GURU GHASIDAS VISHWAVIDYALAYA
BILASPUR (C.G.)

(A Central University)

Koni, Bilaspur-495009, C.G (India)

OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM (CBCS)

MASTER OF TECHNOLOGY
IN
Information Technology

COURSE STRUCTURE AND SYLLABUS

M.Tech Regular Two Year Degree Program
(Effective from the academic year 2022-23)

DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY,
GGV, BILASPUR, C.G. (INDIA)

DEPARTMENT OF INFORMATION TECHNOLOGY

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY, GGV, BILASPUR, C.G. (INDIA)

SCHEME OF EXAMINATION

M.TECH. INFORMATION TECHNOLOGY

M.Tech. I-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	ITPATT1	Mathematical Foundations of Computer Science	3	0	0	40	60	100	3
2.	ITPATT2	Advanced Data Structures	3	0	0	40	60	100	3
3.	ITPATT3	Principles of Wireless Sensor & Actuator Networks	3	0	0	40	60	100	3
4.	 ITPATP1 ITPATP2 ITPATP3 ITPATP4	Elective – I 1. Advance Operating System 2. Digital Forensics 3. Mobile Application Development 4. Machine Learning	3	0	0	40	60	100	3
5	 ITPATP5 ITPATP6 ITPATP7 ITPATP8	Elective – II 1. Network Security 2. Cloud Computing 3. Data Mining 4. Deep Learning	3	0	0	40	60	100	3
6.	ITPALT2	Wireless Sensor Network Lab	0	0	4	30	20	50	2
7.	ITPATC1	Research Methodology and IPR	2	0	0	-	50	50	2
Total			17	0	4	230	370	600	19

M.Tech. II-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	ITPBTT1	Advanced Algorithms	3	0	0	40	60	100	3
2.	ITPBTT2	Advanced Computer Architecture	3	0	0	40	60	100	3
3.	 ITPBTP1 ITPBTP2 ITPBTP3 ITPBTP4	Elective – III 1. Web and Database Security 2. Internet of Things 3. Data Science 4. High Performance Computing	3	0	0	40	60	100	3
4.	 ITPBTP5 ITPBTP6 ITPBTP7 ITPBTP8	Elective – IV 1. Information Warfare & Security 2. Cyber Security 3. Advanced Computer Networks 4. Big Data Analytics	3	0	0	40	60	100	3
5	 MSPBTO1 IPPBTO2 IPPBTO3 CEPBTO4 MEPBTO5 CHPBTO6 ECPBTO7 MCPBTO8	Open Elective-1 1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 6. Waste to Energy 7. IoT (Not for IT) 8. MOOCs	3	0	0	40	60	100	3
6.	ITPBLT1	Advanced Algorithms Lab	0	0	4	30	20	50	2
7.	ITPBLT2	Data Science Lab	0	0	4	30	20	50	2
8.	 ELPBTX1 PEPBTX2 CEPBTX3 LAPBTX4	Audit Course/Value Added Course English for Research Paper Writing Stress Management by Yoga Disaster Management Constitution of India	2	0	0	40	60	100	2
Total			17	0	08	300	400	700	21

Note: Under MOOCs the students have to opt any subject other than Information Technology from NPTEL/UGC SWAYAM

M.Tech. III-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	ITPCPT1	Dissertation Stage–I	0	0	28	100	100	200	14
Total			0	0	28	100	100	200	14

M.Tech. IV-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	ITPDPT1	Dissertation Stage–II	0	0	32	100	200	300	16
Total			0	0	32	100	200	300	16

Total Credits for the Program = 19 + 21 +14 +16 = 70

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.) (A CENTRAL UNIVERSITY)
B. TECH. INFORMATION TECHNOLOGY

Programme Outcomes: Graduates will be able to:

PO1: Fundamentals: Apply knowledge of mathematics, science and engineering.

PO2: Problem analysis: Identify, formulate and solve real time engineering problems using first principles.

PO3: Design: Design engineering systems complying with public health, safety, cultural, societal and environmental considerations

PO4: Investigation: Investigate complex problems by analysis and interpreting the data to synthesize valid solution.

PO5: Tools: Predict and model by using creative techniques, skills and IT tools necessary for modern engineering practice.

PO6: Society: Apply the knowledge to assess societal, health, safety, legal and cultural issues for practicing engineering profession.

