple input and output operations.
2. Practice and write programs on Operators and Expressions.
3. Practice and write programs on branching statements.
4. Practice and write programs on looping (control) statements.
5. Practice and write programs on Arrays.
6. Practice and write programs on Character Arrays.
7. Practice and write programs on Functions.
8. Practice and write programs on Pointers.
9. Practice and write programs on Structures.
10. Practice simple programs on file handling.

BC19003 STATISTICS LAB CREDITS: 2

List of Experiments:

1. Familiarization of environments in Excel and perform simple arithmetic using Excel.
2. Use various graphical techniques.
3. Create different charts for visualization of given set of data.
4. Draw a Pareto chart to illustrate the Pareto principle.
5. Find the mean, median, mode, standard deviation and quartiles of a set of observations.
6. Find the Skewness and Kurtosis of a given dataset distribution.
7. Compute Karl Pearson's coefficient of correlation for the given set of data.
8. Compute the Spearman rank correlation for the given data.
9. Construct a scatter plot to investigate the relationship between two variables.
10. Calculate the regression coefficient and obtain the lines of regression for the given data.

SESSIONAL

YG18001 SPORTS AND YOGA CREDITS: 1

UNIT-I

Concept and significance of consciousness: Modern and ancient approach of consciousness, Types of consciousness viz., Jagrata, Svapna, Susupti, Turya, and Turiyatita.

UNIT-II

Preparatory practices: Breathing practices, Suksma vyayma (all 46 practices), and Sthoolavyayma (all 14)

UNIT-III

Dharana practices: Principles and procedure of Antaranga&Bahrangatrataka, Jatrutrataka& Jyoti trataka; Principles and practices of Ajappajapa, Antarmouna, Chakra meditation, Cyclic meditation, and Transcendental meditation.

UNIT-IV

Concept and practice of Dhyana: Concept of Jyoti and Bindu dhyana, principle and procedure of Vipassana meditation, Preksha meditation, Transcendental meditation, Brahma kumari Raja yoga meditation, and Yoga nidra.

Reference Book:

Yogic Sukshma Vyayma by Dhirendra Brahmachari, MDNIY publisher, Ashoka Road, New Delhi 2. Mandukya Upanishad by Swami Harsanansda, R K Mission Publication, Belur math, Kolkata

SECOND SEMESTER (SPRING)

BC10002 DATA STRUCTURES CREDITS: 3

UNIT - I

Introduction: Data structure and data structure operations, applications of data structure, basic data structures, and Basic concepts of complexity theory.
Arrays: Introduction, Types of Array, Memory representation, Applications and operations.

Stacks: Introduction and primitive operations on the stack, Stack application: Infix, postfix, prefix expressions, Evaluation of postfix expression, Conversion from infix to postfix.

UNIT - II

Linked List: Operations:Traversing, Searching, Inserting, Deleting, Operations Header Linked List, Circular Linked List, Doubly Linked List, Memory Representation, Applications, Polynomial Manipulation.
Queue: Introduction, types, memory representation and applications.

UNIT - III

Trees: Definition and basic concepts, representation in contiguous storage, binary tree, binary tree traversal, searching, insertion and deletion in binary trees, binary search tree.
Graphs: Introduction, memory representation, graph traversal (DFS and BFS).

UNIT – IV

Searching: Binary and Linear Search.
Sorting: Bubble sort, Insertion sort, Selection sort, Merge Sort, Quick sort. Comparison of various searching and Sorting algorithms.

Reference Books

1. *Reema Thareja, Data Structures using C, 3rd Edition, Oxford University Press, 2023*
2. *Gilberg and Forouzan, C Programming and Data Structures, 3rd Edition, Cengage Learning, 2022.*
3. *Seymour Lipschutz, Schaum's outline series, Data Structure With C, 1st Edition, MGH, 2017.*
4. *R. S. Salaria, Data Structures, Theory, Problems & Algorithms, 3rd Edition, Khanna Publishing, 2017.*
5. *E Balagurusamy, Data Structures using C, 1st Edition, MGH, 2013.*
6. *Narasimha Karumanchi, Data Structures And Algorithms Made Easy, Data Structures And Algorithmic Puzzles, CareerMonk Publications, 2023.*
7. *Shriram K. Vasudevan, Abhishek S. Nagarajan, Data Structures using Python, Oxford, 2021.*

COURSE OUTCOMES

On taking the 'Data Structures' course the students will be able to:

CO1: Design correct programs to solve problems.
CO2: Compare and apply the various programming concepts of decision structures, loops and functions.
CO3: Choose efficient data structures and apply them to solve problems.
CO4: Analyse the efficiency of programs based on time complexity.
CO5: Prove the correctness of a program using loop invariants, pre-conditions and post-conditions in programs
CO6: Design reusable ADTs.

BC10004 INTRODUCTION TO PROBABILITY CREDITS: 3

UNIT - I

Probability: Introduction, random experiments, sample space, events and algebra of events.Definitions of Probability: classical, statistical, and axiomatic, conditional probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem.

UNIT - II

Random variables: Discrete and continuous random variables, probability mass function, probability density function, cumulative density function, illustrations and properties of random variables, univariate transformations with illustrations.
Two Dimensional Random Variables: Discrete and continuous type, joint, marginal and conditional probability mass function, probability density function, cumulative density function, independence of variables, bivariate transformations with illustrations.

UNIT - III

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

UNIT – IV

Standard Probability Distributions: Binomial, Poisson, geometric, negative binomial, hyper geometric, uniform, normal, exponential, Cauchy, beta, and gamma along with their properties and limiting/approximation cases.

Reference Books

1. *S. Ross, A First Course in Probability, 10th Edition, Pearson, 2018.*
2. *J. L. Devore, Probability and Statistics for Engineering and the Sciences, 9th Edition, Cengage Learning, 2020.*
3. *Michael Baron, Probability and Statistics for Computer Scientists, 3rd Edition, CRC Press, 2019.*
4. *S.C. Gupta &V.K.Kapoor, Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, 2020.*
5. *S. Ghahramani, Fundamentals of Probability, 5th Edition, CRC Press, 2024.*
6. *Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 6th Edition, John Wiley & Sons, Inc, 2016.*
7. *J.N. Kapur and H.C. Saxena, Mathematical Statistics, 20th Edition, S. Chand, 2022.*

COURSE OUTCOMES

On taking the 'Introduction to Probability' course, the students will be able to:

CO1: Understand the basic principles of probability, including Bayes theorem, and use these principles in problem-solving situations.
CO2: Understand the most common discrete and continuous probability distributions.
CO3: Identify the characteristics of different discrete and continuous distributions.
CO4: Use the normal probability distribution, including standard normal curve calculations for appropriate areas.
CO5: Compute marginal and conditional distributions from joint distributions.
CO6: Calculate the simple linear regression equation for a set of data.

BC10006 COMPUTER ARCHITECTURE CREDITS: 3

UNIT - I

Introduction to Digital Electronics: Number systems, complements, floating point representation, addition, subtraction, hamming code for error detection and correction, Logic gates, Boolean algebra, Simplification of Boolean algebra, Combinational circuits, Sequential circuits & flip flops, Encoders, Decoders, Multiplexers, shift registers & counters, Design of counters.

UNIT – II

Register Transfer and Micro-operations: Register Transfer Language, Register Transfer, Bus Structure, Bus and Memory Transfers, Arithmetic Micro-operations, Logic Micro-operations, Shift Micro operations. Basic Computer Organization and Design: Computer registers, bus system, instruction set, timing and control, instruction cycle, memory reference, input-output and interrupt.

UNIT - III

Central Processing Unit: Register organization, arithmetic, and logical micro-operations, stack organization, microprogrammed control. Computer Arithmetic: Introduction, Multiplication and Division, Algorithms for fixed point-members. Programming the Basic Computer: Instruction formats, addressing modes, instruction codes, machine language, assembly language, and input-output programming.

UNIT - IV

Computer Arithmetic: Introduction, Multiplication and Division Algorithms for fixed point-members. Memory: Characteristic terms of various memory devices, RAM, ROM, PLA, PAL, Cache Memory, Virtual Memory. Input-output Organization: Peripheral devices, I/O interface, Modes of data transfer, direct memory access.

Reference Books

1. *M. Morris Mano, Computer System Architecture, 3rd Edition, Pearson, 2017.*
2. *Modern Digital Electronics, 4th Edition, McGrawHill Education, 2018.*
3. *William Stallings, Computer Organization and Architecture: Designing for Performance, 9th Edition, Pearson, 2013.*
4. *Hamacher, Computer Organization, 5th Edition, MGH, 2011.*
5. *John P Hayes, Computer Architecture and Organization, 3rd Edition, MGH, 2017.*

COURSE OUTCOMES

On taking the 'Computer Architecture' course, the students will be able to:

CO1: Illustrate the working of Computer Systems.
CO2: Classify and interpret the Instruction Set Architecture.
CO3: Solve problems related to the advanced pipelining techniques.
CO4: Analyse the system performance.

CO5: Prioritize the current state in memory system design.
CO6: Design alternate/ advanced architecture using data flow computing.

BC10008 OPERATING SYSTEMS CREDITS: 3

UNIT - I

Introduction: Operating System Fundamentals, System Software vs Application Software.
Types of operating systems: Multiprogramming, Batch, Time Sharing, Single user and Multiuser, Process Control &Real-Time Systems.
Operating System Organization: Factors in operating system design, Basic OS functions, Implementation consideration, process modes, methods of requesting system services, systemcalls and system programs.

UNIT - II

Process Management: System view of the process and resources, initiating the OS, process address space, process abstraction, resource abstraction, process hierarchy, and thread model.
Scheduling: Scheduling Mechanisms, Strategy selection, non-pre-emptive and pre-emotive strategies.

UNIT - III

Memory Management: Mapping address space to memory space, memory allocation strategies, fixed partition, variable partition, paging, virtual memory.
Deadlock: Deadlock criteria, prevention, avoidance, detection and recovery algorithm.

UNIT – IV

File Systems: File system implementation, directories, security and protection mechanism.
Introduction to Shell and Shell Scripting: Shell and its types, editors in Linux, modes of operation in vi editor, shell scripting, writing and executing shell scripts, shell variables, system calls, pipes and filters, decision making in shell scripts, functions, utility programs and pattern matching utility.

Reference Books

1. *Silberschatz & Galvin, Operating System Concepts, 9th Edition, Wiley, 2020.*

2. *D. M. Dhamdhere, Operating Systems a Concept-Based Approach, 3rd Edition, MGH, 2017.*
3. *P. C. Bhatt, An Introduction to Operating Systems: Concepts & Practice, 4th Edition, PHI.*
4. *Andrew S Tanenbaum and Albert S Woodhull, Operating System Design & Implementation, 3rd Edition, Pearson Education, 2015.*
5. *Godbole, A.S.,Operating Systems, 3rd Edition., MGH, 2018.*
6. *William Stallings. Operating Systems. 9thEdition, Pearson Educations, 2018.*
7. *A. K. Sharma, Operating Systems, Universities Press, 2016.*

COURSE OUTCOMES

On taking the 'Operating Systems' coursethe students will be able to:

CO1: Define fundamentals of Operating System.
CO2: Compare processes scheduling algorithms.
CO3: Apply the concepts of memory management, paging and virtual memory.
CO4: Analyse and discuss the policies of synchronization.
CO5: Evaluate the uses of system call.
CO6: Develop interaction techniques among the various components of computing system.

BC10010 OOP USING JAVA CREDITS: 3

UNIT - I

Fundamentals of Object-Oriented Programming: Introduction, Object Oriented paradigm, Basic Concepts of OOP, Benefits of OOP, and Applications of OOP.
Java Features: Overview of Java Language: Introduction, Simple Java program structure, Java tokens, Java Statements, Implementing a Java Program, Java Virtual Machine, Command line arguments.
Data Types, Variables & Constants: Introduction, Constants, Variables, Data Types, Declaration of Variables, Giving Value to Variables, Scope of variables, Symbolic Constants, Type casting, Getting Value of Variables, Standard Default values; operator & expressions.

UNIT - II

Decision Making & Branching: Introduction, Decision making with if statement, Simple if statement, if. Else statement, Nesting of it. else statements, the else if ladder, the switch statement, the conditional operator. Looping: Introduction, The While statement, the do-while statement, for the statement, Jumps in loops.

Classes, Objects & Methods: Introduction, defining a class, adding variables, adding methods, Creating objects, Accessing class members, Constructors, Method overloading, Static members, Nesting of methods.
Arrays and Strings: Arrays, One-dimensional arrays, Creating an array, Two – dimensional arrays, Strings, Wrapper classes.

UNIT - III

Inheritance: Extending a class, Overriding methods, Final variables and methods, Final classes, Abstract methods and classes.
Interfaces: Multiple Inheritance: Introduction, defining interfaces, extending interfaces, implementing interfaces, Assessing interface variables.
Packages: Introduction, Java API Packages, Using System Packages, naming conventions, Creating Packages, accessing a Package, using a Package.
Exception handling: Error and Exception, Exception handling using try...catch, multiple catch statements, Throw & Throws, use of finally block.
Java IO: Introduction, Concept of Streams, Stream classes, Byte Stream Classes, Input Stream Classes, Output Stream Classes, Character Stream classes: Reader stream classes, Writer Stream classes, Using Streams, Reading and writing files.

UNIT – IV

Multithreaded Programming: Introduction Thread, Creating Threads, Extending the Threads, Thread Lifecycle, Using Thread Methods,Thread Priority, Synchronization, Thread Groups, Implementing the 'Runnable' Interface.
AWT & Event Handling: Layout Managers, Border layout, Flow layout, Grid layout, Card layout, AWT all components, Event delegation Model, Event source and handler, Event categories, Listeners, interfaces, Anonymous classes.
Database Connectivity with JDBC: Java database connectivity, Types of JDBC drivers, writing first JDBC applications, Types of statement objects (use of Statement and Prepared Statement object), Resultset object, ResultSetmetadata object, inserting, updating and deleting records.

Reference Books

1. *Dr R Nageswara Rao, Core Java: An Integrated Approach, New: Includes All Versions upto Java 8, 3rd Edition (Updated), DreamTech Press, 2016.*
2. *Kathy Sierra, Bert Bates, Trisha Gee, Head First Java: A Brain-Friendly Guide, 3rdEdition (Grayscale Indian Edition),SPD, 2022.*
3. *John R. Hubbard, Programming with Java, 2nd Edition, Schaum's outline Series, MGH, 2004.*
4. *Patric Naughton, Herbert Schildt, Java 2 Complete Reference, MGH.*

5. *Paul Deital& Harvey Deital, Java: How to Program, Pearson Education.*
6. *E. Balagurusamy, Programming with Java, 6th Edition, MGH, 2019.*
7. *S Sagayaraj, R. Denis, P. Karthik, D. Gajalakshmi, Constructive Java Programming, Universities Press, 2020.*

COURSE OUTCOMES

On taking the 'OOP Using Java' course the students will be able to:

CO1: Describe the differences between object-oriented programming and procedural programming.
CO2: Understand the fundamental concepts of object-oriented programming.
CO3: Apply the advanced concept of object-oriented programming such as inheritance and polymorphism.
CO4: Analyse the additional features of JAVA that are not available in function-oriented programming languages such as exceptional handling, Interface, collection classes, etc.
CO5: Evaluate the functionalities like Multithreading.
CO6: Develop small scale projects using AWT and JDBC.

BC10012 WEB TECHNOLOGIES CREDITS: 2

UNIT - I

Introduction to the WWW: How internet works? Web Servers, DNS Servers, Web client, IP address, URL, Hosting, HTTP/s protocol.
Hyper Text Markup Language: Introduction to HTML language, HTML tag and elements, essentials of web page, using tags, making ordered and unordered list using bullets or numbers**.** Page Formatting and Hyperlinks in HTML, Frames and Graphics, HTML Tables.

UNIT - II

Cascading Style Sheet and Forms: Importance of CSS, Different ways of using CSS - Internal, External and Inline, Different ways of styling text - Color, Fonts, Size, Decoration, Alignment. Types of Fonts in CSS, Concepts of class and id, Styling using class and id, Concept of and , Styling tables using CSS, States of a link (anchor tag) – a:link, a:visited, a:hover, a:active.
CSS Positioning: Types of CSS positioning - Float property, Relative positioning, Absolute positioning, Fixed positioning, top, left, bottom, and right properties. Concept of z-index. CSS box model - Content, padding, border, margin and its associated properties. Display property in CSS, CSS overflow property.

UNIT - III

JavaScript Fundamentals: Client-Side Programming: JavaScript Language, History and versions of JavaScript, Introduction to JavaScript, JavaScript in Perspective, Basic Syntax, Variables and Data Types, Statements, Operators, Literals, Functions - Objects - Arrays, Built-in Objects, Host Objects: Browsers and the DOM, Introduction to the Document Object Model, Intrinsic Event Handling, DOM History and Levels.

UNIT – IV

Applications of HTML, CSS and JavaScript: Designing and validation of forms, Creation of horizontal and vertical navigation menus, designing of interactive web page layouts and creating photo gallery.

Reference Books

1. *Ivan Bayross, HTML, DHTML, JavaScript, Perl & CGI, 3rd Edition, BPB Publication, 2005.*
2. *Jon Duckett, Beginning HTML, XHTML, CSS, and Javascript, 1st Edition (Paperback), Wiley India Pvt Ltd, 2010.*
3. *Julie C. Meloni, Sams Teach Yourself HTML, CSS, and JavaScript All in One, 3rd Edition (Paperback), Pearson, 2020.*
4. *Thomas Powell, HTML &CSS:The Complete Reference, 5th Edition, MGH.*
5. *Thomas Powell, Fritz Schneider, JavaScript: The Complete Reference, 3rd Edition, 2017.*
6. *Terry Felke-Morris, Web Development and Design Foundations with HTML5, 9th Edition, Pearson Uttam K. Roy; Web Technologies, Oxford Universities Press, 2010.*

COURSE OUTCOMES

On taking the 'Web Technologies' course, the students will be able to:

CO1: Understand the Internet's workings and its associated technologies.
CO2: Create a structure of a webpage using HTML.
CO3: Understand the styling of a webpage using Cascading Style Sheets (CSS).
CO4: Create different webpage layouts using HTML and CSS anddivs and positioning techniques.
CO5: Build interactive webpages using JavaScript.
CO6: Apply HTML, CSS and JavaScript to create modern websites.

PRACTICAL

BC19002 DATA STRUCTURES LAB CREDITS-2

List of Experiments:

1. Revision of C Programs based on if-else, switch-case, loops, arrays, pointers and structures.
2. Array implementation of Stacks ADTs.
3. Applications of Stacks.
4. Array implementation of Queues, Priority Queue and circular queue.
5. Applications of Queues.
6. Array implementation of List ADT.
7. Applications of Linked Lists.
8. Linked list implementation of List, Stack and Queue ADTs.
9. Implementation of Binary Trees and operations of Binary Tree.
10. Implementation of Binary Search Trees.
11. Implementation of searching and sorting algorithms.