PO7: Environment: Understand the importance of the environment for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics, and responsibilities and norms of the engineering practice.

PO9: Teamwork: Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.

PO10: Communication: Communicate effectively by presentations and writing reports.

PO11: Management: Manage projects in multidisciplinary environments as member or a team leader.

PO12: Life-long learning: Engage in independent lifelong learning in the broadest context of technological change.

Programme Specific Outcomes:

PSO1: Design software systems, components, or processes to meet identified needs within economic, environmental and social constraints.

PSO2: Ability to apply mathematical foundations and algorithmic principles for modeling and simulation of engineering problems.

PSO3: Use research based knowledge and tools for the analysis and interpretation of data to synthesize information for obtaining valid conclusions.

Subject:	MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE (ITPATT1)	Credits			
Type:	Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Pre-Requisites: UG level course in Discrete Mathematics/ Mathematical Foundations of Computer Science

Course Objectives:

1. To understand the mathematical fundamentals that are prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
2. To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
3. To study various sampling and classification problems.

Course Outcomes: After completion of course, students would be able to:

1. To understand the basic notions of discrete and continuous probability**.**
2. To understand the methods of statistical inference, and the role that sampling distributions play in those methods.
3. To be able to perform correct and meaningful statistical analyses of simple to moderate complexity.

UNIT – I

Probability mass, density, and cumulative distribution functions, parametric families of distributions, Expected value, variance, conditional expectation,

Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markovchains

UNIT - II

Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood,

UNIT - III

Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of over fitting model assessment.

UNIT – IV

Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition, Specialized techniques to solve combinatorial enumeration problems

UNIT-V

Computer science and engineering applications Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Recent Trends in various distribution functions in mathematical field of computer science for varying, fields like bio-informatics, soft computing, and computer vision.

Text Book:

John Vince, Foundation Mathematics for Computer Science, Springer.

References:

1. K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications.Wiley.
2. M. Mitzenmacher and E. Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
3. Alan Tucker, Applied Combinatorics,Wiley

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1			1	2	1		1	2	1
CO2	3	2	2	2	1				1	1	2	1	1	2	2
CO3	3	3	3	3	3	2			2	2	2	2	1	2	3
CO4	3	3	2	3	3				1	1	2	1	1	2	3
CO5	3	3	2	3	3	2			2	3	3	3	1	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	ADVANCED DATA STRUCTURES (ITPATT2)	Credits			
Type:	Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Pre-Requisites: UG level course in Data Structures

Course Objectives:

1. The fundamental design, analysis, and implementation of basic data structures.
2. Basic concepts in the specification and analysis of programs.
3. Principles for good program design, especially the uses of data abstraction.
4. Significance of algorithms in the computer field
5. Various aspects of algorithm development
6. Qualities of a good solution

Course Outcomes: After completion of course, students would be able to:

1. Basic ability to analyze algorithms and to determine algorithm correctness and timeefficiency class.
2. Master a variety of advanced abstract data type (ADT) and data structures and their implementations.
3. Master different algorithm design techniques.
4. Ability to apply and implement learned algorithm design techniques and data structures tosolve problems.

UNIT – I

Algorithms, Performance analysis- time complexity and space complexity, AsymptoticNotation-Big Oh,Omega and Theta notations, Complexity Analysis Examples. Datastructures-Linear and nonlinear data structures, ADT concept, Linear List ADT, Arrayrepresentation, Linked representation, Vector representation, singly linked lists - insertion,deletion, search operations, doubly linked lists-insertion, deletion operations, circular lists.Representation of single, two dimensional arrays, sparse matrices and their representation.

UNIT – II

Stack and Queue ADTs, array and linked list representations, infix to postfix conversionusing stack, implementation of recursion, Circular queue-insertion and deletion, DequeueADT, array and linked list representations, Priority queue ADT, implementation using Heaps,Insertion into a Max Heap, Deletion from a Max Heap.

UNIT – III

Searching–Linear and binary search methods, Hashing-Hash functions, Collision Resolutionmethods-OpenAddressing, Chaining, Hashing.Sorting –Bubble sort, Insertion sort, Quick sort, Merge sort, Heap sort, Radix sort,comparison of sorting methods.