BC19010 JAVA PROGRAMMING LAB CREDITS-2

List of Experiments:

1. An overview of JAVA program, data types, variable and arrays, operators, control statements.
2. The general form of a class, declaring objects, assigning object reference variables, methods, constructors.
3. Inheritance basics, member access and inheritance, using super to call super class constructors. Creating a multilevel hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance.
4. Defining a package, finding packages and CLASSPATH, access protection, importing packages.
5. Defining an interface, implementing interfaces, applying interfaces, variables in interfaces, use static methods in an interface.
6. Exception-Handling Fundamentals, Exception Types.
7. Streams, reading console input, writing console output, reading and writing files.
8. The java thread model, creating a thread, creating multiple threads.
9. Introducing the AWT, working with windows, graphics, and text.
10. Introduction to JDBC, Drivers Types, JDBC Objects, SQL query objects.

BC19012 WEB TECHNOLOGIES LAB CREDITS-1

List of Experiments:

1. Creating html pages using <head>, <body>, <title>, <p>,
, <h1>, <h2>, etc. tags.
2. Inserting images in HTML using the <img> tag and adjusting the width and height.
3. Creating Ordered and Unordered lists in HTML.
4. Tables in HTML - <table>,<th>,<tr>,<td>, rowspan, colspan etc.
5. Forms in HTML - form, textbox, text area, dropdown, radio button, checkbox, field set and labels, submit button.
6. Styling the HTML elements using internal, external and inline CSS.
7. Designing CSS layouts using and CSS positioning.
8. Creating horizontal and vertical menu bars using HTML and CSS.
9. Creating Java script functions to create interactive HTML page.
10. Use Java script functions to validate HTML forms.

THIRD SEMESTER (AUTUMN)

BC20001 DATABASE MANAGEMENT SYSTEMS CREDITS-3

UNIT - I

Introduction: Database Approach, Characteristics of a Database Approach, Database System Environment.
Roles in Database Environment: Database Administrators, Database Designers, End Users, Application Developers.
Database Management Systems: Definition, Characteristics, Advantages of Using DBMS Approach, Classification of DBMS.
Architecture: Data Models, Categories of Data Models- Conceptual Data Models, Physical data Models, Representational Data Models, such as, Object Based Models, Record Based Models, Database Schema and Instance, Three Schema Architecture, Data Independence – Physical and Logical data Independence.

UNIT – II

Database Conceptual Modelling by E-R model: Concepts, Entities and Entity Sets, Attributes, Mapping Constraints, E-R Diagram, Weak Entity Sets, Strong Entity Sets.
Enhanced E-R Modelling: Aggregation, Generalization, Converting ER Diagrams to Tables.Relational Data Model: Concepts and Terminology, Characteristics of Relations.
Constraints: Integrity Constraints, Entity and Referential Integrity constraints, Keys- Super Keys, Candidate Keys, Primary Keys, Secondary Keys and Foreign Keys.

UNIT - III

Relational Algebra: Basic Operations, Additional Operations, Example Queries.
Database Design: Informal Design Guidelines for Relation Schemas, Problems of Bad Database Design,
Normalization: Functional Dependency, Full Functional Dependency, Partial Dependency, Transitive Dependency, Normal Forms– 1NF, 2NF, 3NF, Boyce-Codd NF.

UNIT – IV

Understanding SQL-1: Data Types, Creating Tables, Creating a Table with data from Another table, Inserting Values into a Table, Updating Column(s) of a Table, Deleting Row(s) from a Table, Dropping a Column, Querying database tables, Conditional retrieval of rows, Working with Null Values, Matching a pattern from a table, ordering the result of a

Query Aggregate Functions, Grouping the Result of a Query, creation and deletion of Views, Managing privileges with Grant and Revoke Command, COMMIT and ROLLBACK.
Functions: Character Functions, Date Functions, Group Functions.

Reference Books

1. *Silbersettatz, Korth, Sudarshan, Database system concepts, 7th Edition, MGH, 2021.*
2. *Bipin Desai, Database Management Systems, Galgotia Publisher, 2012.*
3. *Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, 3rd Edition, MGH, 2014.*
4. *Elmasri &Navathe, Fundamentals of Database Systems, 7th Edition, Pearson Education, 2017.*

COURSE OUTCOMES

On taking the 'Database Management Systems' course the students will be able to:

CO1: Define basic database concepts, role of a database management system including the structure and operation of the relational data model.
CO2: Compare simple and moderately advanced database queries using SQL and Relational algebra.
CO3: Apply logical database design principles, including E-R diagrams and database normalization.
CO4: Analyse the concept of a database transaction and related database facilities, including concurrency control, backup and recovery, and data object locking and protocols.
CO5: Evaluate the performance of query processing in distributed database systems.
CO6: Design basic database storage structures & access techniques.

BC20003 SOFTWARE ENGINEERING CREDITS-3

UNIT – I

Introduction: Role of Software Engineer, Software Components, Software Characteristics,Software Crisis, Software Engineering Processes. Emergence of Software Engineering.
Software Process: Software development life cycle (SDLC), life cycle models -water fall, incremental, spiral, evolutionary, prototyping, rapid application development model, agile model).

UNIT – II

Software requirements: Functional and non-functional, user, system, requirement engineering process, feasibility studies, requirements, elicitation, validation and management. Analysis and modelling, data, functional and behavioural models, structured analysis and data dictionary.

Design Concepts and Principles: Design process and concepts, modular design, design heuristic, design model and document, Architectural design, software architecture, data design. Structure oriented design. Object oriented design using UML.

UNIT - III

Testing: Taxonomy of software testing, levels, test activities, types of s/w test, black box testing, boundary conditions, structural testing, test coverage criteria based on data flow, mechanisms, regression testing, testing in the large. S/W testing strategies, strategic approach and issues, unit testing, integration testing, validation testing, system testing and debugging.

Coding: Coding Standards, code walk through and code review process, Internal and external documentation, Readability Index.

UNIT – IV

Introduction to Software Project Management: Measures and measurements, S/W complexity and science measure, size measure, data and logic structure measure, information flow measure. Estimations for Software Projects, Empirical Estimation Models, Project Scheduling.

Reference Books

1. *Rajib Mall, Fundamentals of Software Engineering, 4th Edition, Prentice Hall of India, 2014.*
2. *I. Summerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, 2017.*
3. *Roger S. Pressman, Software Engineering A Practitioner's Approach, 8th Edition, MGH, 2019.*
4. *Craig Larman, Applying UMI and Patterns An introduction OOAD and the Unified Process, 3rd Edition, Pearson Education, 2015.*
5. *Ugrasen Suman, Software Engineering: Concepts and Practices, 2nd Edition, Cengage, 2022.*
6. *Pankaj Jalote, Software Engineering: A Precise Approach, 1st Edition, Wiley, 2015.*
7. *Sajan Mathew, Software Engineering,1st Edition, S.Chand, 2013.*

COURSE OUTCOMES

On taking the 'Software Engineering' course, the students will be able to:

CO1: Identify requirements of the software projects.
CO2: Understand the software requirements and translate them to Design and development process.
CO3: Apply and map various testing methods to the phases of SDLC.
CO4: Analyse the basic project management practices and tools in real life projects.
CO5: Evaluate various quality factors for software.
CO6: Develop small real-world project with the help of software engineering concepts.

BC20005 DISCRETE MATHEMATICS CREDITS-3

UNIT – I

Sets, relations, and functions: Definition, examples and basic properties of ordered sets, operations on sets. Different types of relations, power of relation and inverses. Types of functions, Function compositions and inverses.
Mathematical Logic: Logical Inferences, Methods of proof of an implication. First order logic and Predicate Calculus, Rules of inference for quantified propositions, Mathematical Induction. Finite Boolean algebra, Axioms of Boolean Algebra, Boolean Function, Logic Circuits.

UNIT – II

Counting: Fundamentals of counting techniques, Permutation and Combinations, Pigeon hole Principle, Recurrence Relation and Generating Functions.

UNIT – III

Introduction to Graph Theory: Definition, examples and basic properties of graphs, pseudographs, complete graphs, bipartite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, Travelling Salesman Problem, Shortest path Method using Dijkstra's algorithm.

UNIT – IV

Group Theory: Groups and properties, Subgroups (finite groups), Cyclic groups, Permutation groups, Normal Subgroup, Isomorphism and Homomorphism. Coding of Binary

Information and Error Detection, Hamming codes, Decoding and Error Correction using Parity-Check matrix decoding.

Reference Books

1. *K. E. Rosen, Discrete mathematics and its applications, 7th Edition, MGH, 2011.*
2. *B. Kolman, R. C. Busby, S. Ross, Discrete Mathematical Structures, 10th Edition, Pearson, 2015.*
3. *Trembley & Manohar, Discrete Mathematical Structure with Applications to Computer Science, 1stEdition, MGH, 2001.*
4. *Thomas Koshy, Discrete Mathematics with Applications, 1st Edition, Elsevier, 2008.*

COURSE OUTCOMES

On taking the 'Discrete Mathematics' course the students will be able to:

CO1: Describe fundamental mathematical concepts and terminology.
CO2: Understand circuit design using Boolean algebra concepts.
CO3: Apply counting principles of different types of discrete structures.
CO4: Analysis of recursive definitions.
CO5: Evaluates the techniques for constructing mathematical proofs using examples.
CO6: Design solutions based on Graph Theory, Coding Theory and Group Theory.

BC20007 PYTHON PROGRAMMING CREDITS-2

UNIT – I

Introduction: Introduction to interactive mode and script, process of writing and running a program, data types, literals, identifiers and operators, operator precedence, console input output functions.

UNIT – II

Selective statements: if, if-else, if-elif-else.
Notion of iterative computation and control flow: for, while, break, continue and pass. Functions Built-In Function, Composition User Define Function: defining, invoking functions, passing parameters, Scope of variables, Modules (Importing entire module or selected objects using from statement).

UNIT – III

Strings: Compare, concatenation, substring. Container types: Lists.

Tuples and dictionary: Finding the maximum, minimum, mean; linear search on list/tuple of numbers, and counting the frequency of elements in a list using a dictionary. Introduce the notion of accessing elements in a collection using numbers and names. Sorting (bubble and insertion sort).

UNIT – IV

Exceptions in Python: Detecting and Handling Exceptions, I/O and File Handling: Output Formatting, Reading and Writing Files(text and binary mode). Basics of NoSQL databases - Mongo DB.

Reference Books

1. *R. Nageswara Rao, Core Python Programming, 2nd Edition, Dreamtech, 2019.*
2. *Reema Thareja, Python Programming: Using Problem-Solving Approach, Oxford, 2018.*
3. *Ljubomir Perkovic, Introduction to Computing Using Python: An Application Development Focus, John Wiley & Sons, 2012.*
4. *Mark Lutz, Learning Python, 5th Edition, O'Reilly Publication, 2013*.

COURSE OUTCOMES

On taking the 'Python programming' course, the students will be able to:

CO1: Explain the basic principles of Python programming language.
CO2: Learn and understand Python looping, control statements and string manipulations.
CO3: Define and demonstrate the use of built-in data structures "lists" and "dictionaries".
CO4: Design and implement a program to solve a real-world problem.
CO5: Implement database and GUI applications.
CO6: Learn and know the concepts of file handling, exception handling and Database Connectivity.

BC20009 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY CREDITS-2

UNIT - I

Multidisciplinary nature of environmental studies: Definition, scope and importance.
Natural Resources: Renewable and non-renewable resources, natural resources and associated problems. a) Forest resources b) Water resources c) Mineral resources d) Food resources e) Energy resources f) Land resources. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

UNIT - II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem.
Biodiversity: Introduction. Definition: genetic, species and ecosystem diversity. Bio geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels. India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India.
Conservation of Biodiversity: In-situ and Ex-situ conservation of biodiversity.
Environmental Pollution: Definition, cause, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution and nuclear hazards. Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

UNIT – III

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

UNIT – IV

Human Population and the Environment: Population growth, variation among nations, population explosion – Family Welfare Program, Environment and human health. Human rights. Value education. HIV/AIDS. Women and Child Welfare. Role of information technology in environment and human health.

Reference Books

1. *Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses (UGC), 2nd Edition, Universities Press.*
2. *G. Tyler Jr. Miller, Environmental Science with MindTap, 14th Edition, Cengage, 2014.*
3. *P N Palanisamy(et-al), Environmental Science, 4th Edition, Pearson.*
4. *Benny Joseph, Environmental Science, 1st Edition, MGH, 2019.*
5. *Kamal Kant Joshi, Deepak Kumar, Environmental Science, 1st Edition, Wiley, 2019.*
6. *Aloka Debi, Environmental Science and Engineering, 1st Edition, Universities Press, 2012.*
7. *Bablu Prasad, Environmental Science Foundation,1st Edition, Himalaya Publication House, 2021.*

COURSE OUTCOMES

On taking the 'Environmental Science and Sustainability' course, the students will be able to:

CO1: Understand the crucial role of environmental studies.
CO2: Understandthe environment and ecosystems.
CO3: Identifythe different types of natural resources.
CO4: Know the importanceof biodiversity and its conservation.
CO5: Assess the causes of environmental pollution and its effects.
CO6: Understand population growth and its ecological impact.

PRACTICAL

BC29001 DATABASE LAB CREDITS-2

List of Experiments:

1. Concept design with E-R Model.
2. Relational Model.
3. Normalization.
4. Practicing DDL commands.
5. Practicing DML commands.
6. Querying (using ANY, ALL, IN, Exists, NOT EXISTS, UNION, INTERSECT, Constraints etc.).
7. Queries using Aggregate functions, GROUP BY, HAVING.
8. Concept of on delete cascade and on delete set null with constrains.
9. Queries related to Join and Sub queries.
10. Creation and dropping of Views.

BC29007 PYTHON PROGRAMMING LAB CREDITS-2

List of Experiments:

1. Compilation and execution of simple Python programs.
2. Programs using data types and operators
3. Programs using String handling operators, functions, Input and Output statements.
4. Programs on decision making and looping using if-else, nested if else and else if ladder, for and while loops.
5. Programs using Python built-in data structures (List, Dictionary, tuple, set), and functions, recursive functions and modules.
6. Develop programs using Packages and concepts of Class and Objects.
7. Programs on Inheritance and Exception Handling
8. Formulate problems on Inheritance and write programs.
9. Formulate problems on file handling and develop programs
10. Write programs to perform file Input/Output operations and Database Connectivity.

FOURTH SEMESTER (SPRING)

BC20002 ENTREPRENEURSHIP AND STARTUP ECOSYSTEM CREDITS-2

UNIT – I

Foundations of Entrepreneurship: The entrepreneur concept**,**Types,Features,Functions, Entrepreneurship Characteristics, Evolution, Entrepreneurial process, Dimensions, Attributes of Strategic Resources, Approaches,Social Entrepreneur:Women Entrepreneur,Role of entrepreneurship in economic development, Constraints for the growth of entrepreneurial culture,Entrepreneurship vs. Intrapreneurship.

UNIT - II

Startup Prospects and Business Strategy: The Basics of Startup,Plans and Business Models,Entrepreneurship competencies,Economic Role of the SSI Sector: Failure, Reasons, and Preventive Actions/Recovery Plans.

UNIT - III

The Entrepreneurial Ecosystem: Components of a startup ecosystem,Legal and Ethical Aspects,Starting up Financial Issues,Funding and Financial Management,Growth and Survival.

UNIT – IV

Leadership: Developing leadership and teamwork skills,Cooperation and networking, Making an investor presentation,Startups' handling of conflict.

Reference Books

1. *Robert Hisrich, Michael Peters and Dean Shepherd, Entrepreneurship,11th Edition,McGraw Hill Education, 2019.*
2. *Poornima M.Charantimath, Entrepreneurship Development and Small BusinessEnterprises, 3rd Edition, Pearson Education, 2018.*
3. *Donald F Kuratko, Jeffrey S. Hornsby, New Venture Management: The Entrepreneur's Road Map, 2nd Edition, Routledge, 2017.*
4. *Andrew Zacharakis, WiliiamBygrave, and Andrew Corbett, Entrepreneurship, 4thEdition, Wiley, 2016.*
5. *Steven Fisher, Ja-nae' Duane, The Startup Equation -A Visual Guidebook for Building Your Startup, Indian Edition, Mc Graw Hill Education India Pvt. Ltd, 2016.*

6. *Kathleen R Allen, Launching New Ventures, An Entrepreneurial Approach,CengageLearning, 2016.*
7. *Vasant Desai, Small-Scale Enterprises and Entrepreneurship Ecosystem, 6th Edition, Himalaya Publishing House, 2016.*

COURSE OUTCOMES

On taking the 'Entrepreneurship and Startup Ecosystem' course, the students will be able to:

CO1: Understand the concept of entrepreneur and entrepreneurship.
CO2: Develop a start-up Enterprise and Analyze start-up capital requirements by analyzing legal factors
CO3: Analyze the business environment of a start-up and access growth stages in new ventures and the reasons for scaling ventures.
CO4: Evaluate financial stability and decide on expansion possibilities
CO5: Know the importance of venture capital and angel investment.
CO6: Understanding a team and leadership styles and Networking and collaboration

BC20004 COMPUTER NETWORKS CREDITS-3

UNIT - I

Introduction: Introduction and evolution of network, Importance of network, Data and Signal, Data Communication, Networks, protocols and standards, Point to Point and Multipoint Line Configuration, Network Topologies Mesh, Star, Tree, Bus, Ring, Transmission modes: Simplex, Half Duplex, Full Duplex. The OSI Model Functions of the layers, TCP/IP Protocol Suite, Physical layer.

UNIT - II

Signals: Analog and digital signals, Time and frequency domains, Frequency Spectrum and Bandwidth, Decomposition of a digital signal. Encoding and modulating: Digital to digital **conversion:** Unipolar, Polar, Bipolar; Analog to digital conversion: PAM, PCM, Digital to analogue conversion: ASK, FSK, PSK, QAM and Analog to Analog conversion: AM, FM, PM.

UNIT - III

Transmission Medium: Guided and unguided transmission media, Parallel and serial transmission,Transmission Impairment, Multiplexing: Frequency division, wave division and time division multiplexing.

Data Link Control: Line discipline, Flow Control, Error Control (Error Detection and **Correction:** Types of errors, Redundancy Checks (VRS, LRC, CRC), Error Correction.), Access Control,Character and Bit-OrientedProtocols (HDLC, PPP Protocols).

UNIT - IV

Local Area Network: IEEE 802 standards, Ethernet. Circuit Switching, Packet Switching. Integrated Services Digital Network (ISDN): Services, History.

Network Layer and Internetworking Devices: Repeaters, Bridges, Routers, Gateways,IP addressing, Subnetting and Super netting, Routing algorithm.