UNIT – IV

Trees- Ordinary and Binary trees terminology, Properties of Binary trees, Binary tree ADT,representations,recursive and non-recursive traversals, Threadedbinary trees.Graphs- Graphs terminology, Graph ADT, representations, graphtraversals/search methods - DFS and BFS, Applications ofGraphs-Minimum cost spanning tree using Kruskal's algorithm, Dijkstra's algorithm forSingle Source Shortest Path Problem.

UNIT –V

Search trees- Binary search tree-Binary search tree ADT, insertion, deletion and searchingoperations, Balanced search trees, AVL trees-Definition and examples only, Red Black trees– Definition and examples only, B-Trees-definition, insertion and searching operations,Comparison of Search trees.Text compression-Huffman coding and decoding, Pattern matching-KMP algorithm.

References:

1. Thomas H .Coreman, Charles E.Leiserson, Ronald L.Rivest, "Introduction to Algorithms", PHI, 2002.
2. Sara Baase, Allen Ran Gelda, "Computer Algorithms and Introduction to Design and Analysis", Pearson,2000

3. S. Sahni, Data Structures, Algorithms, and Applications in C++, Silicon Press, 2/e, 2005.
4. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson,2004.
5. Aho. A.V,Hopcroft J.E, and Ullman.J.D, "Design and analysis of Computer Algorithms", Addison wesley ,1974.
6. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley,2002.
7. A. M. Tenenbaum, Y. Langsam, and M. J. Augenstein, Data Structures Using C and C++, Prentice Hall, 2/e, 1995.

CO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	1	3	3	2	2								3	3	3
CO2	2	3	1	2	3								3	3	3
CO3	3	3	3	3	3								3	3	3
CO4	2	3	2	3	3								3	3	3
CO5	3	2	1	2	3								3	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	PRINCIPLES OF WIRELESS SENSOR & ACTUATOR NETWORKS (ITPATT3)	Credits			
Type:	Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course Objectives

1. To provide in depth knowledge of sensors
2. To introduce the students the upcoming challenges of WSN
3. To give a fundamental knowledge on the basic laws and phenomena on which operation of sensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and deployment of sensors
5. To understand practical implementation of WSN

UNIT-I

Overview of Wireless sensor and actuator networks, comparison of adhoc network, infrastructure network and sensor networks. Introduction to wireless sensor Networks and wireless sensor actuator networks, Terminology WSN architecture, requirements and standards, Topologies uses in Wireless sensor and actuator network.

UNIT-II

Applications of wireless sensor networks and wireless sensor actuator networks, , what the challenges ,issues in wireless sensor actuator networks ?requirement for wireless sensor network deployment various standards for WSAN Development of sensor network. Overview of broadcasting techniques, backbone and broadcasting in sensor actuator networks, coverage and connectivity criteria.

UNIT-III

Placement and deployment of sensors in wireless sensor networks.Static sensors and mobile sensors placements. Placement by Actuators: - Least Recently Visited Approach, Snake like Deployment Approach, BackTracking-Deployment Approach Different methods used for sensor placement and deployment, Issues with the Wireless sensor network deployment Sensor Self Deployment Methods :- Virtual Force/Vector Based Approach, Mobile Sensor Migration.

UNIT-IV

Multicasting, multiratingcasting, geocasting and anycasting in sensor network, Routing in Wireless Sensor and Actuator Networks: flooding, gossiping, classification of routing protocols, Study of types of routing protocols used in wireless sensor network. Routing protocols based on network structures Flat networks routing – directed diffusion, SPIN, Rumor, GBR hierarchicial networks routing: - LEACH, PEGASIS, TEEN routing, location based routing: - Greedy, Face, Geographic adaptive fidelity, Geographic and energy aware routing.

UNIT-V

Sink Mobility:- Data gathering in Wireless Sensor Networks : - Sink tour and RP based data collection methods : Direct

contact data collection, Rendezvous based data collection, Introduction to sink mobility, energy problems, Topology Control in Sensor, Actuator : - use of MST and LMST , Introduction and detection of critical nodes and links : how to identify the critical nodes and links, how to solve the problem of critical nodes and critical links.

Text Books:

1.Wireless Sensor and Actuator Networks Algorithms and Protocols for Scalable Coordination and Data Communication, Edited by AmiyaNayak and Ivan Stojmenovic A JOHN WILEY & SONS, INC., PUBLICATION,2010.

2. Wireless Communications & Networks, 2nd Edition, William Stallings ,Pearson Education India,2009 3. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao and Leonidas Guibas ,Morgan Kauffman Publication,2004

Course Outcome

1. Implementation of WSN
2. Critical areas of WSN
3. Deployment of WSN
4. Research issues in WSN
5. Exposure to IOT

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2								2	3	3
CO2	3	2	2	2	3								3	3	2
CO3	3	3	3	2	3								3	3	3
CO4	3	2	3	3	2								3	2	3
CO5	2	3	3	3	3								2	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	**MACHINE LEARNING (ITPATP4)**	Credits			
Type:	**Elective – I**	L	T	P	Total
Teaching Scheme:	**Lectures: 3 hours/week**	3	0	0	3

Course Objectives:

1. To learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
2. To design and analyses various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3. Explore supervised and unsupervised learning paradigms of machine learning.
4. To explore Deep learning technique and various feature extraction strategies.
5. To learn the advanced machine learning technique

Course Outcomes: After completion of course, students would be able to:

1. Extract features that can be used for a particular machine learning approach in various IOT applications.
2. To compare and contrast pros and cons of various machine learning techniques
3. Learn to choose particular machine learning approach.
4. To mathematically analyses various machine learning approaches and paradigms.
5. To able to apply combination of ML technique

UNIT - I

Supervised Learning (Regression/Classification)

Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes. Linear models: Linear Regression, Logistic Regression, Generalized Linear Models.

Support Vector Machines, Nonlinearity and Kernel Methods.

Beyond Binary Classification: Multi-class/Structured Outputs, Ranking.

UNIT – II

Unsupervised Learning:

Clustering: K-means/Kernel K-means.

Dimensionality Reduction: PCA and kernel PCA.

Matrix Factorization and Matrix Completion.

Generative Models (mixture models and latent factor models).

UNIT - III

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

UNIT - IV

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

UNIT - V

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning,

Springer 2009 (freely availableonline)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer,2007

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	1							3	3	3	3
CO2	3	3	3	3	1							3	3	3	3
CO3	3	3	3	3	1							3	3	3	3
CO4	3	3	3	3	1							3	3	3	3
CO5	3	3	3	3	1							3	3	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	NETWORK SECURITY(ITPATP5)	Credits			
Type:	Elective – II	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Pre-Requisites: Computer Networks, Web Programming

Course Objectives:

1. To learn the basics of security and various types of security issues.
2. To study different cryptography techniques available and various security attacks.
3. Explore network security and how they are implemented in real world.
4. To get an insight of various issues of Web security and biometric authentication.
5. To understand various protocols for network security to protect against the threats in the networks.

Course Outcomes: After completion of course, students would be able to:

1. To understand basics of security and issues related to it.
2. Understanding of biometric techniques available and how they are used in today's world.
3. Security issues in web and how to tackle them.
4. Learn mechanisms for transport and network security.
5. Do research in the emerging areas of cryptography and network security.

UNIT – I

Data security: Review of cryptography. Examples RSA, DES, ECC.

UNIT –II

Authentication, non-repudiation and message integrity. Digital signatures and certificates. Protocols using cryptography (example Kerberos).Attacks on protocols.

UNIT -III

Network security: Firewalls, Proxy-Servers, Network intrusion detection.

Transport security: Mechanisms of TLS, SSL, IPSec.

UNIT - IV

Web security – SQL injection, XSS, etc. Software security and buffer overflow.

Malware types and case studies. Access Control, firewalls and host/network intrusion detection.

UNIT - V

Other topics: Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication. Recent trends in IOT security, IDS and Biometric.

References:

1. W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security. Addison Wesley,1994.
2. W. Stallings. Cryptography and Network Security. Prentice Hall,1999.
3. B. Schneier. Applied Cryptography. Wiley,1999.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							3	2	3	3
CO2	3	3	3	1	3	2						2	3	3	3
CO3	3	3	3	1	1							2	2	2	3
CO4	3	2	2	1	1							2	3	3	3
CO5	3	3	3	3	3	2						2	2	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	WIRELESS SENSOR NETWORK LAB (Lab - I) (ITPALT2)	Credits			
Type:	Practical	L	T	P	Total
Teaching Scheme:	Lectures: 4 hours/week	0	0	2	2

Prerequisites: A course on Computer Network.