Transport Layer: Flow control, TCP and UDP Protocols, Three Way Handshaking ApplicationLayers, Client-server model, DHCP, Telnet, DNS, FTP, SMTP, HTTP, World Wide Web.

Reference Books

1. *B. A. Foruzan, Data Communications and Networking, McGraw Hill, 2003.*
2. *D. E. Comer and M. S. Narayanan, Computer Networks and Internets with Internet Applications, Pearson, 4th Edition, 2008.*
3. *ITL Education Solutions Limited, Express Learning – Data Communications and Computer Networks, Pearson, 2012.*

COURSE OUTCOMES

On taking the 'Computer Networks' course, the students will be able to:

CO1: Define fundamental concepts of computer networking.
CO2: Classify the basic taxonomy and terminology of computer networking.
CO3: Apply advanced networking concepts.
CO4: Analyse specific areas of networking such as the design and maintenance of individual networks.
CO5: Evaluate routes to create interconnect of nodes.
CO6: Design and implement the protocols used in computer networks.

BC20006 DESIGN AND ANALYSIS OF ALGORITHMS CREDITS-3

UNIT-I

Growth of Functions, Asymptotic notations, Analysis of Insertion sort, Divide and Conquer technique, Recurrences, Solving Recurrences - Substitution Method, Recurrence tree, Master's theorem, Analysis of Merge sort.

UNIT-II

Heap sort, Priority queue, Analysis of heap sort, Greedy Technique: Huffman Codes, Fractional Knapsack problem.

UNIT-III

Dynamic programming: Matrix chain multiplication, Longest Common Subsequence (LCS), Graph Algorithms: Minimum spanning tree (Algorithm of Kruskal & Prim), Single source shortest paths (Dijkstra's Algorithm), All pairs shortest paths (Floyd-Warshall algorithm).

UNIT-IV

Concept of Backtracking: N Queen Problem, Branch and Bound, Approximation Algorithms: Polynomial Time, Polynomial-Time certification, NP-Completeness, NP Completeness and reducibility, NP-Complete problems: The circuit satisfiability problem, The clique problem, The vertex-cover problem, The subset sum problem, Algorithm for travelling-salesperson problem.

Reference Books

1. *S. Sridhar, Design and Analysis of Algorithms, 2nd Edition, Oxford, 2023.*
2. *T.H.Coremen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, 3rd Edition, MIT Press.*
3. *E.Horwitz, S.Sahani, Fundamentals of Computer Algorithms, 2nd Edition, Universities Press, 2008.*
4. *Michael T. Goodrich, Design and Analysis of Algorithms, 1st Edition, Wiley, 2019.*
5. *Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 2017.*

COURSE OUTCOMES

On taking the 'Design and Analysis of Algorithms' course students will be able to:

CO1: Explain different computational models, order notation and various complexity measures.
CO2: Compare the complexities of problem-solving techniques.
CO3: Apply the fundamental graph theory algorithms and solve related problems.
CO4: Analyze efficient algorithms in everyday engineering design situations.
CO5: Evaluate the criteria and specifications of algorithmic design techniques.
CO6: Design approximation algorithms.

BC20008 ARTIFICIAL INTELLIGENCE CREDITS-3

UNIT-I

Introduction: Overview of A.I, Introduction to AI, Importance of AI, AI and its related field, AI techniques, Criteria for success.
Intelligent Agents: Agents and environment, Rationality, The nature of environment, The structure of agents.

UNIT-II

Solving Problems by Searching: Problem-solving agents, well defined problems & solutions, formulating problems, Searching for solution.
Uninformed search strategies: (BFS, DFS, DLS, IDDFS, Bidirectional Search).
Informed Search and Exploration: Informed search strategies, Heuristic functions, On-line search agents and unknown environment.

UNIT–III

Constraint Satisfaction Problems: Constraint satisfaction problems, Backtracking search for CSPs, Local search for CSPs.
Adversarial search: Games, Optimal decisions in games, Alpha-Beta pruning.

UNIT–IV

Logical Agents: Knowledge-based agents, The wumpus world as an example world, Logic: Propositional logic, Reasoning patterns in propositional logic.
First-order Logic: Syntax and semantics of first-order logic; Use of first-order logic.

Reference Books

1. *Dr. Nilakshi Jain, Artificial Intelligence, Making a System Intelligent,Wiley,2019.*
2. *Lavika Goel, Artificial Intelligence, Concepts and Applications,Wiley, 2021.*
3. *Stuart Russel, Peter Norvig Artificial Intelligence, A Modern Approach, 3rd Edition, Pearson, 2009.*
4. *Elaine Rich, Kevin Knight and Shivashankar B Nair, Artificial Intelligence 3rd Edition, Tata McGraw Hill, 2008.*
5. *Dan W. Patterson,Introduction to Artificial Intelligence and Expert Systems, 2nd Edition, PHI, 2009.*

COURSE OUTCOMES

On taking the 'Artificial Intelligence' course students will be able to:

CO1: Describe the key components of the artificial intelligence (AI) field
CO2: Explain search strategies and solve problems by applying a suitable search method
CO3: Apply artificial intelligence techniques, including search heuristics, knowledge representation, planning and reasoning
CO4: Analyse and apply probability theorem, Bayesian networks, knowledge representation.
CO5: Describe and list the key aspects of planning in artificial intelligence
CO6: Design and implement appropriate solutions for search problems and for planning problems.

BC20010 DESIGN THINKING AND INNOVATION CREDITS-2

UNIT - I

Basics of Design Thinking: Understand the concept of innovation and its significance in business. Understanding creative thinking process and problem-solving approaches. Know Design Thinking approach and its objective. Design Thinking and customer centricity – real world examples of customer challenges, use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product. Discussion of a few global success stories like AirBnB, Apple, IDEO, Netflix etc. Explain the four stages of Design Thinking Process – Empathize, Define, Ideate, Prototype, Implement.

UNIT – II

Learning to Empathize and Define the Problem: Know the importance of empathy in innovation process – how can students develop empathy using design tools Observing and assimilating information. Individual differences & Uniqueness Group Discussion and Activities to encourage the understanding, acceptance and appreciation of individual differences. What are wicked problems. Identifying wicked problems around us and the potential impact of their solutions.

UNIT – III

Ideate, Prototype and Implement: Know the various templates of ideation like brainstorming, systems thinking. Concept of brainstorming – how to reach consensus on wicked problems. Mapping customer experience for ideation. Know the methods of prototyping, purpose of rapid prototyping. Implementation.

UNIT – IV

Feedback, Re-Design & Re-Create: Feedback loop, focus on User Experience, address ergonomic challenges, user focused design. Final concept testing, Final Presentation – Solving Problems through innovative design concepts & creative solution.

Reference Books

1. B. Mahesh Babu, Design Thinking and Innovation: Creating tomorrow, Today, Astitva Prakashan, 2024.

2. Anuradha H N, Jagadeesha M, Priya K, Shashidhar S M,Sonal Sawakar, Deepa D, Jayan V.K, Pavithra Gowtham N S, Innovation and Design Thinking, Astitva Prakashan, 2024.

3. Chandramouli S., Thiyagarajan., Sankaran V.,Design Thinking: A Hands-on Approach, Orient Blackswan Pvt Ltd, 2025.

4. Anuja Agarwal, Design Thinking: A Framework for Applying Design Thinking in Problem Solving, 1st Edition, Cengage Learning India Pvt. Ltd., 2023

COURSE OUTCOMES

On taking the 'Design Thinking and Innovation' course students will be able to:

CO1: Understand and apply the core principles and stages of design thinking to drive innovation.
CO2: Learn to empathize with users and accurately define complex "wicked problems."
CO3: Master ideation techniques to create and evaluate creative solutions to identified problems.
CO4: Gain practical skills in prototyping and implementing design solutions.

CO5: Utilize user feedback to refine and enhance their design solutions.
CO6: Demonstrate their ability to solve real-world problems using the complete design thinking process.

PRACTICAL

BC29004 COMPUTER NETWORKS LAB CREDITS-2

List of Experiments:

1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture, ping and traceroute PDUs using a network protocol analyzer and examine.
2. Write a HTTP web client program to download a web page using TCP sockets.
3. Applications using TCP sockets like, echo client and echo server, chat and file transfer
4. Simulation of DNS using UDP sockets.
5. Write a code simulating ARP /RARP protocols.
6. Study of Network simulator (NS) and Simulation of Congestion Control Algorithms usingNS.
7. Study of TCP/UDP performance using the Simulation tool.
8. Simulation of Distance Vector/ Link State Routing algorithm.
9. Performance evaluation of Routing protocols using Simulation tool.
10. Simulation of error correction code (like CRC).

BC29008 ARTIFICIAL INTELLIGENCE LAB CREDITS-2

List of Experiments:

1. Create a random number and print it.
2. Develop a simple game program using random numbers and predict from user.
3. Formulate problems using Sting handling operators and functions.
4. Programs on decision making using if else, nested if else and else if ladder.
5. Implement loop-control structures using for and while loops.
6. Programs using python built in data structures (List, Dictionary, tuple, set).
7. Develop programs using functions.
8. Programs using recursive function.
9. Formulate problems and write programs using modules.
10. Write a Game program scissor paper stone.
11. Programs to represent a graph.
12. Programs on find nodes and edges in graph.

FIFTH SEMESTER (AUTUMN)

1. **Professional Elective –III**
2. **Professional Elective –IV**
3. **Professional Elective –V**

BC30001 QUANTITATIVE TECHNIQUES CREDITS-2

UNIT –I

Fundamentals of Linear Programming: Mathematical Formulation of Linear Programming Problem, Graphical Solution of LPP. General LPP – Canonical and Standard Forms of LPP, Computational Procedure. Simplex Method, Big-M Method, Two Phase Simplex Method.

UNIT -II

Optimizing Resource Allocation: General structure of Transportation Problem, Initial Basic Solution procedure for Transportation Problem, Test for optimality. Maximization of Transportation Problem. Mathematical Formulation of an Assignment Problem, Solution Methods of an Assignment Problem- Hungarian Method, Maximization in an Assignment Problem, Unbalanced Assignment Problem.

UNIT -III

Strategic Algorithms and Decision Models: Integer Programming, linear vs integer programming, pure and mixed types, Branch and Bound, Cutting Plane methods.
Game Theory: strategic decision-making, two-person zero-sum games, saddle point, dominance, mixed strategies.

UNIT -IV

Network Analysis in Decision Making: Introduction, Basic Differences between PERT and CPM, Phases of Project Management, PERT/CPM Network Components and Precedence Relationships, constraints in the network, Critical Path Analysis, Time Cost Trade-off aspects in network technique, Advantages of the network.

Reference Books

1. P.K.Gupta & Hira, Operations Research, 5th Edition, S Chand, 2015.
2. Hamdy A. Taha, Operations Research: An Introduction, 8th Edition, PHI New Delhi, 2008.
3. Kanti Swarup, Gupta, P.K.and Man Mohan, Operations Research, Sultan Chand & Sons, 2010.

COURSE OUTCOMES

On taking the 'Quantitative Techniques' course the students will be able to:

CO1: Understand the fundamentals of Linear Programming and formulate mathematical models for real-world optimization problems.
CO2: Apply graphical and simplex-based methods, including Big-M and Two-Phase methods, to solve Linear Programming Problems.
CO3: Develop efficient solutions for resource allocation problems using Transportation and Assignment Models, including variations like maximization and unbalanced problems.
CO4: Analyze integer programming models and solve them using Branch & Bound and Cutting Plane techniques, distinguishing them from linear programming approaches.
CO5: Utilize game theory principles to model and solve strategic decision-making problems, including two-person zero-sum games and mixed strategies.
CO6: Implement PERT and CPM techniques for project management, perform critical path analysis, and evaluate time-cost trade-offs for decision-making in networks.

PRACTICAL

1. **Professional Elective Lab –III**
2. **Professional Elective Lab –IV**
3. **Professional Elective Lab –V**

SIXTH SEMESTER (SPRING)

BC30002 GENERATIVE AI CREDITS-2

UNIT- I

Introduction to Generative AI: Definition of Generative AI, Applications of Generative AI, Overview of Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Transformers and Diffusion Models.

UNIT- II

Probability and Data Modeling Fundamentals: Basics of probability distributions, Maximum likelihood estimation (MLE) and Latent variable models. Introduction to GANs and adversarial learning, Training dynamics (generator vs discriminator) and Implementing GANs for image generation.

UNIT- III

Transformers and Language Models: Sequence-to-sequence modeling, Introduction to BERT, Tokenization and attention mechanisms. Pre-training and fine-tuning, Prompt engineering,Ethical considerations in Generative AI.

UNIT- IV

Evaluation Metrics for Generative Models: Frechet Inception Distance (FID), Perplexity and BLEU scores for text, Subjective evaluation techniques. Societal impacts and Emerging Trends in Generative AI.

Reference books

1. *Martin Musiol,Generative AI: Navigating the Course to the Artificial General Intelligence Future, Wiley, 2024.*
2. *Numa Dhamani and Maggie Engler,Introduction to Generative AI, Simon and Schuster, 2024.*
3. *Pedro Cuenca, Apolinário Passos, Omar Sanseviero, Jonathan Whitaker,Hands-On Generative AI with Transformers and Diffusion Models (First Early Release), O'Reilly Media, Inc. 2023.*
4. *ZonunfeliRalte, Indrajit Kar,Learn Python Generative AI: Journey from autoencoders to transformers to large language models, BPB Publications, 2024.*
5. *Shreyas Subramanian,Large Language Model-Based Solutions: How to Deliver Value with Cost-Effective Generative AI Applications, John Wiley & Sons Inc. 2024.*
6. *David Foster, Generative Deep Learning, O'Reilly, 2023.*

COURSE OUTCOMES

On taking the 'Generative AI' course, the students will be able to:

CO1: Understand the foundational principles of generative models.
CO2: Understand the foundational concepts and algorithms behind Generative AI.
CO3: Build, train, and evaluate Generative AI models.
CO4: Analyze ethical concerns about Generative AI.
CO5: Societal impacts of Generative AI.
CO6: Apply Generative AI techniques to real-world problems.

BC30004 SOFT SKILLS CREDITS-2

UNIT – I

Knowing Oneself: Introduction to Soft skills, self-analysis and self-awareness, perception building, value addition.

UNIT – II

Understanding Others: Interpersonal skills, group formation and group dynamics, networking skills, improved work relationships.

UNIT - III

Communication Skills: The art of listening, conversation, reading skills, writing etiquette.

UNIT – IV

Corporate Skills: Practicing etiquette, time and stress management, the art of job hunting, resume building, interview and group discussion etiquette, goal setting and career planning.

Reference Books

1. *Soma Mahesh Kumar, Soft Skills: Enhancing Personal and Professional Success, McGraw Hill, 2023.*
2. *S. P. Dhanavel,English and Soft Skills, Orient Black Swan, 2010.*
3. *G.S. Chauhan and Sangeeta Sharma, Soft Skills: An Integrated Approach to Maximise Personality, Wiley, 2015.*
4. *Raman and Sharma, Technical Communication, OUP, 2015.*
5. *Jeff Butterfield, Soft Skills for Everyone, Cengage, 2020.*

COURSE OUTCOMES

On taking the 'Soft Skills' course, the students will be able to:

CO1: Gain self-understanding to improve personal effectiveness.
CO2: Build strong relationships and collaborate effectively.
CO3: Become proficient in listening, speaking, reading, and writing.
CO4: Learn etiquette and time/stress management for workplace success.
CO5: Master job hunting and career planning techniques.
CO6: Apply learned skills for overall professional growth.

PRACTICAL

BC39002 GENERATIVE AI LAB CREDITS-2

List of Experiments:

1. Setting up the development environment (Python, TensorFlow/PyTorch, Colab) for Generative AI.
2. Practical implementation of generative AI models using popular frameworks (e.g., TensorFlow, PyTorch).
3. Implementing a basic GAN to generate synthetic data.
4. Experimenting with image-to-image translation using CycleGAN.
5. Building a VAE to generate images and visualizing and manipulating latent spaces.
6. Text generation using GPT-like models.
7. Experimenting with text-to-image generation using DALL-E or similar tools.
8. Training a diffusion model on a small dataset.
9. Develop an application based on a generative AI.
10. Case studies showcasing real-world applications of generative AI.

1. **Professional Elective –VI Lab**
2. **Professional Elective –VII Lab**

SEVENTH SEMESTER – BCA (HONOURS) (AUTUMN)

SPECIALIZATION-AI & ML

BC40001 SOCIAL NETWORK ANALYSIS CREDITS-3

UNIT - I

Introduction to Semantic Web: Limitations of current web, development of semantic web,emergence of the social web. Introduction of social network, Social Network analysis: ddevelopment of social networkanalysis, key concepts and measures in network analysis, types of social networks (e.g., Facebook, Twitter, Instagram).

Measurement and Collection of Social Network Data: Measurement and Collection of social network data. Techniques to study different aspects of online social networks, follower-following dynamics, link farming, spam detection, hashtag popularity and prediction. Case Study: An analysis of demographic and behaviour trends using social media: Facebook, Twitter and Instagram.

UNIT – II

Knowledge representation: Ontology and their role in the semantic web,ontology-based knowledge representation, ontology languages for the semantic web. Resource description framework, web ontology language.

Modeling and Aggregating: Modelling and aggregating social network data, State-of-the-art in network data representation, ontological representation of social individuals, ontological representation of social relationships, aggregating and reasoning with social network data, working with social network data.

UNIT - III

Extraction and mining in web social networks: Introduction of web communities, detecting communities in social networks, Evaluating communities - Methods for community detection and mining. Applications of community mining algorithms, tools for detecting communities. Social network infrastructures and communities - decentralized online social networks, multi-relational characterization of dynamic social network communities.

Understanding and predicting human behaviour for social communities: User data management. Inference and Distribution - Enabling new human experiences, reality mining.

Context Awareness: Privacy in online social networks, trust in online environment, trust models based on subjective logic, trust network analysis.

UNIT – IV

Visualization of Social Networks: Graph theory, Centrality Clustering, Node-Edge diagrams matrix representation, visualizing online social networks, visualizing social networks with matrix-based representations, Matrix and Node-Link diagrams, Hybrid representations.

Applications of Social Networks: Cover networks, Community welfare, Collaboration networks, Co-Citation networks.

Reference Books

1. *Peter Mika, Social Networks and the Semantic Web, 1st Edition, Springer 2007.*
2. *Borko Furht, Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.*
3. *Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013.*
4. *GuandongXu,Yanchun Zhang and Lin Li, Web Mining and Social Networking – Techniques and applications, 1st Edition Springer, 2011.*
5. *Dion Goh and Schubert Foo, Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.*
6. *Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.*

COURSE OUTCOMES

On taking the 'Social Network Analysis' course, the students will be able to:

CO1: Grasp the core concepts of social networks, their analysis, and the evolution of the social web.