Course Objectives:

1. To provide in basic knowledge of sensors
2. To deploy WSN in real time environment
3. To create & simulate WSN network of certain nodes
4. To create IOT product.
5. To perform energy analysis of WSN.

List of Programs

1. Perform Installation of NS2 simulator in Linux OS.
2. Perform Simulation in NSG (NS-2 Scenario Generator).
3. Create a scenario of 50 Nodes to study the performance of AODV, DSDV and DSR Routing Protocols through NS2 simulation.
4. Create a scenario of 100 Nodes to study the performance of AODV, DSDV and DSR Routing Protocols through NS2 simulator.
5. Create a scenario of 150 Nodes to study the performance AODV, DSDV and DSR Routing Protocols through NS2 simulator.
6. Perform Installation and Configuration of Cup Carbon Simulator.
7. Create a environment using Mobility Sensor and marker in cup Carbon to detect the intruders in any system.
8. Write a program to perform communication between two or more sensors using Cup Carbon.
9. Perform Installation and Configuration of Contiki/Cooja Simulator.
10. Implement RPL protocol in Cooja Simulator.
11. Implement Client Server Model in Cooja Simulator.

TEXT BOOKS:

1. Wireless Sensor and Actuator Networks Algorithms and Protocols for Scalable Coordination and Data Communication, Edited by AmiyaNayak and Ivan Stojmenovic A JOHN WILEY & SONS, INC., PUBLICATION,2010.
2. Wireless Communications & Networks, 2nd Edition, William Stallings ,Pearson Education India,2009 3. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao and Leonidas Guibas ,Morgan Kauffman Publication,2004.

Course Outcomes:

1. Implementation of WSN.
2. Installation of WSN.
3. Deployment of WSN.
4. Research issues in WSN.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	2								3	3	3
CO2	2	3	3	2	3								2	3	3
CO3	3	2	3	2	3								3	2	3
CO4	2	3	3	3	3								2	2	3
CO5	3	2	2	3	3								3	3	2

3. **Weightage: 1-Sightly, 2-Moderately, 3-Strongly**

Subject:	Research Methodology and IPR (IPPATC1)	Credits			
Type:	MLR	L	T	P	Total
Teaching Scheme:	Lectures: 2 hours/week	2	0	0	2

Course Objective

1.Demonstrate the ability to choose methods appropriate to research aims and objectives
2.Understand the limitations of particular research methods
3.Develop skills in qualitative and quantitative data analysis and presentation
4.Develop advanced critical thinking skills
5.Demonstrate enhanced writing skills

Course outcomes:

1 Understand research problem formulation.
2 Analyze research related information
3 Follow research ethics
4 Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property
5 Right to be promoted among students in general & engineering in particular.

Syllabus Contents:

- **Introduction and Design of research**: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

- **Data and Methods of Data Collection**: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

- **Data Analysis:** Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution, analysis of variance: one way, two way, chi square test and its application, students 'T' distribution, non-parametric statistical techniques, binomial test. Correlation and regression analysis – discriminate analysis – factor analysis – cluster analysis, measures of relationship

- Research report preparation and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of

interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references.

- Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

References:

- Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
- Research Methodology – Methods and Techniques, C K Kothari, New Age International.
- Design and Analysis of Experiments, D C Montgomery, Wiley.
- Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.
- Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	1	2							3	2	3
CO2	2	1	2	3	1	2							3	3	2
CO3	2	1	2	2	2	3							3	3	3
CO4	2	1	2	2	2	2							3	3	3
CO5	1	2	2	2	2	3							2	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	ADVANCED ALGORITHMS (ITPBTT1)	Credits			
Type:	Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Pre-Requisites: UG level course in Algorithm Design and Analysis

Course Objectives:

1. Introduce students to the advanced methods of designing and analyzing algorithms.
2. The student should be able to choose appropriate algorithms and use it for a specific problem.
3. To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
4. Students should be able to understand different classes of problems concerning their computation difficulties.
5. To introduce the students to recent developments in the area of algorithmic design.

Course Outcomes: After completion of course, students would be able to:

1. Analyze the complexity/performance of different algorithms.
2. Determine the appropriate data structure for solving a particular set of problems.
3. Categorize the different problems in various classes according to their complexity.
4. Students should have an insight of recent activities in the field of the advanced data structure.