CO2: Learn techniques for measuring, collecting, and analyzing social network data from platforms like Facebook, Twitter, and Instagram.

CO3: Utilize ontologies and semantic web languages to represent and model social network knowledge.

CO4: Detect communities, mine social network data, and predict user behavior within online social communities.

CO5: Explore privacy concerns and implement trust models to analyze trust networks in online environments.

CO6: Visualize social network data using graph theory and apply social network analysis to diverse areas like collaboration and co-citation networks.

BC40003 OPTIMIZATION TECHNIQUES IN MACHINE LEARNING CREDITS-3

UNIT –I

Definition of vectors, vector addition, and scalar multiplication, Vector spaces and subspaces: Basis, dimension, and null space, Orthogonality: Orthogonal bases, Gram-Schmidt process. EigenValue Decomposition, Singular Value Decomposition - Algorithms and Methods, PSD Matrices and Kernel Functions, Vector Calculus. Partial order derivatives.

UNIT –II

Convex sets and their properties, Convex functions: Definition and examples, Geometric interpretation: Convex curves and epigraphs, Properties of Convex Functions : Linearity and convexity, Preservation under addition, scaling, and composition, Gradient (∇f) and its role in optimisation, Optimality conditions for unconstrained optimization, Subgradients and their application in non-differentiable convex functions, Hessian matrix and its properties, Positive definite and semi-definite conditions for local optimality, Convex Optimisation problems: Lasso Regression, Differences between convex and non-convex optimization, Non-convex objective functions and constraints, k-means clustering.

UNIT – III

Convex Optimisation: Gradient Descent: math, programming basic optimisation problems and their solutions.Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Training a Neural Network: Theory

UNIT – IV

Non Convex Optimisation: Gaussian Mixture Model (GMM), Gaussian Mixture Model (GMM) using Expectation Maximization (EM) Technique, Optimization for Neural networks, SGD Mini-batches Initialization Batchnorm Gradient clipping Adaptive methods Momentum Layerwise params. ADAM.

Reference Books

1. A. Beck, First-Order Methods in Optimization, MOS-SIAM Series on Optimization, 2017.
2. S. Bubeck, Convex Optimization: Algorithms and Complexity, Foundations and Trends in Optimization, 2015.

3. Numerical Optimization. J. Nocedal and S. J. Wright, Springer Series in Operations Research, Springer-Verlag, New York, 2006 (2nd edition).

COURSE OUTCOMES

On taking the 'Optimization Techniques in Machine Learning' course, the students will be able to:

CO1: Demonstrate knowledge of linear algebra and vector calculus foundations in the context of machine learning optimization.
CO2: Identify and analyze convex functions, their properties, and apply convex optimization techniques to relevant problems.
CO3: Apply gradient-based algorithms (including variations like SGD and accelerated methods) for solving machine learning tasks.
CO4: Design and optimize neural networks using advanced techniques such as batch normalization, gradient clipping, and adaptive optimizers.
CO5: Understand non-convex optimization concepts and employ methods like Expectation Maximization and GMM in practice.
CO6: Evaluate and select appropriate optimization strategies for complex real-world machine learning applications.

PRACTICAL

BC49003 OPTIMIZATION TECHNIQUES LAB CREDITS: 2

1. Implementation of Gradient Descent.
2. Implementation of Fixed-Point Problems.
3. Implement a simple random walk on a torus graph and will check its convergence to uniform distribution.
4. Implementation ofregression model to predict a person's weight from their height using SGD.
5. Implementation of Newton's method.
6. Implementation of Quasi-Newton Method.
7. Implementation of classification using SVM.
8. Implementation of classification using Lasso Regression.
9. Implementation of K-Means clustering algorithm.
10. Implementation of Gaussian Mixture Model (GMM) using Expectation Maximization (EM) Technique.

SEVENTH SEMESTER–BCA (HONOURS) (AUTUMN)

SPECIALIZATION–DATA SCIENCE

BC40005 ADVANCED STATISTICAL METHODS FOR DATA SCIENCE CREDITS-3

UNIT- I

Advanced Probability and Distribution Theory: Random variables, distributions, and expectations. Copulas, multivariate distributions, and extreme value theory. Dependency modeling in high-dimensional data.

UNIT- II

Statistical Inference and Hypothesis Testing: Maximum likelihood estimation (MLE) and its properties, Likelihood ratio tests and Bayesian inference, Multiple hypothesis testing and false discovery rate (FDR), Applications in real-world datasets.

UNIT- III

Multivariate Statistical Analysis: Principal Component Analysis (PCA) and Factor Analysis. Canonical Correlation Analysis and Discriminant Analysis. Clustering and classification techniques.

UNIT- IV

Time Series Analysis: Stationarity, autocorrelation, and partial autocorrelation. ARIMA, SARIMA and GARCH models. Seasonal decomposition and forecasting. Applications in financial and environmental data.

Reference books

1. *Leonardo Grilli et al., Statistical Models and Methods for Data Science, Springer, 2023*
2. *Hastie, Tibshirani, and Friedman, The Elements of Statistical Learning.*
3. *Gelman et al, Bayesian Data Analysis.*
4. *James D. Hamilton, Time Series Analysis.*
5. *Dr. Carlos Andre et al., Introduction to Statistical and Machine Learning Methods for Data Science SAS Institute, 2021.*
6. *Steven Cooper, Data science from scratch: the #1 data science guide for everything a data scientist needs to know: Python, linear algebra, statistics, coding, applications, neural networks, and decision trees, 2018.*

COURSE OUTCOMES

On taking the 'Advanced Statistical Methods for Data Science' course, the students will be able to:

CO1: Master advanced statistical concepts and their applications in data science.
CO2: Develop skills to model, analyze, and interpret complex datasets.
CO3: Understand and apply Bayesian statistics, time series analysis, and statistical learning techniques.
CO4: Build and evaluate statistical models for predictive analytics.
CO5: Utilize statistical software to solve real-world problems.
CO6: Communicate statistical findings effectively through reports and presentations.

BC40007 PYTHON FOR DATA SCIENCE CREDITS-3

UNIT –I

Overview of Python: Python features, basic syntax, interactive mode programming, script mode programming, input/output statements, keywords, identifiers, operators, expressions, string handling and manipulation, control statements, Iterations.

UNIT –II

Lists: Operations, slicing, built in list functions, list comprehension.
Tuple: introduction, accessing tuples, operations using built in tuple functions.
Dictionaries: introduction, accessing values in dictionaries, built in dictionary functions, working with dictionaries, Sets, Sequences.

UNIT – III

Function, Recursion, Global variables; Modules: Creating modules, import statement, packages.
Object Oriented Programming: Abstract data types.
Classes and Objects: Creating class and object, using a class, methods, overriding methods, Inheritance, types of inheritance, encapsulation and information hiding; Exception Handling: try, except and finally.

UNIT – IV

Inheritance, types of inheritance, encapsulation and information hiding;
Exception Handling: try, except and finally.

File Handling: text files, opening and closing file, reading and writing files, format operator; command line arguments.
Database: Introduction, connections, executing queries, transactions.

Reference Books

1. *P.Barry,HeadFirstPython,2nd Edition,O'ReillyMedia,2010.*
2. *A. B. Downey, Think Python:How to Think Like a Computer Scientist, 2nd Edition, O'Reilly Media, 2012.*
3. *J. Zelle,PythonProgramming:AnIntroductiontoComputerScience,3rd Edition,Franklin, Beedle& Associates, 2016.*
4. *L.Ramalho,FluentPython,1st Edition, O'ReillyMedia,2015.*

COURSE OUTCOMES

On taking the 'Python for Data Science' course, the students will be able to:

CO1: Understand Python syntax, flow control, and functions to solve real life application.
CO2: Use functions and core data structure like list, dictionaries, tuple.
CO3: Develop application using Object Oriented Programming concepts of Python.
CO4: Solve problems using the concept of Inheritance and Exception handling.
CO5: Create programs using file Input, Output concepts.
CO6: Apply concept of file handling and database connectivity for solving real world applications.

PRACTICAL

BC49007 PYTHON FOR DATA SCIENCE LAB CREDITS-2

List of Experiments:

1. Compilation and execution of simple python programs.
2. Programs using data types and operators
3. Programs using String handling operators, functions, Input and Output statements.
4. Programs on decision making and looping using if else, nested if else and else if ladder, for and while loops.
5. Programs using python built in data structures (List, Dictionary, tuple, set), and functions, recursive function and modules.
6. Develop programs using Packages, concept of Class and Object.
7. Programs on Inheritance and Exception Handling

8. Formulate problems on Inheritance and write programs.
9. Formulate problems on file handling and develop programs
10. Write programs to perform file Input/Output operations and database Connectivity.

EIGHTH SEMESTER BCA (HONOURS) (SPRING)

1. **Professional Elective –X**
2. **Professional Elective –XI**
3. **Professional Elective –XII**

PRACTICAL

1. **Professional Elective –X Lab**
2. **Professional Elective –XI Lab**

SEVENTH SEMESTER– BCA (HONOURS WITH RESEARCH) (AUTUMN)

BC40007 ADVANCED DATA ANALYSIS CREDITS-3

UNIT – I

Mathematics for Data Science: Linear Algebra: Vectors, matrices, eigenvalues, eigenvectors, singular value decomposition. Probability and Statistics: Probability distributions, random variables, hypothesis testing, confidence intervals, regression analysis.
Programming Fundamentals: Introduction to Python: Data types, control flow, functions, object-oriented programming. Data Structures: Lists, dictionaries, sets, tuples. Introduction to Data Science: What is Data Science? The Data Science Life cycle: Data collection, cleaning, transformation, analysis, visualization, interpretation. Ethical considerations in data science.

UNIT – II

Data Handling and Manipulation: Data Collection and Management: Data sources: APIs, databases, web scraping, sensors. Data cleaning: Handling missing values, outliers, inconsistencies. Data transformation: Feature engineering, scaling, normalization. Data warehousing and data lakes. Data Wrangling with Python: Pandas: Data manipulation, cleaning, and analysis. NumPy: Numerical computing with Python.
Working with Databases: Introduction to SQL: Data Definition Language (DDL), Data Manipulation Language (DML). Relational databases and NoSQL databases.

UNIT – III

Data Analysis and Visualization: Descriptive Statistics: Data summarization: Measures of central tendency, dispersion, and shape.Data visualization: Histograms, box plots, scatter plots, heatmaps.Inferential Statistics: Hypothesis testing: t-tests, chi-square tests, ANOVA.Confidence intervals.Sampling techniques.Matplotlib and Seaborn: Creating various types of plots and visualizations.
Machine Learning and Advanced Topics: Machine Learning Fundamentals: Supervised learning: Linear regression, logistic regression, decision trees, support vector machines.Unsupervised learning: Clustering (k-means, hierarchical), dimensionality reduction (PCA).

Model evaluation: Metrics (accuracy, precision, recall, F1-score), cross-validation.

UNIT – IV

Advanced Machine Learning: Deep Learning: Neural networks, convolutional neural networks, recurrent neural networks.Natural Language Processing(NLP): Text classification, sentiment analysis.Recommendation Systems: Collaborative filtering, content-based filtering.

Big Data Technologies: Introduction to Hadoop and Spark. Cloud computing platforms (AWS, Azure, GCP).

Reference Books

1. *J Moreira, Andre Carvalho, T Horvath,A General Introduction to Data Analytics, Wiley, 2019.*
2. *Intelligent Data Analysis, M.Berthold and D.J.Hand, 2nd Edition, Springer, 2007.*
3. *Aurélien Géron,Hands-On Machine Learning with Scikit-Learn, Keras& TensorFlow.*
4. *Jake VanderPlas,Python Data Science Handbook - Covers data manipulation, visualization, and machine learning with Python.*
5. *Murtaza Haider, Getting Started with Data Science: Making Sense of Data with Analytics, IBM Press 2016.*
6. *Wes McKinney,Python for Data Analysis - A deep dive into the Pandas library for data manipulation.*
7. *G. Sudha Sadasivam & R. Thirumahal, Big Data Analytics, Oxford, 2020.*

COURSE OUTCOMES

On taking the 'Advanced Data Analytics' course the students will be able to:

CO1: Acquire essential math and coding skills for robust data science applications.
CO2: Learn to effectively manage and transform data from diverse sources using Python and SQL.
CO3: Utilize statistical methods and visualization tools to analyze and present data insights.
CO4: Build and assess various machine learning models using appropriate metrics.
CO5: Discover advanced AI and big data tools for complex data analysis.
CO6: Conduct data science responsibly by incorporating ethical principles.

RM40009 RESEARCH METHODOLOGY CREDITS-3

UNIT - I

Introduction to research: Structure of research: Scientific method and Engineering design cycle,Definingand scoping Research problems, Formulating research objectives and research questions.

UNIT - II

Literature Review: Searching for literature; Narrative and systematic literature review; Summarizing,paraphrasing, and quoting and referencing styles.

Design of Experiments: Basic Principles of randomization, replication, and Blocking; Factors and responses; Analysis of variance, Experiments with blocking factors, and Factorial designs.

UNIT - III

Data Analytics: Data pre-processing, Data visualization, Tests of hypothesis, Decision trees,and artificial neural networks.

Theoretical Models: Typology of models; Optimization models, forecasting models, and control models;Monte Carlo simulation; Genetic Algorithm; Model verification and validation; and Measurement and uncertainty analysis.

UNIT – IV

Drawing Inferences: Drawing inferences,Generalizing, finding potential applications, imagining future scope, and highlighting the novelty of research.

Research Ethics: Ethics and morality; Utilitarian and deontological theories of ethics; Fabrication,falsification, plagiarism, and questionable research practices; Issues related to privacy and confidentiality;and Ethical issues related to publications.

Reference Books

1. *Chawla & Sodhi, Research Methodology, Concepts and Cases, Vikas Publishing House,2018.*
2. *Kothari and Garg, Research Methodology, New Age International Publishers,2019.*
3. *Mangal, Research Methodology in Behavioural Sciences, Prentice Hall India Learning Private Limited, 2013.*

COURSE OUTCOMES

On taking the 'Research Methodology' course the students will be able to:

CO1: Identify research topics and develop corresponding research queries.
CO2: Conduct a literature search and create a review of literature.
CO3: Learn about a variety of experimental, theoretical, quantitative, and qualitative research techniques.
CO4: Learn the methods used for gathering, analyzing, and interpreting data.
CO5: Understand the importance of research ethics and the implications of the broader impact of research.
CO6: Engage in research with transparency and ethical principles.

PRACTICAL

BC49007 ADVANCED DATA ANALYSIS LAB CREDITS-2

List of Experiments:

1. Explore and Manipulate a Dataset, explore its structure using Pandas, and perform basic manipulations like filtering and sorting to extract specific data subsets.
2. Clean and Preprocess Dataand document the changes made.
3. Aggregate and Summarize Dataand present the results.
4. Visualize Data Relationships by creating various plots (histograms, scatter plots, box plots) using Matplotlib and Seaborn to explore relationships between variables within a given dataset.
5. Conduct Exploratory Data Analysis (EDA) through Visualization, identifying patterns and insights from a dataset.
6. Create and Communicate Insights through Effective Visualizations, including interactive plots with libraries like Plotly, to effectively communicate findings from a dataset.
7. Retrieve and Filter Data with SQL queries to select, filter, and join data from a sample database, extracting specific information.
8. Clean and Transform Data Using SQL Queries within a database, handling missing values and inconsistencies.
9. Analyze and Summarize Data with SQL Aggregations
10. Train and Evaluate a Basic Model (e.g., linear or logistic regression) on a provided dataset and evaluate its performance using relevant metrics.
11. Model Performance Optimization through Hyperparameter Tuning and analyzing the impact on evaluation metrics.
12. Implement Model Selection techniques to evaluate and select the best performing machine learning model from a set of trained models.

EIGHTH SEMESTER–BCA(HONOURS WITH RESEARCH) (SPRING)

SESSIONAL

Dissertation (20 credits)

During their dissertation, the students will conceptualize, execute, and meticulously document original research within a specialized area of the field.

DISCIPLINE-SPECIFIC ELECTIVES (DSE)

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

SL. NO.	Semester	Subject Code	Professional Elective
1	III	BC20041	Feature Engineering
2	1V	BC20042	Introduction to ML
3	V	BC30041	Artificial Neural Networks
4	V	BC30043	Image Processing
5	V	BC30045	Natural Language Processing
6	VI	BC30042	Computer Vision
7	VI	BC30044	Predictive Analysis
8	VII	BC40041	Explainable AI
9	VII	BC40043	Evolutionary Algorithm
10	VIII	BC40042	Reinforcement Learning
11	VIII	BC40044	Digital Signal Processing
12	VIII	BC40046	Security aspects of ML

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (LAB)

SL. NO.	Semester	Subject Code	Professional Elective Lab
1	III	BC29041	Feature Engineering
2	1V	BC29042	Introduction to ML
3	V	BC39041	Artificial Neural Networks
4	V	BC39043	Image Processing
5	V	BC39045	Natural Language Processing
6	VI	BC39042	Computer Vision
7	VI	BC39044	Predictive Analysis
8	VII	BC49041	Explainable AI
9	VIII	BC49042	Reinforcement Learning
10	VIII	BC49044	Digital Signal Processing

BC20041 FEATURE ENGINEERING CREDITS: 2

UNIT – I

Introduction to Feature Engineering: Introduction to Data and Features: Importance of Features in Machine Learning. Data typesand features: Numerical, Categorical, Ordinal, Discrete, Continuous, Interval and Ratio.

BasicFeature Pre-processing: Handling Missing Data, Data Cleaning, Feature Scaling, Normalization, and Transformation.

UNIT - II

Feature Engineering Techniques: Techniques for Numerical Data: Binning and Discretization, Polynomial and InteractionFeatures.

Categorical Data Techniques: One Hot Encoding, Label Encoding.

UNIT – III

Feature Selection: Feature extraction vs. feature selection, Steps in feature selection.
Feature Selection Methods: Filter, Wrapper,and Hybrid.

UNIT – IV

Dimensionality Reduction: Introduction and application of Principal Components Analysis.

Reference Books

1. *M.C. Trivedi, Data Science and Data Analytics Using Python Programming, Khanna Publishing House, 2024.*
2. *Zheng, Alice, & Casari, Amanda. (2018). Feature engineering for machine learning: Principles and techniques for data scientists. O'Reilly Media, Inc., 2018.*
3. *Kalita, J. K., Bhattacharyya, D. K., & Roy, S., Fundamentals of Data Science: Theory and Practice. Elsevier. ISBN-13: 9780323917780, 2023.*
4. *Duda, R. O., Hart, P. E., Stork, D., Pattern classification (2Ed), John Wiley &Sons, ISBN-13: 978-8126511167, 2007.*
5. *N. Bhaskar, Vasundhara, Machine Learning, Khanna Publishing House, 2024.*
6. *M.C. Trivedi, Deep Learning and Neural Network, Khanna PublishingHouse, 2024.*
7. *Han, Jiawei, Kamber, Micheline, & Pei, Jian., Data mining: Concepts andtechniques (3rd ed.). Morgan Kaufmann Publishers. ISBN 978-0123814791, 2011.*

COURSE OUTCOMES

On taking the ‘Feature Engineering'course the students will be able to:

CO1: Understand the importance of features in machine learning and differentiate between various types of data and features (structured vs. unstructured, categorical, numerical, text, and date-time).

CO2: Apply basic feature pre-processing techniques such as handling missing data, data cleaning, and feature scaling and normalization.

CO3: Implement feature engineering techniques for numerical data, including binning, discretization, polynomial and interaction features, and log transformation.

CO4: Utilize categorical data techniques, such as one-hot encoding and label encoding, and understand feature selection methods, including filter and wrapper methods.

CO5: Perform feature transformation using techniques like Principal Component Analysis and understand its application in machine learning.

PRACTICAL

BC29041 FEATURE ENGINEERING LAB CREDIT: 1

List of Experiments:

1. Handle missing values: Fill in missing data points in columns like 'Age' or 'Weight' using a central tendency measure, such as the mean, median, or mode.
2. Clean a dataset: Identify and remove invalid or inconsistent data entries from a dataset, such as 'invalid data' in a 'Name' column.
3. Scale numerical features: Use Min-Max normalization to scale numerical data, like 'Height' and 'Weight', to a specific range.
4. Perform exploratory data analysis (EDA): Visualize data distributions using histograms and boxplots to understand key characteristics and identify outliers.
5. Compute and visualize a correlation matrix: Calculate and display the correlations between two or more numerical columns in a dataset to see how they relate to each other.
6. Bin numerical data: Group numerical values into discrete intervals or bins to simplify the data, for example, converting ages into age ranges.
7. Create polynomial and interaction features: Generate new features from existing ones to capture more complex relationships within the data.
8. Apply logarithmic transformation: Use a logarithmic transformation on skewed numerical features, like 'Distance', to make their distribution more normal.
9. Perform one-hot encoding: Convert categorical features, such as 'Category' or 'Gender', into a numerical format that machine learning models can understand.
10. Preprocess text data: Prepare text data for analysis by performing tasks like tokenization, stemming, or lemmatization.

BC20042 INTRODUCTION TO ML CREDITS: 2

UNIT - I

Introduction to Machine Learning: Definition, History and Application of Machine Learning, Types of MachinesLearning: Supervised, Unsupervised, Semi-Supervised, and Reinforcement Learning.Labeled and Unlabeled Dataset. Supervised Learning Tasks: Regression vs. Classification.

Learning Framework: Training, Validation and Testing of ML models. Performance Evaluation Parameters: Confusion matrix, Accuracy, Precision, Recall, F1 Score, and AUC.

UNIT - II

Supervised Learning: Regression: Linear and non-linear Regression, Logistic Regression. Classification: NaïveBayes, K-Nearest Neighbors, Decision Trees. Linear model: Introduction to Artificial NeuralNetworks, Perceptron Learning Algorithm, Single Layer Perceptron, Introduction to SupportVector Machine for linearly separable data.

UNIT - III

Unsupervised Learning: Clustering: K-Means, Hierarchical Clustering, DBSCAN, Clustering Validation Measures.

UNIT – IV

ML Applications: Ethical Considerations inMachine Learning, Case study and Real-worldApplications.

Reference Books

1. *Rajiv Chopra, Machine Learning and Machine Intelligence, Khanna Publishing House,2024.*
2. *Jeeva Jose, Introduction to Machine Learning, Khanna Publishing House, 2023.*
3. *Mitchell T.,Machine Learning, First Edition, McGraw-Hill, 1997.*
4. *Kalita, J. K., Bhattacharyya, D. K., & Roy, S., Fundamentals of Data Science: Theory and Practice. Elsevier. ISBN9780323917780,2003.*
5. *Flach, P. A. (2012). Machine Learning: The Art and Science of Algorithms that Make Sense of Data. Cambridge University Press. ISBN: 9781107422223, 2012.*
6. *Duda, R. O., Hart, P. E., Stork, D.,Pattern classification (2Ed), John Wiley & Sons, ISBN-13: 978-8126511167,2007.*

7. *HaykinS.,Neural Networks and Learning Machines, Third Edition, PHI Learning, 2009.*
8. *Chollet, F.,Deep Learning with Python. Manning Publications,2018.*
9. *Bishop, C. M., Pattern Recognition and Machine Learning. Springer, 2006.*
10. *Goodfellow, I., Bengio, Y., & Courville, A.,Deep Learning. MIT Press,2016.*

COURSE OUTCOMES

On taking the 'Introduction to ML'course the students will be able to:

CO1: Define and explain machine learning concepts, types, and basic metrics.
CO2: Implement and apply supervised learning techniques (e.g., KNN, Linear Regression, Logistic Regression).
CO3: Apply unsupervised learning methods (e.g., K-Means, Hierarchical Clustering, Association Rules).
CO4: Develop and evaluate simple machine learning models (e.g., Perceptron, single-layer neural networks).
CO5: Analyze and apply appropriate machine learning algorithms depending on the problems with some real-world data.

PRACTICAL

BC29042 INTRODUCTION TO ML LAB CREDIT: 1

List of Experiments:

1. Implement linear regression on a dataset and visualize the regression line.
2. Implement logistic regression on a binary classification dataset and plot the decision boundary.
3. Implement and evaluate the performance of Decision tree ID3/Cart classifier for any given dataset.
4. Implement and evaluate the performance of the Naive Bayes Classifier on a given dataset.
5. Build and evaluate a random forest classifier using a numerical dataset.
6. Implement a support vector machine for linearly separable classes and visualize the margins and decision boundary.
7. Implement K-Means clustering on a point dataset and visualize and evaluate the clusters.
8. Implement hierarchical clustering on a dataset and plot the dendrogram.

9. Implement DBSCAN clustering on a dataset and visualize and evaluate the clusters.
10. Perform Principal Components Analysis (PCA) and apply any one or more classifiers to show the performance variation with or without feature reduction.
11. Build a single layer perceptron model to classify AND, OR, and XOR problems (may use TensorFlow/Keras) and visualize their decision boundaries. Also evaluate its
12. performance.
13. Demonstrate the concept of boosting using the AdaBoost algorithm.

BC30041 ARTIFICIAL NEURAL NETWORKS CREDITS: 3

UNIT –I

Biological neurons and its working, Simulation of biological neurons to problem solving, Different ANNs architectures, McCulloch Pitts Neuron, Thresholding Logic, Perceptron Learning Algorithm and Convergence, ADALINE Network.

UNIT –II

Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Backpropagation, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Radial Basis Function Networks.

UNIT – III

Bias Variance Tradeoff, L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Cross-entropy cost function, Softmax layer.

UNIT – IV

Recurrent Neural Networks, Vanishing and Exploding Gradients, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs. Convolutional Neural Networks.

Reference Books

1. *Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2019.*
2. *Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press book, 2016.*
3. *Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola, Dive into Deep Learning.*

COURSE OUTCOMES

On taking the ‘Artificial Neural Network'course the students will be able to:

CO1: Describe various types of ANNs.
CO2: Carry out simple simulations of ANNs
CO3: Discuss the theory on which ANNs are based.
CO4: Explain how simple ANNs can be designed

CO5: Explain how ANNs can be trained.
CO6: Discuss the limitations and possible applications of ANNs.

PRACTICAL

BC39041 ARTIFICIAL NEURAL NETWORKS LAB CREDITS: 3

List of Experiments:

1. Implementation of different Activation Functions and Learning Rules to train Neural Network.
2. Implementation of Perceptron Networks.
3. Implementation of ADALINE Network for system identification.
4. Implementation of Multilayer Feed Forward Neural Networks.
5. Implementation of Multilayer Neural Networks (MLP) using Backpropagation.
6. Implementation of MLP and optimize the weights and biases of the neural network by minimizing the loss function using Gradient Descent.
7. Implementation of Radial Basis Function Networks.
8. Implementation of RNN and GRU.
9. Implementation of LSTM.
10. Implementation of CNN.

BC30043 IMAGE PROCESSING CREDITS: 3

UNIT-I

Digital Image Representation-Fundamental steps in Image Processing, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization- Relationships between pixels-colour models. Transforms: 2-D FFT, Properties, Walsh Transform, Hadamard Transform, Discrete Cosine Transform, Haar Transform.

UNIT-II

Spatial Domain: Introduction, Image Enhancement in Spatial Domain, Enhancement through Point Processing, Types of Point Processing, Histogram Manipulation, Linear and Non-Linear Gray Level Transformation, Local or Neighbourhood criterion, Median Filter, Spatial Domain High-Pass Filtering. Image Enhancement (Frequency Domain): Filtering in Frequency Domain, Low Pass (Smoothing) and High Pass (Sharpening) Filters in Frequency Domain.

UNIT-III

Image Restoration: Degradation Model, Algebraic Approach to Restoration, Inverse Filtering, Least Mean Square Filters, Constrained Least Squares Restoration, Interactive Restoration.
Image Segmentation: Detection of Discontinuities, Edge Linking And Boundary Detection, thresholding, Region Oriented Segmentation. Morphological Image Processing: Dilation and Erosion: Dilation, Structuring Element Decomposition, Erosion, Combining Dilation and Erosion, Opening and Closing, Hit or Miss Transformation.

UNIT-IV

Compression: Fundamentals – Image Compression models, Error Free Compression, Lossy compression– Image Compression standards.
Boundary representation, Chain Code, Polygonal approximation, signature, boundary segments, Boundary description, Shape number, Fourier Descriptor, moments, Regional Descriptors –Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

Reference Books

1. *Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3rd Edition, Pearson, 2008.*
2. *S Jayaraman, S Esakkirajan, T Veerakumar, Digital Image Processing, TMH, 2010.*

3. *Scotte Umbaugh, Digital Image Processing and Analysis-Human and Computer Vision Application with using CVIP Tools, 2nd Edition, CRC Press, 2011.*
4. *Rafael C. Gonzalez, Richard E Woods and Steven L. Eddings,Digital Image Processing using MATLAB, 2nd Edition, TMH, 2010.*
5. *Somka, Hlavac, Boyle,Digital Image Processing and Computer Vision, Cengage Learning (Indian edition), 2008.*
6. *Adrian low,Introductory Computer Vision Imaging Techniques and Solutions, 2nd Edition, BS.*

COURSE OUTCOMES

On taking the 'Image Processing' course the students will be able to:

CO1: Describe and analyze the basic components of digital image processing, including representation, sampling, and quantization.
CO2: Apply spatial and frequency domain techniques for image enhancement.
CO3: Implement algorithms for image restoration and segmentation.
CO4: Understand and apply image compression standards and algorithms.
CO5: Analyze image boundary representations, regional descriptors, and pattern recognition techniques.

CO6: Analyze and implement morphological operations for image processing and feature extraction.

PRACTICAL

BC39043 IMAGE PROCESSING LAB CREDITS: 2

List of Experiments:

1. Implementation of Image Representation and Basics.
2. Implementation of Image Sampling and Quantization.
3. Implementation of Histogram Equalization and Gray-Level Transformations.
4. Implementation of Spatial Filtering with Median Filter.
5. Implementation of Spatial Domain High-Pass Filtering.
6. Implementation of Frequency Domain Filtering (2D FFT).
7. Implementation of Image Restoration (Noise Removal).
8. Implementation of Edge Detection and Image Segmentation.
9. Implementation of Morphological Operations.
10. Implementation of Image Compression and Quality Analysis.

BC30045 NATURAL LANGUAGE PROCESSING CREDITS: 3

UNIT –I

Introduction to Natural Language (NL).
Levels of Language Processing, Linguistic Fundamentals for NLP.
Text Processing and Preprocessing: Tokenization, Normalization, Stop word removal, Stemming, lemmatization, Morphological Analysis & Finite State Transducers.

UNIT –II

Part-of-speech tagging and Named Entities.
Sequence Models: Hidden-Markov Models and CRF.
Classification Models: Naïve Bayes, Logistic Regression, Clustering.

UNIT – III

Syntax and Parsing: Constituency parsing, Dependency parsing, Parsing algorithms.
Meaning Representation: Logical Semantics, Semantic Role Labelling.

UNIT – IV

Distributional Semantics, n-gram and Word2Vec.
Discourse Processing: Anaphora and Coreference Resolution and Discourse Connectives.
Machine Translation.

Reference Books

1. *Daniel Jurafsky, James H.Martin,Speech and Language Processing.*
2. *CH Manning, H Schuetze,Foundations of Statistical Natural Language Processing.*
3. *Steven Bird, Ewan Klein, Edward Loper,Natural Language Processing with Python.*

COURSE OUTCOMES

On taking the 'Natural Language Processing' course the students will be able to:

CO1: Understand the wide spectrum of problem statements, tasks, and solution approaches within NLP.
CO2: Extract information from text automatically using concepts and methods from natural language processing (NLP) including stemming, n-grams, POS tagging, and parsing.
CO3: Analyze the syntax, semantics, and pragmatics of a statement written in a natural language.
CO4 Apply machine learning algorithms to natural language processing.

CO5: Write scripts and applications in Python to carry out natural language processing using libraries such as NLTK, Gensim, and spaCY.
CO6: Design NLP-based AI systems for question answering, text summarization, and machine translation.

PRACTICAL

BC39045 NATURAL LANGUAGE PROCESSING LAB CREDITS: 2

List of Experiments:

1. Write a python program to perform Tokenization, Normalization, Stop word removal, Stemming, lemmatization of word and sentences using nltk.
2. Write a python program to perform Parts of Speech tagging using nltk.
3. Write a python program to perform Named Entity Recognition using nltk.
4. Write a python program to find Term Frequency and Inverse Document Frequency (TF-IDF).
5. Write a python program to find all unigrams, bigrams and trigrams present in the given corpus.
6. Write a python program to find the probability of the given statement “This is my cat” by considering the example corpus.
7. Use the Stanford named Entity recognizer to extract entities from the documents. Use it programmatically and output for each document, which named entities it contains, and of which type.
8. Write the python code to implement Word2Vec.
9. Write the python code to develop sentiment analysis using NLP.
10. Write the python code to detect fake news using NLP.

BC30042 COMPUTER VISION CREDITS: 3

UNIT – I

Overview of computer vision, history, and applications, Image representation: pixels, color spaces (RGB, HSV, grayscale), Image formats and their applications in computer vision, Basics of image processing: filtering, convolution, smoothing, and edge detection, Morphological operations: dilation, erosion, opening, and closing.

UNIT-II

Feature detection methods: Harris Corner, FAST, and SIFT, Descriptors: SIFT, SURF, and ORB, Feature matching: brute force and FLANN-based matching, Homography and perspective transformations, Applications in panorama stitching and object detection.

UNIT-III

Motion estimation concepts: optical flow and block matching, Lucas-Kanade and Farneback optical flow methods, Basics of object recognition, Introduction to machine learning for object recognition, Object detection algorithms: sliding window, region proposal methods, Pre-trained models: YOLO, SSD, and Faster R-CNN for object detection.

UNIT-IV

Image segmentation: thresholding, clustering, and semantic segmentation, Optical flow and motion analysis, 3D vision: stereo vision, depth estimation, and structure from motion, Real-time vision applications: augmented reality, self-driving cars, and surveillance, Ethical considerations in computer vision.

Reference Books

1. *Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson.*
2. *Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.*
3. *Adrian Kaehler and Gary Bradski, Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, 2nd Edition, O'Reilly Media.*
4. *Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press.*
5. *Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press (for deep learning basics in vision).*
6. *Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.*
7. *Michael Beyeler, Machine Learning for OpenCV,Packt Publishing.*

COURSE OUTCOMES

On taking the 'Computer Vision'course the students will be able to:

CO1: Understand core computer vision concepts: Grasp fundamental algorithms, image representation, color spaces, and basic image processing techniques.

CO2: Apply image processing methods: Use techniques like filtering, convolution, and edge detection to analyze visual data.

CO3: Implement feature detection and matching: Apply methods like Harris Corner, SIFT, and ORB, and perform feature matching for tasks like panorama stitching.

CO4 Utilize motion estimation and object recognition: Use optical flow and pre-trained models like YOLO for object detection and motion analysis.

CO5: Integrate machine learning in computer vision: Apply machine learning algorithms for tasks like object detection and image segmentation.

CO6: Develop applications with Python and Open CV: Build and deploy real-world computer vision applications using Python and Open CV.

PRACTICAL

BC39042 COMPUTER VISION LAB CREDITS: 2

List of Experiments:

1. Implementation of Basic Image Processing Operations.
2. Implementation of Image Enhancement Techniques.
3. Implementation of Morphological Operations.
4. Implementation of Feature Detection Using Harris Corner and FAST.
5. Implementation of Feature Descriptors and Matching Using SIFT and ORB.
6. Implementation of Image Transformation Using Homography.
7. Implementation of Object Detection with Haar Cascades.
8. Implementation of Introduction to Convolutional Neural Networks (CNN) for Image Classification.
9. Implementation of Object Detection with YOLO or SSD.
10. Implementation of Image Segmentation Techniques.

BC30044 PREDICTIVE ANALYSIS CREDITS: 3

UNIT-I

Overview and fundamentals of Analytics, landscapes of tools and environment in business and corporate sectors, properties of data, attributes, datasets types, data quality measurement, noise analysis. Techniques of Data Modelling: data pre-processing, aggregation and sampling. Applications and need of modelling in business.

UNIT-II

Introduction to concepts of simple and multiple linear regression, geometry of regression model, sampling distribution of regression coefficients. Logistic Regression: basic concepts and its applications in binary classification, estimation of coefficients of logistic Regression and statistical inferences.

Linear Regression: fundamentals and model construction, model fitting, model applications on various domains.

Least Squares Method: Basic concepts and estimation methods, variable rationalization, BLUE property assumption.

UNIT-III

Introduction to segmentation, comparison of regression and segmentation, exploratory data analysis, dataset and tools exploration.

Clustering and Classification techniques: designing of probabilistic models, outlier analysis, over fitting, pruning and complexity.

Predictive Model Construction: Designing parametric and non-parametric models, ANOVA,t-test. Linear Discriminant Analysis and Fisher Discriminant Analysis.

UNIT-IV

Time series Model: ARMA, ARIMA, ARFIMA, Factor Analysis, Matrix Factorization, Measures of Forecast Accuracy.

Forecasting: Long-term and short-term forecasting, auto-regressive model.

Feature Selection: various techniques of feature selection, dimensionality reduction, feature ranking.