UNIT –I
Sorting:

Review of various sorting algorithms, topological sorting
Graph:
Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

UNIT – II
Matroids:

Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.
Graph Matching:
Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

UNIT - III
Flow-Networks:

Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.
Matrix Computations:
Stassen’s algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

UNIT - IV
Shortest Path in Graphs:

Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.

Modulo Representation of integers/polynomials:
Chinese Remainder Theorem, Conversion between base-representation and modulo-representation.Extension to polynomials. Application: Interpolation problem.
Discrete Fourier Transform (DFT):
In complex field, DFT in modulo ring.Fast Fourier Transform algorithm.Schonhage-Strassen Integer Multiplication algorithm.

UNIT - V
Linear Programming:

Geometry of the feasibility region and Simplex algorithm
NP-completeness:
Examples, proof of NP-hardness and NP-completeness.
One or more of the following topics based on time and interest:
Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm
Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

References:

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest,Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft,Ullman.
3. "Algorithm Design" by Kleinberg andTardos.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2							3	2	1
CO2	3	3	2	3	2	2							2	3	1
CO3	2	3	2	3	2	3							3	2	1
CO4	3	2	3	2	3	2							3	2	1
CO5	2	3	2	3	2	3							3	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	ADVANCED COMPUTER ARCHITECTURE (ITPBTT2)	Credits			
Type:	Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Prerequisites: Computer Organization

Course Objectives:

1. To impart the concepts and principles of parallel and advanced computer architectures.

2.To analyze various memory organizations and parallel processing application

3. To apply the concepts of pipe lining and superscallar architecture.

4.To Apply the concepts and techniques of parallel and advanced computer architectures to design modern computer systems

5. To develop the design techniques of Scalable and multithreaded Architectures.

UNIT - I

Theory of Parallelism, Parallel computer models, The State of Computing, Multiprocessors and Multi-computers, Multi vector and SIMD Computers, PRAM and VLSI models, Architectural development tracks, Program and network properties, Conditions of parallelism, Program partitioning and Scheduling, Program flow Mechanisms, System interconnect Architectures.

UNIT - II

Principals of Scalable performance, Performance metrics and measures, Parallel Processing applications, Speed up performance laws, Scalability Analysis and Approaches, Hardware Technologies, Processes and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

UNIT - III

Bus Cache and Shared memory, Backplane bus systems, Cache Memory organizations, Shared- Memory Organizations, Sequential and weak consistency models, Pipelining and superscalar techniques, Linear Pipeline Processors, Non-Linear Pipeline Processors, Instruction Pipeline design, Arithmetic pipeline design, superscalar pipeline design.

UNIT - IV

Parallel and Scalable Architectures, Multiprocessors and Multi-computers, Multiprocessor system interconnects, cache coherence and synchronization mechanism, Three Generations of Multi-computers, Message-passing Mechanisms, Multivetor and SIMD computers, Vector Processing Principals, Multi-vector Multiprocessors, Compound Vector processing, SIMD computer Organizations, The connection machine CM-5,

UNIT - V

Scalable, Multithreaded and Dataflow Architectures, Latency-hiding techniques, Principals of Multithreading, Fine-Grain Multicomputers, Scalable and multithreaded Architectures, Dataflow and hybrid Architectures.

Text Book

1. Advanced Computer Architecture, Kai Hwang, 2nd Edition, Tata McGraw HillPublishers.

References:

1. Computer Architecture, J.L. Hennessy and D.A. Patterson, 4th Edition,ELSEVIER.
2. Advanced Computer Architectures, S.G.Shiva, and Special Indian edition, CRC, Taylor&Francis.
3. Introduction to High Performance Computing for Scientists and Engineers, G. Hager and G. Wellein, CRC Press, Taylor & FrancisGroup.
4. Advanced Computer Architecture, D. Sima, T. Fountain, P. Kacsuk, Pearsoneducation.
5. Computer Architecture, B. Parhami, Oxford Univ.Press.