Reference Books

1. *Dursun Delen, Predictive Analytics, 1st edition, 2020.*
2. *Gareth James' Daniela Witten Trevor Hastie Robert Tibshirani. An Introduction to Statistical Learning with Applications in R.*
3. *Student's Handbook for Associate Analytics-Ill.*

COURSE OUTCOMES

On taking the **'**Predictive Analysis' course, the students will be able to:

CO1: Develop knowledge of the predictive modeling process.
CO2: Analyse requirements of complex data-driven problems and techniques and write algorithms to implement discrete-time systems.
CO3: Analyse and interpret data using an ethically responsible approach.
CO4: Critically review the use of and assist in the selection of industry standard analytics tools.
CO5: Appraise appropriate goals for a predictive analytics implementation in organizations.
CO6: Apply predictive analytics tools to analyse real-life business problems.

PRACTICAL

BC39044 PREDICTIVE ANALYSIS LAB CREDITS: 2

List of Experiments:

1. Write a code to implement the basics of predictive modelling process.
2. Implement all the possible statistical inference Techniques.
3. Implement all the regression types with a suitable dataset.
4. Implement Least Square Estimation mechanism for a particular dataset of your interest.
5. Apply the tools for analysing and segmenting the dataset. Observe its variations.
6. Implement Clustering techniques with a robust Algorithm.
7. Implement Classification techniques with a recently developed algorithm.
8. Write a code to test the performance measures of the above stated algorithms.
9. Write a code to implement the time series model.
10. Write a code to implement the feature selection techniques.

BC40041 EXPLAINABLE AI CREDITS: 3

UNIT-I

Introduction to eXplainable Artificial Intelligence (XAI), why it is important. XAI techniques, importance of interpretability, evaluation of interpretability, datasets used in case studies, black-box models, trust, transparency, accountability, interpretable machine learning and explanations, applications and examples, limitations of XAI.

UNIT-II

Interpretable models: linear regression, logistic regression, decision trees, decision rules, Generalized Linear Models (GLMs) and Generalized Additive Models (GAMs).

UNIT-III

Global model-agnostic methods: partial dependence plots, permutation feature importance, global surrogate models. Local model-agnostic methods: LIME, Anchors, SHAP, counterfactual explanations and Causal Inference. Interactive explanations and visualizations.

UNIT-IV

Transparency and privacy concerns in explainable models. Human-AI interaction and trust in complex decisions. Regulatory frameworks and guidelines for XAI development. Explainable reinforcement learning and decision-making systems. Societal implications and regulatory frameworks for explainable AI.

References Books

1. *Samek W., Montavon G., Vedaldi A., Hansen L. K., & Müller K. R., Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Springer, 2019.*
2. *Molnar C., Interpretable Machine Learning: A Guide for Making Black Box Models Explainable. Independently published, 2020.*
3. *Raschka S., &Mirjalili V., Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn and TensorFlow 2, 3rd Edition, Packt Publishing, 2019.*
4. *John Liu and Uday Kamath, Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning, Springer Nature Switzerland AG, 1stEdition, 2021.*
5. *Antonio Di Cecco and Leonida Gianfagna, Explainable AI with Python, Springer Nature Switzerland AG; 1stEdition, 2021.*

COURSE OUTCOMES

On taking the 'Explainable AI' course, the students will be able to:

CO1: Define and explain the need for Explainable AI (XAI) in various AI applications.
CO2: Categorize and apply different XAI methodologies based on model types and explainability goals.
CO3: Implement XAI techniques using practical tools and libraries.
CO4: Evaluate XAI techniques using practical tools and libraries.
CO5: Critically analyse the strengths and limitations of XAI explanations and their impact on human decision-making.
CO6: Discuss the ethical and societal implications of XAI development and deployment..

PRACTICAL

BC49041 EXPLAINABLE AI LAB CREDITS: 3

List of Experiments:

1. Python libraries for explainable AI. eXplainable AI toolkit for python PyTorch.
2. Interpretable models: Decision tree classifier for eXplainable AI using python, Linear models (linear and logistic regression) for eXplainable AI using python, Clustering for eXplainable AI using python.
3. Hands-on implementation of XAI libraries Local Interpretable Model-Agnostic Explanations (LIME) in python.
4. Hands-on implementation of XAI libraries SHapley Additive exPlanations (SHAP) in python. Counterfactual Explanations: What-If Analysis, hands-on implementation of explainable tools of Google What-IF Tool (WIT) with example.
5. Post-hoc explanations: surrogate models, sensitivity analysis with example implementation. Evaluating Model Transparency with Fairness Metrics of LIME and SHAP.

BC40043 EVOLUTIONARY ALGORITHM CREDITS: 3

UNIT-I

Background and fundamentals of EA, components of EA, binary representation of operators, mutation and recombination. Population management, parent, survivor and fitness selection.

UNIT-II

Genetic Algorithm and its applications, designing EA, Differential Evolution, Evolutionary Algorithms parameter tuning, parameter control, evaluation function.
Working with EA: performance measures, solving and testing real-world problem, Evolutionary programming.

UNIT-III

Multi Objective EA (MOEA): Theoretical and statistical analysis, Dominance and Pareto Optimality, various approaches to EA. Constraint handling: different approaches and applications.
Interactive EA: design, challenges and applications.

UNIT-IV

Basics of global and local optimum,constrained optimization, multi-modal optimization, hybridization of algorithms. Applications of Particle Swarm Optimization, Ant colony optimization, Meta-heuristic algorithms in solving engineering problems.

Reference Books

1. *Simon, Evolutionary Optimization Algorithms, Wiley.*
2. *Bäck T., Evolutionary Algorithms in Theory and Practice, Oxford University Press, Oxford, 1996.*
3. *Jansen, T., Analyzing Evolutionary Algorithms, Springer-Verlag, Berlin Heidelberg, 2013.*
4. *K. Deb, Multi-objective Optimization using Evolutionary Algorithms, Wiley, 2001.*

COURSE OUTCOMES

On taking the **'**Evolutionary Algorithm**'** course, the students will be able to:

CO1: Learn the main algorithms in the field, in particular genetic algorithms and evolutionary strategies.

CO2: Understand the underlying principles of evolutionary computation.

CO3: Learn the theoretical foundations of evolutionary computation.

CO4: Apply the algorithms to some application area and obtain some practical experience.

CO5: Learn about applications in science and industry.

CO6: Learn how to write a short scientific paper in evolutionary computation.

BC40042 REINFORCEMENT LEARNING CREDITS: 3

UNIT-I

Origin and history of Reinforcement Learning, RL task formulation (action space, state space, environment definition). Defining RL environments. State of the art applications. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

UNIT-II

Overview of Monte Carlo methods for model free RL, Formulation of MDP, First visit and every visit Monte Carlo, Monte Carlo control. Monte Carlo Methods for Model Free Prediction and Control.On policy and off policy learning, Importance sampling.

UNIT-III

Getting started with the function approximation methods, Revisiting risk minimization, Linear value function approximation, Eligibility trace for function approximation, Afterstates, Control with function approximation, Least squares. Non-linear value function approximation: Deep Q- networks: Double DQN, Dueling DQN, PER.

UNIT-IV

Getting started with policy gradient methods, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, actor-critic methods. Multi-agent reinforcement learning: introduction, fundamental properties and applications, Bellman's Optimality Equations. Basics of Exploration vs Exploitation: Upper Confidence Reinforcement Learning (UCRL).

Reference Book:

1. *Richard S. Sutton and Andrew G. Barto, Introduction to Reinforcement Learning, 2nd Edition, MIT Press. 2017.*

COURSE OUTCOMES

On taking the ‘Reinforcement Learning’ course the students will be able to:

CO1: Learn how to define RL tasks and the core principals behind the RL, including policies, value functions, deriving Bellman equations.
CO2: Implement in code common algorithms following code standards and libraries used in RL.
CO3: Understand and work with tabular methods to solve classical control problems.
CO4: Understand and work with approximate solutions.
CO5: Learn the policy gradient methods from vanilla to more complex cases.
CO6: Recognize current advanced techniques and applications in RL.

PRACTICAL

BC49042 REINFORCEMENT LEARNING LAB CREDITS: 2

List of Experiments:

1. Implementation of concepts of RFL using python:its relationship with all elements.
2. Implementation of Markov Decision Process.
3. Hands-on for Monte Carlo methods for model free prediction.
4. Write codes for evaluation of Least square methods in a particular domain.
5. Implementation of Policy gradients methods and control approximation.
6. Demonstration of RFL in areas like: health care, business, engineering, traffic control etc.
7. Review reports on Deep Q-networks and other non-linear value functions.
8. Implementation of DeepMind and AlphaGo using policy network.
9. Demonstration of RFL to balance pendulum with image observation.
10. Implementation of Naive REINFORCE Algorithm and Upper Confidence Reinforcement Learning (UCRL).

BC40044 DIGITAL SIGNAL PROCESSING CREDITS: 3

Unit – I

Classification of Signals, The Concept of Frequency in Continuous-Time and Discrete-Time Signals, Analog-to-Digital and Digital-to-Analog Conversion, Discrete-Time Signals, Discrete-Time Systems, Analysis of Discrete-Time Linear Time-Invariant Systems.

Unit-II

Frequency Analysis of Discrete-Time Signals, Properties of the Fourier Transform for Discrete-Time Signals, Z-Transform, Properties of the z-Transform, Rational z-Transforms. Linear Time-Invariant Systems as Frequency-Selective Filters.

Unit-III

Frequency Domain Sampling: The Discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods Based on the DFT, Frequency Analysis of Signals Using the DFT, Efficient Computation of the DFT: FFT Algorithms.

Unit-IV

Design of FIR Filters: Symmetric and Antisymmeiric FIR Filters, Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method, Design of Optimum Equiripple Linear-Phase FIR Filters, Design of FIR Differentiators, Comparison of Design Methods for Linear-Phase FIR Filters.
Design of IIR Filters From Analog Fiiters: IIR Filter Design by Approximation of Derivatives, IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation, Characteristics of Commonly Used Analog Filters.

Reference Books

1. *John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms, And Applications.*
2. *Alan V. Oppenheim, Ronald W. Schafer, Digital Signal Processing.*
3. *Thomas J. Cavicchi, Digital signal processing.*
4. *S. Salivahanan, A. Vallavaraj, C. Gnanapriya, Digital Signal Processing.*

COURSE OUTCOMES

On taking the **'**Digital Signal Processing' course the students will be able to:

CO1: To describe signals mathematically and understand how to perform mathematical operations on signals.
CO2: Describe the characteristics and transformations of discrete time signals mathematically.
CO3: Apply techniques in time and transform domains to the analysis and design of discrete-time systems.
CO4: Estimate the spectra of deterministic and stochastic signals, and appropriately interpret the information contained therein.

CO5: Demonstrate the ability to manipulate signals using analytical techniques and write algorithms to implement discrete-time systems.
CO6: Design digital filters and apply them to real-world applications of signal and information processing.

PRACTICAL

BC49044 DIGITAL SIGNAL PROCESSING LAB CREDITS: 2

List of Experiments:

1. Discrete- time signal generation (Square wave, Sine wave, & Impulse signal) using Matlab.
2. Impulse and Step response of an LTI system using Matlab.
3. Representation of continuous time signal and its FT, sampled signal & its DFT using Matlab.
4. Linear Convolution using DFT in Matlab.
5. Generate a Discrete- time signal and observe its spectrum for different down sampling factors and effects of different sampling rates of DFT using Matlab.
6. Implementation of FFT using Matlab.
7. To design a Digital IIR filter, using Bilinear transformation method using Matlab.
8. To design a Digital IIR filter, using Impulse invariance method using Matlab.
9. To design a Digital FIR filter, using Windowing method using Matlab.
10. Digital filter Structures using Matlab.

BC40046 SECURITY ASPECTS OF ML CREDITS: 2

UNIT-I

Machine learning overview: Types of learning, supervised and unsupervised learning. Introduction to security and privacy concerns in machine learning, overview of security threats of machine learning (adversarial attack, data poisoning, and evasion attack), applications of machine learning in cyber security domain.

UNIT-II

Adversarial attacks in machine learning, defence against adversarial attacks. Side channel attack and mitigation methods in machine learning. Security evaluation metrics for machine learning models.

UNIT-III

Machine learning is used as tool to enhance security: malware detection, penetration testing, fraud detection. Machine learning models for outlier detection. Machine learning applied to intrusion detection, online learning methods for detecting malicious executables.

UNIT-IV

Privacy issues in machine learning (data leakage, membership inference attacks), Techniques for privacy preserving in ML (differential privacy, federated learning), ensuring data and model integrity (model water marking, temper detection), ethical challenges in ML (bias, fairness, transparency), regulatory framework and guidelines.

Reference Books

1. *Tom Mitchell, Machine Learning, McGraw Hill, 1997.*
2. *Clarence Chio and David Freeman, Machine Learning and Security: Protecting Systems with Data and Algorithms, O'Reilly Media, 1st Edition (13 March 2018).*
3. *Gupta, Brij B., and Quan Z. Sheng, eds., Machine learning for computer and cyber security: principle, algorithms, and practice, CRC Press, 2019.*
4. *Tsai, Jeffrey JP, and S. Yu Philip, eds., Machine learning in cyber trust: security, privacy, and reliability, Springer Science & Business Media, 2009.*

COURSE OUTCOMES

On taking the 'Security aspects of ML' course the students will be able to:

CO1: Understand the Security Challenges in Machine Learning

CO2: Analyze and Mitigate Adversarial Threats

CO3: Evaluate ML Security Using Appropriate Metrics

CO4: Apply ML for Cyber security Solutions

CO5: Implement Privacy-Preserving Techniques in ML

CO6: Address Ethical and Regulatory Aspects of ML Security

DISCIPLINE-SPECIFIC ELECTIVES (DSE)

DATA SCIENCE

DATA SCIENCE

SL. NO.	Semester	Subject Code	Professional Elective
1	III	BC20031	Basics of Data Analytics using Spreadsheet
2	1V	BC20032	Data Visualization
3	V	BC30031	Introduction to Data Science
4	V	BC30033	Time Series Analysis
5	V	BC30035	Machine Learning
6	VI	BC30032	Big Data Analytics
7	VI	BC30034	Exploratory Data Analysis
8	VII	BC40031	Business Intelligence & Analytics
9	VII	BC40033	Data Mining & Warehousing
10	VIII	BC40032	Advanced Data Visualization
11	VIII	BC40034	Cloud Computing Data Analytics
12	VIII	BC40036	Data Security & Privacy

DATA SCIENCE (LAB)

Sl. No	Semester	Course Code	Professional Elective
1	III	BC29031	Basics of Data Analytics using Spreadsheet
2	1V	BC29032	Data Visualization
3	V	BC39031	Introduction to Data Science
4	V	BC39033	Time Series Analysis
5	V	BC39035	Machine Learning
6	VI	BC39032	Big Data Analytics
7	VI	BC39034	Exploratory Data Analysis
8	VII	BC49031	Business Intelligence & Analytics
9	VIII	BC49032	Advanced Data Visualization
10	VIII	BC49034	Cloud Computing Data Analytics

BC20031 BASICS OF DATA ANALYTICS USING SPREADSHEET CREDITS: 3

UNIT- I

Introduction of a spreadsheet: What is spreadsheet**,** Microsoft Excel, Google Sheet, LibreOffice. User interface, Ribbon, Quick Access toolbar.
Introduction to Excel: Uses of Excel, Excel software, Spreadsheet window pane, Title Bar,Menu Bar, Standard Toolbar, Formatting Toolbar, Ribbon, File Tab and Backstage View,Formula Bar, Workbook Window, Status Bar, Task Pane, Workbooks and Worksheets. Working with multiple sheets, inserting and deleting sheets, renaming sheets.
Columns & Rows: Selecting Columns & Rows, Changing Column Width & Row Height, Autofitting Columns &Rows, Hiding/Unhiding Columns & Rows, Inserting & Deleting Columns & Rows, Cell, Address of a cell, merging cells, Components of a cell – Format, value, formula, Use of paste and paste special**;** Functionality Using RangesUsing Ranges, Selecting Ranges, Entering Information into a Range, Using Autofill.

UNIT- II

Excel Functions: Basic Formulas & Functions: Sum, Average, Count, Max, Min, Proper, Upper, Lower, Trim, Round, Using AutoSum, Combining Formulas Between Multiple Worksheets.
Logical Functions: IF, AND, OR, Nested IF, NOT, VLOOKUP and HLOOKUP functions in Excel.

UNIT - III

Filtering: Filtering, Grouping and Sorting**.**
Data Visualization: Introduction to charts, various type of charts (Bar, Pie, Column and line); Understanding and constructing Histograms and Scatterplots; 3-D Shape (Bar, Cylinder, Cone, Pyramid); Chart elements (Title, Subtitle, X-axis, Y-axis, Z-axis, Display grids, Legends, Display data series); Creating a Chat: Selecting data series, select chart type, select chart components – label, Background, Axes, format and design.

UNIT- IV

Data Analysis: Importing & Entering Data: Importing files, Entering and arranging data.
Creating Pivot Tables: Creating pivot table, Pivot table summarization, Frequency summarization, pivot chart.
Basic data analysis: Descriptive statistics, Correlation, Regression & its interpretation.
What-If Analysis: Data Tables. Goal Seek. Quadratic Equation.

Reference Books

1. *Manisha Nigam. Data Analysis with Excel. BPBPublications, 2020.*
2. *Wayne L. Winston. Microsoft Excel Data Analysis and Business Modeling (Office 2021 and Microsoft 365), 7th Edition. PHI Learning Pvt. Ltd.,2024.*
3. *Alex Holloway. Data Analysis in Microsoft Excel: Deliver Awesome Analytics in 3 Easy Steps Using VLOOKUPs, Pivot Tables, Charts and More. Alex Holloway, 2023.*
4. *B. G. Kore. Statistical Data Analysis using MS-Excel. Nirali Prakashan, 2017.*

COURSE OUTCOMES

On taking the **'**Basics of Data Analytics using Spreadsheet'course the students will be able to:

CO1: Understand the principles of data analytics and fundamental Excel operations for essential data manipulation.

CO2: Explore foundational mathematical and statistical analysis techniques in Excel for informed decision making

CO3: Use of data analysis techniques such as sorting, filtering, pivot tables, charts and graphs, and advanced statistical analysis.

CO4: Familiarize with Excel for comprehensive data visualization and modelling for insight generation.

CO5: Ability to identify patterns and trends in data, and to draw insights and conclusions from that data.

BC29031 BASICS OF DATA ANALYTICS USING SPREADSHEET LAB CREDITS: 2

List of Experiments:

1. Introduction to Microsoft Excel Spreadsheet, functions and features of Microsoft Excel 2007, Getting started with excel: Opening a new workbook, worksheet, Functions available in MS excel: Home, Insert, page layout, formulas, Data, review, view, add-inns. Customizing the Quick Access Toolbar, working with Data: Entering, Editing, Copy, Cut, Paste, Paste Special.
2. Manipulating Data, using Data Names and Ranges, Filters and Sort and Validation Lists, Data from External Sources, Use of Basic Formulas and Functions, Data Analysis Using Charts and Graphs.

3. Conditional Formatting: IF, COUNTIF, SUMIF, AVERAGEIF CONCAT, CONCATENATE. Use of Basic Mathematical and Statistical Formulas in MS Excel. Simulations of simple probability problems (coin toss, Dice roll) and simple arithmetic problems simulations including finding roots of a quadratic equation, Solving system of equations,
4. INDEX, MATCH, UNIQUE, IFS, COUNTIFS, SUMIFS, AVERAGEIFS, VLOOKUP, HLOOKUP, XLOOKUP, COUNT, COUNTA.
5. Array formulas, FILTER, FRQUENCY, SEQUENCE, RANDARRAY, IFERROR
6. PIVOT TABLES, WHAT-IF ANALYSIS, DATA VALIDATION, SUBTOTALS WITH RANGES
7. Measure of central tendency: Mean, median, mode, Measure of dispersion: variance, standard deviation, Coefficient of variation.
8. Correlation, and regression
9. t-test , F-test, ANOVA one way classification
10. Time series: forecasting Method of least squares
11. Machine learning: Classification, Predictions using benchmark datasets.
12. Moving average method, Inference and discussion of results.

BC20032 DATA VISUALIZATION CREDITS: 3

UNIT- I

Introduction to Data Visualization: Understand the purpose and significance of data visualization, Basic plotting: Line Plot, customizing line colors, markers and width. Bar Plot: Vertical and horizontal bar plots, plotting categorical data, grouped and comparative bar charts, adding value labels, gridlines and legends, stacked Bar Charts. Pie Charts: Plotting proportion data with pie charts, customizing labels, colors, and slices. Scatter plot: plotting two numerical variables, identifying trends, clusters, and outliers. Histogram: visualizing data distributions and frequency, adjusting bin size and range.

UNIT- II

Matplotlib basics: Introduction to Matplotlib and its architecture, creating basic plots using plt.plot(), Subplots: plotting multiple charts in a single figure, Seaborn library, seaborn styles, plotly library, plotting line, bar, pie, scatter and 3D plots.
Applied Visualizations: Box Plot, display distribution, spread, and outliers of numerical data. Density plot, visualize the probability density of continuous data, Area Chart, stacked and unstacked area charts.

UNIT- III

Heat map: Correlation matrices, annotated heatmaps, color gradients and normalization. Tree Map, Graph Networks.

Interactive Visualizations and Animations: Dynamic charts - Dynamic maps - Animation types - 2D, 3D, Motion Animation - Animation Principles - Altair Package - Statistical Visualizations.

UNIT- IV

Principles of Information Visualization: Visual Perception and Cognition - Gestalt's Principles -Tufte's Principles of Information Visualization, Dashboard Design,dashboard layouts: supporting clarity, focus, and decision-making,Principles of dashboard structure: modularity, flow, grouping, white space, guiding viewer attention, reveal and interaction,Task-driven chart design: affordances for comparison, causality, multivariate display.

Reference Books

5. *Sringeswara, Sharada; Tiwari, Purvi; and U. Dinesh Kumar. Data Visualization: Storytelling Using Data. Wiley India, 15 July 2022.*
6. *Knaflic, Cole Nussbaumer. Storytelling with Data: A Data Visualization Guide for Business Professionals. Wiley, 2015.*
7. *Joshi, Prachi Manoj; Mahalle, Parikshit Narendra. Data Storytelling and Visualization with Tableau: A Hands-on Approach. CRC Press, 2023.*
8. *Ranganathan, Kavitha. Impactful Data Visualization: Hide and Seek with Graphs. Penguin India, 2020.*
9. *Roy, Shirshendu. Data Visualization Using Power BI, Orange, and Excel. Notion Press, 2023.*

COURSE OUTCOMES

On taking the **'**Data Visualization'course the students will be able to:

CO1: Explain the purpose and principles of effective data visualization.

CO2: Create and customize basic plots libraries like Matplotlib, Seaborn, and Plotly

CO3: Apply advanced visualization techniques to explore and communicate complex datasets.

CO4: Develop interactive and animated visualizations using Plotly and Altair.

CO5: Analyze multi-chart dashboards, visual design principles to support data-driven decision making

CO6: Evaluate and select appropriate visualization methods based on data characteristics for identifying trends, making comparisons, and visualizing multivariate relationships.

BC29031 DATA VISUALIZATION LAB CREDITS: 2

List of Experiments:

1. Create and customize a line plot using Matplotlib to display time-series data. Modify line color, width, and marker styles.
2. Design a grouped bar chart showing categorical data. Include legends, value labels, and gridlines.
3. Plot a pie chart to represent market share distribution. Customize the colors, label, and explode specific slices for emphasis.
4. Generate a scatter plot for two numerical variables and identify any clusters or outliers in the dataset.
5. Create a histogram to visualize the distribution of exam scores. Adjust the number of bins and experiment with different ranges.
6. Use subplots in Matplotlib to display four different charts (line, bar, pie, scatter) in one figure with appropriate layout and titles.
7. Compare Matplotlib and Seaborn by plotting the same data using both libraries. Apply different Seaborn styles.
8. Create a box plot and a density plot using Seaborn to visualize the spread and distribution of a numerical dataset.
9. Visualize a correlation matrix using a heatmap with annotations and color gradients. Explain the insights you gain from the plot.
10. Build an interactive 3D scatter plot or animated chart using Plotly or Altair. Include hover effects or motion transitions.
11. Design a simple dashboard layout using subplots or a dashboard framework. Organize different chart types to support a business decision.

BC30031 INTRODUCTION TO DATA SCIENCE CREDITS: 3

UNIT –I

Introduction: Introduction to data science. Different terminologies like Big data. Roles of data scientist in Academia and Industry. Data science and Data analytic. Data science process. Statistical data analysis.

Exploratory Data Analysis: Data collection and pre-processing. Steps in data pre-processing. Handling outliers and missing values.

UNIT –II

Data Modelling Algorithms: Machine Learning Algorithms, Supervised: Linear Regression, Classification: k-Nearest Neighbors (k-NN), Naive Bayes and decision trees, Introduction to Association rule Mining.

UNIT – III

Unsupervised learning Algorithms Clustering: Different data clustering methods, Hierarchical, Partition based clustering: k-means, k-mediods, Density based and grid-based clustering.

Dimensionality Reduction: Correlation between variables, Multicollinearity, Feature subset selection.

UNIT – IV

Feature Extraction method: Principal Component Analysis. Linear Discriminant Analysis.

Data Visualization: Basic principles, ideas and tools for data visualization. Examples of data visualization projects. Data science project and case study.

Data Science and Ethical Issues: Data science and risk. Detecting suspicious activity. Privacy, security and ethics.

Reference Books

1. *Reema Thareja, Data Science & Machine Learning With R, MGH Publications.*
2. *Rachel Schutt and Cathy O'Neil, Doing Data Science - Straight from the Frontline, O'Reilly 2013.*
3. *Sanjiv Jaggia, Raj Kamal, Reema Thareja, Data Analytics, MGH Publications, 2025.*
4. *Joel Grus, Data Science from Scratch, O'Reilly, 2015.*
5. *Murtaza Haider, Getting Started with Data Science: Making Sense of Data with Analytics, IBM Press, 2016.*
6. *Michael Freeman, Programming Skills For Data Science, Pearson.*
7. *Davy Cielen, Arno D.B. Meysman, Mohamed Ali, Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Wiley.*

COURSE OUTCOMES

On taking the **'**Introduction to Data Science'course the students will be able to:

CO1: Have a clear idea about the data science and its ecosystem.

CO2: Apply the tools and techniques in data acquisition, cleaning, and preprocessing

CO3: Use statistical tool and statistical methods that can be applied on big data.

CO4: Have a clear idea about how to represent the unstructured data in the data bases.

CO5: Learn fundamental data analysis techniques, including statistical modeling and machine learning

CO6: Apply the knowledge for data describing and visualization using tools.

PRACTICAL

BC39031 INTRODUCTION TO DATA ANALYTICSLAB CREDITS: 2

List of Experiments:

1. Implementation of statistical analysis of data.
2. Implementation of data preprocessing (Handling of null values).
3. Implementation of data preprocessing (Handling of outliers using Boxplot, z-score).
4. Implementation of normalization of data (MAX-MIN, Z-Score).
5. Implementation of KNN algorithm for classification.
6. Implementation of Decision tree classifier.
7. Implementation of Support vector machine (SVM).
8. Implementation of Logistic Regression.
9. Implementation of Multiple linear Regression.
10. Implementation of Regression using KNN.
11. Implementation of Regression using Decision Tree.
12. Implementation of Regression using Support Vector Machine.
13. Implementation of feature subset selection, PCA.

BC30033 TIME SERIES ANALYSIS CREDITS: 3

UNIT-I

Introduction to Time Series Analysis: What is a time series?Characteristics of time series data,Sources of time series data.Applications of time series analysis in different fields.
Exploratory Data Analysis: Time series plots and their interpretation, Autocorrelation and partial autocorrelation functions (ACF and PACF).

UNIT-II

Smoothing Methods: Moving averages (simple, weighted), Exponential smoothing (simple, double, triple), Choosing appropriate smoothing parameters.

UNIT-III

ARIMA Models: Autoregressive (AR) models, Moving Average (MA) models, Autoregressive Integrated Moving Average (ARIMA) models, Model identification, estimation, and diagnostics.

UNIT-IV

Forecasting and Evaluation: Point forecasting and interval forecasting, Accuracy measures (MAE, MSE, RMSE, MAPE), Model selection and evaluation, Forecasting with seasonality, Applications in specific domains (e.g., finance, economics, environmental science).

Reference Books

1. *Box G.E.P., Jenkins G.M. and Reinsel G.C., Time Series Analysis, Forecasting and Control, Englewood Cliffs, NJ: Prentice-Hall, 1994.*
2. *Jason Brownle, Introduction to Time Series Forecasting with Python, Machine Learning Master, 2017.*
3. *Bruce Bowerman, Richard O'Connell, Anne Koehler,Forecasting, Time Series, and Regression, Cengage, 2004.*
4. *Rob J Hyndman and George Athanasopoulos,Introduction to Time Series and Forecasting.*
5. *Nielsen, Aileen., Practical time series analysis: Prediction with statistics and machine learning, O'Reilly Media,2019.*

COURSE OUTCOMES

On taking the ‘Time Series Analysis’course the students will be able to:

CO1: Have a clear idea about the sources of time series data and their interpretations.
CO2: Apply the techniques for preprocessing of time series data.
CO3: Use statistical tool and statistical methods that can be applied on time series data.
CO4: Have a clear idea about identifying appropriate model and estimating its cost effectiveness.
CO5: Learn fundamental of forecasting and different measures for model selection.
CO6: Apply the knowledge for time series forecasting forsolving reallife problems.

PRACTICAL

BC39033 TIME SERIES ANALYSIS LAB CREDITS: 2

List of Experiments:

1. Obtain a real-world time series dataset, visualize it to identify patterns, calculate descriptive statistics like mean, variance, and autocorrelation, and decompose it into trend, seasonal, and residual components.
2. Forecast future values of a stationary time series, fit an AR model, determine its optimal order using criteria like AIC or BIC, and evaluate the model's performance with metrics such as RMSE or MAE.
3. Fit an MA model to a stationary time series, determine the optimal order of the MA model using techniques like AIC, BIC, forecast future values using the fitted MA model and evaluate the model's performance.
4. Fit an ARMA model to a stationary time series, determine the optimal order of the ARMA model using techniques like AIC, BIC, forecast future values using the fitted ARMA model and evaluate the model's performance using appropriate metrics.
5. A. Identify and address non-stationarity in the time series using differencing, fit an ARIMA model to the differenced series, forecast future values using the fitted ARIMA model, invert the differencing to obtain forecasts for the original time series and valuate the model's performance using appropriate metrics.
6. A. Implement simple exponential smoothing, Holt's linear trend method, and Holt-Winters seasonalmethod, compare the performance of different exponential smoothing methods, forecast future values using the chosen exponential smoothing method, and Evaluate the model's performance using appropriate metrics.

7. Prepare the time series data for machine learning (e.g., create lagged features), train and evaluate different machine learning models, compare the performance of machine learning models with traditional time series models.
8. Use the fitted model to forecast future values of the time series, split the data into training and testing sets to evaluate the model's forecasting accuracy, calculate appropriate forecast error metrics (e.g., RMSE, MAE, MAPE) and compare the forecasting performance of different ARIMA models.

BC30035 MACHINE LEARNING CREDITS: 3

UNIT–I

Overview of learning, Supervised Learning: K-nearest neighbour, Multiple linear regression, Shrinkage methods (Ridge regression, Lasso regression),Classification: Logistic regression.

UNIT –II

Bias, Variance, and model complexity, Bias-variance trade off, Bayesian approach and BIC, Cross-validation, Bootstrap methods, Performance of Classification algorithms (Confusion matrix, Precision, Recall and ROC Curve).

UNIT – III

Generative model for discrete data (Bayesian concept learning, Naive Bayes classifier), SVM for classification, Reproducing Kernels, SVM for regression, Regression and classification trees, Random Forest.

UNIT – IV

Clustering: Heirarchical, K-means, DBSCAN, STING, and CLIQUE. Introduction to dimensionality reduction, Feature Subset Selection, SFS, SFFS, SBFS, Feature Extraction (Principal Component Analysis (PCA), Independent Component Analysis (IDA).

ReferenceBooks

1. *T.Hastie,R.TibshiraniandJ.Friedman,The ElementsofStatisticalLearning:DataMining,InferenceandPrediction,2nd Edition,SpringerVerlag,2009.*

2. *S.Haykin,NeuralNetworks:ACoMprehensiveFoundation,2nd Edition,PearsonEducation,1999.*
3. *C.Bishop,PatternRecognitionandMachineLearning,1st Edition,Springer,2007.*
4. *T.Mitchel,MachineLearning,1st Edition,McGraw-HillEducation,1997.*
5. *G.James,D.Witten,T.Hastie, and R. Tibshirani, An Introduction to Statistical Learning with Applications, 7th Edition,Springer,2013.*
6. *K.P.Murphy,Machinelearning:AProbabilisticPerspective,4th Edition,MITPress,2012.*

COURSE OUTCOMES

On taking the **'**Machine Learning' course, the students will be able to:
CO1: Have a clear idea about Machine Learning fundamentals and its application areas.
CO2: Apply the concepts of supervised machine learning and its functions.
CO3: Determine the most appropriate model in a specific context using model selection techniques.
CO4: Perform classification using Bayes classifier, SVM, Decision Tree, and Random Forest
CO5: Develop unsupervised learning models using different clustering algorithms.
CO6: Reduce dimensionality using features election and apply machine learning for solvingreal-life problems.

PRACTICAL

BC39035 MACHINE LEARNING LAB CREDITS: 2

List of Experiments:

1. Write a python program to read and preprocess various real-life data (CSV files).
2. Write a python program to implement multiple linear regression and compute the performance using MSE, R-squared value.
3. Write a python program to ridge regression and compute the performance using MSE, R-squared value.
4. Write a python program to LASSO regression and compute the performance using MSE, R-squared value.
5. Write a python program to implement Logistic Regression Classifier and compute Confusion Matrix, Accuracy, Precision, Recall, and F1-Score.
6. Write a python program to implement Support vector Machine Classifier with various kernels and compute Confusion Matrix, Accuracy, Precision, Recall, and F1-Score.

7. Write a python program to implement Support vector Machine Regression with various kernels and compute the performance using MSE, R-squared value.
8. Write a python program to implement Random Forest Classifier and compute Confusion Matrix, Accuracy, Precision, Recall, and F1-Score.
9. Write a python program to implement Random Forest Regression with various kernels and compute the performance using MSE, R-squared value.
10. Write a python program to implement K-means clustering and compute Silhouette coefficient.
11. Write a python program to implement DBSCAN clustering and compute Silhouette coefficient.
12. Write a python program to implement SFS,SFFS with SVM classifier, compute the performance and Compare.
13. Write a python program to implement PCA, LDA with SVM classifier, compute the performance and Compare.

BC30032 BIG DATA ANALYTICS CREDITS: 3

UNIT – I

Introduction to Big Data, Data Management for Big Data, Data Exploration and Reproducibility, Data Quality; Introduction to Map Reduce, Map Reduce algorithm, patterns & relations, Parallel databases vs. Map Reduce, Storage solutions.

UNIT-II

Big Data Algorithms-I: Nearest Neighbor Search, Shingling of Documents, Similarity Preserving Summaries of Sets, Locality Sensitive Hashing for Documents, Distance Measures, Theory of Locality Sensitive Functions.

UNIT-III

Big Data Algorithms-II: Streaming Data Models, Sampling Data in a Stream, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in Window, Page Rank, Efficient Computation of Page Rank. Clustering Techniques - BFR Algorithm

UNIT-IV

Big Data Algorithms-III: Recommendation Systems and Collaborative Filtering. Introductions to Spark, Hadoop, Hive, Pig-Latin, Large Scale Visualization

Reference Books

1. *J.Leskovec,A.Rajaraman,andJ.D.Ullman,MiningofMassiveDatasets,2nd Edition,CambridgeUniversityPress,2014.*
2. *J.Bell,MachineLearningfor BigData:Hands-OnforDevelopersandTechnicalProfessionals,Wiley,2014.*
3. *J.Han,M.Kamber,andJ.Pei,DataMiningConceptsandTechniques,3rd Edition,Morgan KaufmanPublications,2011.*
4. *T.M.Mitchell,MachineLearning,1st Edition,McGraw-HillEducation,2017.*

COURSE OUTCOMES

On taking the **'**Big Data Analytics'course the students will be able to:

CO1: Have a clear idea about big data concepts and its applications.
CO2: Solve different problems in Map Reduce frame work.
CO3: Apply different tools and techniques used for finding similar items.
CO4: Demonstrateapplicationofalgorithmsforanalysisofstreamingdataandlinkanalysis.
CO5: Compare different clustering techniques to apply them for large dataset.
CO6: Apply different techniques for recommendation systems & collaborative filtering. Explore the concepts of Hadoop, Map Reduce, and Spark and apply them to implement big data algorithms.

PRACTICAL

BC39032 BIG DATA ANALYTICS LAB CREDITS: 2

List of Experiments:

1. Introduction to HADOOP Framework.
2. Execution of various HADOOP Commands.
3. Introduction of MAP REDUCE Environment.
4. Implementation of WORD COUNT problem in MAP REDUCE.
5. Implementation of Matrix Vector Multiplication using MAP REDUCE.
6. Implementation of Matrix Matrix Multiplication using MAP REDUCE.
7. Introduction to Apache Spark Environment.
8. Implementation of spark commands.
9. Implementation Stream processing using Spark.
10. Introduction to HIVE for Bigdata Analysis.

BC30034 EXPLORATORY DATA ANALYSIS CREDITS: 3

UNIT-I

Introduction to Exploratory Data Analysis (EDA): Definition and objectives of EDA, Descriptive and inferential statistics, Steps in EDA, Understanding and handling missing data, Identifying and handling duplicates, outlier detection and treatment, categorical data processing.

UNIT-II

Statistical Analysis in EDA: Descriptive Statistics usingmean, median, mode, variance, standard deviation, skewness, kurtosis. Inferential Statistics with overview of hypothesis testing: null vs. alternative hypothesis, p-value, confidence intervals.

UNIT-III

Advanced EDA Techniques: Creating new features using mathematical transformations, Normalization and standardization of features, Handling skewed data, Introduction to PCA (Principal Component Analysis) and LDA (Linear Discriminant Analysis).

UNIT-IV

EDA Best Practice: Case studies of real-world EDA in domains such as healthcare and cybersecurity.

Reference Books

1. *John W. Tukey, Exploratory Data Analysis.*
2. *Cleveland, Visualizing Data.*
3. *Allen B. Downey,Think Stats: Exploratory Data Analysis, 2014.*
4. *Ronald K. Pearson,Exploratory Data Analysis Using R, CRC Press.*
5. *Unwin Antony,Graphical Data Analysis with R.*
6. *S. H. C. DuToit, A. G. W. Steyn, R. H. Stumpf,Graphical Exploratory Data Analysis.*

COURSE OUTCOMES

On taking the **'**Exploratory Data Analysis'course the students will be able to:

CO1: Understand the principles and importance of exploratory data analysis.
CO2: Identify and handle missing, outlier, and categorical data during the EDA process.

CO3: Understand various visualization techniques to summarize data distributions and relationships.

CO4: Conduct basic statistical analysis to guide further analysis or modelling for EDA tasks.

CO5: Perform complex EDA techniques on open-source datasets.

CO6: Develop effective storytelling techniques through data visualization to communicate findings.

PRACTICAL

BC39034 EXPLORATORY DATA ANALYSIS LAB CREDITS: 2

List of Experiments:

1. **Libraries for EDA:** Introduction to essential Python libraries: Pandas, NumPy, Matplotlib, Seaborn, Plotly. Hands-on exercises with a small dataset (e.g., Titanic dataset) to load and explore basic structures.
2. **Understanding and Handling Missing Data:** Identifying missing values and understanding the causes of missing data. Techniques for dealing with missing data. Advanced imputation methods: using mean, median, mode, or regression-based imputation.
3. **Identifying and Handling Duplicates:**How to find and remove duplicate records in the dataset.
4. **Outliers Detection and Treatment:** Techniques for identifying outliers: box plots, z-scores, IQR (Interquartile Range). Handling outliers: transformation, capping, or removal.
5. **Handling categorical data:** encoding methods (e.g., one-hot encoding, label encoding). Analyzing the distribution of categorical variables.
6. **Univariate Visualization:** Visualizing single variables using histograms, bar charts, and density plots. Interpreting distributions: skewness, kurtosis, normality.
7. **Bivariate Visualization:** Scatter plots and correlation matrices to explore relationships between two continuous variables. Pairplots to examine relationships in multi-dimensional data.
8. **Multivariate Visualization:** Visualizing relationships between more than two variables: pair plots, 3D plots. Techniques for visualizing high-dimensional data: Using color, size, and shape to represent additional dimensions.

BC40031 BUSINESS INTELLIGENCE AND ANALYTICS CREDITS: 3

UNIT-I

Introduction to Business Intelligence and Analytics: Defining BI: Data collection, reporting, querying, and decision support. BI vs. Business Analytics (BA): Differences and overlaps. BI lifecycle: Data extraction, transformation, reporting, and visualization.

UNIT-II

Data Preparation and Cleaning for BI: Handling missing data and outliers in BI systems. Normalization, scaling, and encoding categorical variables. Grouping and summarizing data. Calculating KPIs and performance metrics.

UNIT-III

Reporting and Business Analytics Techniques: Key components of a business dashboard: KPIs, metrics, filters, and charts. Descriptive analytics in business, Basic predictive techniques used in BI: regression analysis, time series forecasting. Predicting future business trends, sales, and customer behavior.

UNIT-IV

Prescriptive Analytics and Real-World Applications: Introduction to prescriptive analytics, Techniques for prescriptive analytics, Case studies of BI and analytics in various industries (e.g., healthcare). Data privacy, security, and ethical use of business data.

Reference Books

1. *Alexandre Blauth, Business Intelligence and Analytics Trends, 2013.*
2. *Anil K. Maheshwari, Business Intelligence and Data Mining, 2015.*
3. *Efraim Turban, Ramesh Sharda, and Dursun Delen, Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 2017.*
4. *Michael Minelli, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, 2013.*
5. *Daniel J. Power, Decision Support, Analytics, and Business Intelligence, 2017.*

COURSE OUTCOMES

On taking the ‘Business Intelligence and Analytics’course the students will be able to:

CO1: Understand the role of Business Intelligence and Analytics in decision-making.
CO2: Learn how to use BI tools for data manipulation and visualization.

CO3: Apply data mining techniques for trend analysis and forecasting.

CO4: Gain proficiency in building reports and dashboards for business stakeholders.

CO5: Understand key performance indicators (KPIs) and metrics for measuring business performance.

CO6: Learn how to perform descriptive, diagnostic, predictive, and prescriptive analytics.

PRACTICAL

BC49031 BUSINESS INTELLIGENCE AND ANALYTICS LAB CREDITS: 3

List of Experiments:

1. **Data Collection and Integration-** Data extraction and transformation: ETL (Extract, Transform, Load) process using data connectors in BI tools (Power BI or Tableau).
2. **Data Cleaning and Transformation-** Handling missing data and outliers in BI systems. Normalization, scaling, and encoding categorical variables. Creating calculated columns and custom metrics in BI tools.
3. **Data Visualization for Business Intelligence-** Types of charts and graphs: bar charts, line charts, scatter plots, pie charts, etc. Heatmaps, tree maps, and geographic visualizations (GIS).
4. **Advanced Visualization Techniques-** Creating dashboards for real-time business monitoring. Interactive visualizations: drill-downs, filters, and slicers.
5. **Hands-on Visualization with BI Tools-** Using Tableau and Power BI to create interactive dashboards. Importing data into BI tools, selecting appropriate visualizations, and formatting reports. Customizing dashboards for different business needs (e.g., sales, marketing, finance).

BC40033 DATA MINING AND WAREHOUSING CREDITS: 3

UNIT-I

Knowledge Discovery Process, Data Mining Techniques, Issues, applications, Data Objects and attribute types, Statistical description of data. Data Preprocessing: Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.

UNIT-II

Data Warehousing and Online Analytical Processing: Basic Concepts, Data Warehousing Architecture, Multidimensional Data Model, Data Warehouse, Schemas for Decision Support, Building a Data Warehouse, Concept Hierarchies, Characteristics of OLAP Systems, Typical OLAP Operations, OLAP and OLTP.

UNIT-III

Frequent Pattern Analysis: Mining Frequent Patterns, Market Basket Analysis: The Apriori Algorithm: Finding Frequent Item sets Using Candidate Generation, Generating Association Rules from Frequent Item sets, Improving the Efficiently of Apriori, Mining Frequent Item sets without Candidate Generation, Measuring the Quality of Rules, Association Mining to Correlation Analysis.

UNIT-IV

Clustering: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Partitioning.
Methods: K-Means, K-medoids, Hierarchical methods: Agglomerative and Divisive Hierarchical Clustering, Density, Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High, Dimensional Data.

Reference Books

1. *J. Han and M. Kamber, Data Mining: Concepts and Techniques, 4th Edition, Morgan Kaufman, 2015.*
2. *M. H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education, 2006.*
3. *I. H. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques,Morgan Kaufmann, 2000.*
4. *T.Mitchel,MachineLearning,1st Edition,McGraw-HillEducation,1997.*
5. *D. Hand, H. Mannila and P. Smyth, Principles of Data Mining, The MIT Press, 2001.*

COURSE OUTCOMES

On taking the **'**Data mining and warehousing'course the students will be able to:

CO1: Understand the basic principles, concepts, applications of datamining and data mining tools.

CO2: Learn different methods used for data pre-processing.

CO3: Know the kinds of patterns discovered by association rule miningalgorithms

CO4: Understand various classification and prediction algorithms

CO5: Develop clustering methods for unsupervised data mining.

CO6: Apply data mining techniques on web, spatial, temporal,text and multimedia data mining.

BC40032 ADVANCED DATA VISUALIZATION CREDITS: 3

UNIT-I

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

UNIT-II

Data visualization tools. Mapping -Time Series - Connections and Correlations – Scatterplot Maps - Trees, Hierarchies, and Recursion - Networks and Graphs Mapping - Time series - Connections and correlations – Indicator-Area Chart-Pivot table Scatter charts, Scatter maps - Tree maps, Space filling and non-space filling methods Hierarchies and Recursion - Networks and Graphs-Displaying Arbitrary Graphs-node link graph-Matrix representation for graphs- Info graphics.

UNIT-III

Acquiring data, - Where to Find Data, Tools for Acquiring Data from the Internet, Locating Files for Use with Processing, Loading Text Data, Dealing with Files and Folders, Listing Files in a Folder,Asynchronous Image Downloads, Web Techniques, Parsing data - Levels of Effort, Tools for Gathering Clues, Text Markup Languages, Regular Expressions.

UNIT-IV

Grammars and BNF Notation, Compressed Data, Vectors and Geometry, Binary Data Formats, Advanced Detective Work. Drawing with data – Scales – Axes – Updates, Transition and Motion – Interactivity - Layouts – Geomapping – Exporting, Framework – D3.js, Tableau Dashboards.

Reference Books

1. *Robert Spence, Information Visualization An Introduction, 3rd Edition, PearsonEducation, 2014.*
2. *Colin Ware, Information Visualization Perception for Design, 3rd edition, Margon Kaufmann Publishers, 2012.*
3. *Robert Spence, Information Visualization Design for Interaction, 2nd Edition, Pearson Education, 2006.*

4. *Matthew O. Ward, George Grinstein, Daniel Keim, Interactive Data Visualization: Foundation, Techniques and Applications, 2nd Edition, A. K. Peters/CRC Press, 2015.*

COURSE OUTCOMES

On taking the 'Advanced Data Visualization'course the students will be able to:

CO1: Understand the basic principles data representation and visualization.

CO2: Apply mathematics and basic science knowledge for designing information visualizing System.

CO3: Know the data visualization tools like scatter plot, Bar Graph, arbitray graphs etc.

CO4: Collect data ethically and solve engineering problem in visualizing the information

CO5: Implement algorithms and techniques for interactive information visualization.

CO6: Conduct experiments by applying various modern visualization tool and solve the space layout problem.

PRACTICAL

BC49032 ADVANCED DATA VISUALIZATION LAB CREDITS: 2

List of Experiments:

1. Understanding Data,what is data, where to find data, Foundations for building Data.
2. Visualizations, Creating Your First visualization.
3. Getting started with Tableau Software using Data file formats, connecting your Data to Tableau, creating basic charts (line, bar charts, Tree maps),Using the Show me panel.
4. Tableau Calculations, Overview of SUM, AVR, and Aggregate features, Creating custom calculations and fields.
5. Applying new data calculations to your visualizations, Formatting Visualizations,
6. Formatting Tools and Menus, Formatting specific parts of the view.
7. Editing and Formatting Axes, Manipulating Data in Tableau data, Pivoting Tableau data.
8. Structuring your data, Sorting and filtering Tableau data, Pivoting Tableau data.
9. Advanced Visualization Tools: Using Filters, Using the Detail panel, using the Size panels,customizing filters, Using and Customizing tooltips, Formatting your data with colors.
10. Creating Dashboards & Storytelling, creating your first dashboard and Story, Design fordifferent displays, adding interactivity to your Dashboard, Distributing & Publishing yourVisualization.

11. Tableau file types, publishing to Tableau Online, Sharing your visualizations, printing, andExporting.
12. Creating custom charts, cyclical data and circular area charts, Dual Axis charts.

BC40034 CLOUD COMPUTING DATA ANALYTICS CREDITS: 4

UNIT – I

Client/Server systems, Thin & Thick Clients, Centralized computing, Parallel & Distributed Computing, Amdahl's Law, P2P Computing, Cluster Computing, Grid Computing, Utility Computing, Autonomic Computing, Hosting, Data Center, Evolution of Computing Paradigms, Convergence of Technologies, Role of Open Standards.

UNIT-II

The NIST Model of Cloud Computing, Characteristics, Deployment Models, Service Models & their comparison, Disadvantages, Cloud Computing Stack, Virtualization, Types of Hypervisors, Levels of Virtualization, Requirements of VMM, Hypervisor & the Xen Architecture, Types of Virtualization, Memory Virtualization, Storage Virtualization, Load Balancing, Horizontal & Vertical Scaling.

UNIT-III

Cloud Implementations: Infrastructure as a Service (IaaS) – Amazon Web Services, Elastic Compute Cloud (EC2), Simple Storage Service (S3), Simple Queuing Service (SQS).
Windows Azure, SQL Azure, Windows Azure AppFabric; Software as a Service (SaaS): Introduction, Web Services, Web 2.0, Web OS, Case studies on SaaS - SalesForce.com, Force.com, LiveMesh.

UNIT-IV

ML Options in the Cloud, Cognitive Services, Intro to Azure Machine Learning,Automated Machine Learning, Cross-Validation and Tuning, Accelerating Training withDistribution and GPUs.

ReferenceBooks

1. *K.Hwang,G.C.FoxandJ.J.Dongarra,DistributedandCloudCoMputing-FroMParallelProcessingtotheInternetofThings,1st Edition,Elsevier,2012.*
2. *B.Sosinsky,CloudCoMputingBible,1st Edition,Wiley-India,2011.*

3. *T. Mather, S. K. Swamy, and S. Latif, Cloud Security and Privacy:An Enterprise Perspective on RisksandCoMpliance,1st Edition,O'ReillyMedia,2009.*
4. *A. T. Velte, T. J. Velte and R. Elsenpeter, Cloud Computing: A Practical Approach, 1st Edition, McGraw-Hill Education, 2017.*
5. *A. Bahga and V. Madisetti, Cloud Computing: A Hands-On Approach, 1st Edition, Orient Blackswan,2014.*
6. *T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts,Technology&Architecture, 1st Edition, Pearson India Education, 2014.*

COURSE OUTCOMES

On taking the **'**Cloud computing Data Analytics'course the students will be able to:

CO1: Define different types of computing paradigms and concepts of cloud technologies.
CO2: Explain the cloud computing architecture, models, and various virtualization techniques.
CO3: UnderstandtheIaaSandPaaSimplementationsbyleadingvendorsintheindustry.
CO4: AppreciatetheSaaSmodelimplementationsandimportanceofSLAincloudenvironment.
CO5: Describe various aspects of security, privacy, and performance in cloud environments.
CO6: Apply machine learning to solve real life problems in cloud computing.

PRACTICAL

BC49034 CLOUD COMPUTING DATA ANALYTICSLA CREDITS: 2

List of Experiments:

1. Create a Collaborative learning environment for a particular learning topic using Google drive or google Apps.
2. Install virtual box and create a windows/linux virtual image and analyze the virtual configuration.
3. Create Amazon AWS EC2 Linux instance with conceptual understanding pf SSH client software protocol and keys.
4. Create Amazon AWS EC2 Linux instance with conceptual understanding of RDP(Remote Desktop Protocol).
5. Create cloud storage Bucket using Amazon Simple Storage Service(S3) and perform the following operations:
   A. Create a folder within a S3 Bucket.

B. Upload content to S3.
C. Change permissions to allow public access of contents.
D. Set Meta Data on an S3 Bucket.
E. Delete an S3 Bucket and its content.

6. Launch and Connect to an Amazon Relational Database(RDS) Service. (Use any one from MySQL,Oracle, SQL Server and post greSQL Database engines.
7. Develop and host a website in Amazon AWS Server.
8. DNS setup in the Route53 in Amazon AWS for a specific domain.
9. Connect to the server using any FTP Client and update the website content.
10. Deploy a word press blog in Amazon AWS.

BC40036 DATA SECURITY & PRIVACY CREDITS: 4

UNIT-I

Introduction to Security: Need for security, Security approaches, Principles of Security, Types of attacks; Encryption Techniques: Plain text, Cipher text, Substitution & Transposition Techniques, Encryption & Decryption, Key range & size.

UNIT-II

Symmetric Key Cryptography: Algorithm types &Modes, AES and its analysis, Differential & Linear Cryptanalysis; Asymmetric Key Cryptography: RSA and El-Gamal cryptosystems, Elliptic Curve Arithmetic, ECC operations, Applications of ECC in asymmetric cryptography.

UNIT-III

Cryptographic Hash Function: Random Oracle Model, Cryptographic Hash Functions: SHA-512, MD5, Pseudo Random Number Generation using Hash Function, Message Authentication Code: HMAC, Digital Signature; User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication.

UNIT-IV

Network and Web Security: Network Security Attacks, Distributed Denial of Service(Botnet), Intrusion Detection & Prevention Systems, Firewall, Browser Attacks, Obtaining user or website data, Web attack targeting users, E-mail attacks and security.

Blockchain: Introduction to Blockchain, Consensus Protocols, Blockchain use cases, Soft fork vs. Hard fork.

ReferenceBooks

1. *D.R.Stinson,Cryptography:TheoryandPractice, 3rd edition,CRCPress,2005.*
2. *C.P.Pfleeger, S.L.Pfleeger andJ.Margulies, Security in Computing, 5th Edition,2015.*
3. *A.Banafa,BlockchainTechnologyandApplications,1st Edition,2020.*
4. *W.Stallings,CryptographyandNetworkSecurity:PrincipleandPractice,7th Edition, Pearson Education,2017.*
5. *B.A. Forouzan, D.Mukhopadhaya, Cryptography and Network Security, 2nd edition, McGraw-Hill Education, 2010.*
6. *A.J.Menezes,P.C.VanOorschotandS.A.Vanstone,HandbookofAppliedCryptography,CRCPress, 1996.*
7. *B.Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd Edition, Wiley, 2007.*

COURSE OUTCOMES

On taking the 'Data Security & Privacy' course, the students will be able to:

CO1: Describe the basics of security and issues related to it.
CO2: Understand concepts of encryption decryption techniques
CO3: Explain symmetric and asymmetric key cryptography, analysis of AES, RSA, and ECC.
CO4: Analyse the security issues in computer networks and web applications and their mitigation.
CO5: Describe various aspects of security, privacy, and performance in cloud environments.
CO6: Explore blockchain technology and its applications in the context of data privacy.

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