Course Outcomes: Gain knowledge of

1. Computational models and Computer Architectures.
2. Concepts of parallel computer models.
3. Scalable Architectures, Pipelining, Superscalar processors, multiprocessors
4. Message Passing and Vector Processing
5. Multithreaded and Dataflow Architectures

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3		1			2			3	3	2	3
CO2	2	3	3	3	2	1			2			3	3	3	3
CO3	2	3	3	3	2	1			2			3	3	3	3
CO4	2	3	3	3					2			3	3	3	3
CO5	2	3	3	3					2			3	3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	**DATA SCIENCE (ITPBTP3)**	Credits			
Type:	**Elective - III**	L	T	P	Total
Teaching Scheme:	**Lectures: 3 hours/week**	3	0	0	3

Course Objectives:

1. Provide you with the knowledge and expertise to become a proficient datascientist.
2. Demonstrate an understanding of statistics and machine learning concepts that are vital for datascience;
3. Produce Python code to statistically analyses adataset;
4. Critically evaluate data visualizations based on their design and use for communicating stories fromdata;
5. To equip students with knowledge and skills in data science and visualization techniques using Bokeh in Python. Students will be able to understand the latest trends in data collection and analysis, various visualization techniques, and application development methods used in data science.

Course Outcomes: After completion of course, students would be able to:

1. Explain how data is collected, managed and stored for datascience;
2. Understand the key concepts in data science, including their real-world applications and the toolkit used by datascientists
3. Implement data collection and management scripts usingMongoDB
4. Understand the fundamental concepts and principles of data science and its applications in various industries.
5. Utilize various data collection and analysis techniques to obtain meaningful insights from data.

UNIT – I

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

UNIT – II

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data Sources

UNIT-III

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

UNIT-IV

Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.

UNIT-V

Applications of Data Science, Technologies for visualization, Bokeh (Python).
Recent trends in various data collection and analysis techniques, various visualization techniques, application

development methods of used in data science.

References:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly.
2. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge UniversityPress.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2								3	2	2
CO2	3	2	3	2	3								3	3	2
CO3	2	3	2	2	3								2	2	3
CO4	3	2	2	3	2								3	2	2
CO5	3	2	2	3	3								2	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	CYBER SECURITY (ITPBTP6)	Credits			
Type:	Elective - IV	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course Objectives:

1. To learn about cyber-crimes and how they are planned.
2. To learn the vulnerabilities of mobile and wireless devices.
3. To learn about the cyber law & crimes in mobile and wireless devices.
4. To understand cyber forensic & Social Media issues related to Cyber security.
5. Case study of cyber security.

UNIT - I

Introduction to Cybercrime: Introduction, Cybercrime and Information security, who are cybercriminals, Classifications of Cybercrimes, Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

Cyber offenses: How criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.

UNIT- II

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies an Measures in Mobile Computing Era, Laptops.

UNIT - III

Cybercrimes and Cyber security: the Legal Perspectives

Introduction, Cyber Crime and Legal Landscape around the world, Why Do We Need Cyber laws: The Indian Context, The Indian IT Act, Challenges to Indian Law and Cybercrime Scenario In India, Digital signatures and the Indian IT Act, Amendments to the Indian IT Act, Cybercrime and Punishment, Cyber law, Technology and Students: Indian Scenario.

UNIT - IV

Understanding Computer Forensics

Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Chain of Custody concept, Network Forensics, Approaching a computer, Forensics Investigation, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing

UNIT - V

Cyber Security: Organizational Implications

Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges forOrganizations.

Text Books:

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, WileyINDIA.
2. Introduction to Cyber Security**,** Chwan-Hwa(john) Wu, J. David Irwin. CRC Press T & F Group.

Reference Book:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC

Course Outcomes:

1. Exposure to cyber-crimes.
2. Able to understand the issues of smart devices.
3. Able to understand cyber law.
4. To relate cyber forensic to real life.
5. Implementation of Firewall.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3								3	3	3
CO2	3	2	2	3	3								3	2	3
CO3	3	3	3	2	3								2	3	3
CO4	2	3	3	2	2								3	3	2
CO5	3	2	3	3	3								3	2	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	Composite Materials (MEPBTO5)	Credits			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course Objectives

1. To learn different types of Composite Materials
2. To train students to be able to design composite structures.
3. To learn how to select composite materials.
4. To get the idea of manufacturing of Composites
5. To familiarize with the applications of Composite Materials

Course outcomes

1. Explain and also implement the composite materials for the required performance based on the characteristics.
2. Adopt the composite materials as reinforcements
3. Implement the methods of manufacturing of metal matrix composites
4. Adopt the methods of manufacturing of polymer matrix composites
5. Evaluate the strength of laminates

Syllabus Contents:

- INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
- REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.
- Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.
- Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.
- Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations

References:

- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.
- Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
- Hand Book of Composite Materials-ed-Lubin.
- Composite Materials – K.K.Chawla.
- Composite Materials Science and Applications – Deborah D.L. Chung.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	2	1	2	-	1	1	1	1	2	1	2	3
CO2	1	2	3	2	1	2	-	1	1	1	1	2	1	2	3
CO3	1	2	3	3	1	3	-	1	1	2	1	2	1	2	3
CO4	1	2	3	3	1	3	-	1	1	2	2	3	1	3	3
CO5	1	2	3	2	1	2	-	1	1	3	2	3	1	3	3

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	ADVANCED ALGORITHMS LAB (Lab - II) (ITPBLT1)	Credits			
Type:	Practical	L	T	P	Total
Teaching Scheme:	Lectures: 4 hours/week	0	0	4	2

Course Objective: The student can able to attain knowledge in advance algorithms.

Course Outcomes: The student can able to analyze the performance of algorithms.

Lab Objective:

1. To basic implementation of graph algorithm.

2. To analyze the code optimization strategy.

3. To expose students how to implement parallel algorithm.

4. To analyze the linear programming and maximum flow implementation.

5. Making good strategy towards the algorithm to be become the good researcher

List of Experiments

1. Implement assignment problem using Brute Forcemethod
2. Perform multiplication of long integers using divide and conquermethod.
3. Implement solution for knapsack problem using Greedymethod.
4. Implement Gaussian eliminationmethod.
5. Implement LUdecomposition
6. Implement Warshall algorithm
7. Implement Rabin Karp algorithm.
8. Implement KMP algorithm.
9. Implement Harspool algorithm
10. Implement max-flowproblem.

Text Book:

1. Design and Analysis of Algorithms, S.Sridhar, OXFORD University Press

References:

1. Introduction to Algorithms, second edition, T.H. Cormen, C.E. Leiserson, R.L. Rivest and C.Stein,PHI Pvt. Ltd./ PearsonEducation.
2. Fundamentals of Computer Algorithms, Ellis Horowitz, SatrajSahniand Rajasekharam, UniversitiesPress.
3. Design and Analysis of algorithms, Aho, Ullman and Hopcroft, Pearsoneducation.

Course Outcome

CO1: Bring the capabilities to students to be become the good researcher.

CO2: To teach hot to make and formulate optimization problem.

CO3: Students spontaneous able to implement the some graph and approximation algorithm.

CO4: Students will able to implement the dynamic type problem.

CO5: To able to develop the mathematical formula and model.

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	2							3	2	1
CO2	3	3	2	2	3	2							2	3	1
CO3	2	3	2	3	2	3							3	2	1
CO4	3	2	3	2	3	3							2	3	1
CO5	3	2	3	2	3	2							3	2	1

Weightage: 1-Sightly, 2-Moderately, 3-Strongly

Subject:	DATA SCIENCE LAB (Lab – III) (ITPBLT2)	Credits			
Type:	Practical	L	T	P	Total
Teaching Scheme:	Lectures: 4 hours/week	0	0	4	2

Course Objectives:

1. To make students understand learn about a Big Data – R Programming, way of solving problems.
2. To explore various data structures and functions available in R.
3. To understand and apply different search and sort algorithms for data manipulation.
4. To learn to work with different file formats and datasets in R.
5. To gain proficiency in creating and modifying basic and advanced plots using R.

Introduction to R Programming:

What is R and RStudio? R is a statistical software program. It has extremely useful tools for data exploration, data analysis, and data visualization. It is flexible and also allows for advanced programming. RStudio is a user interface for R, which provides a nice environment for working with R.

1.	Write an R program to evaluate the following expression ax+b/ax-b.
2.	Write an R program to read input from keyboard (hint: readLine()).
3.	Write an R program to find the sum of n natural numbers: 1+2+3+4+….n
4.	Write an R program to read n numbers. (i) Sum of all even numbers (ii) Total number of even numbers.
5.	Write an R program to read n numbers. (i) Total number of odd numbers (ii) Sum of all odd numbers
6.	Write an R program to obtain (i)sum of two matrices A and B (ii) subtraction of two matrices A and B (iii) Product of two matrices.
7.	Write an R program for “declaring and defining functions “
8.	Write an R program that uses functions to add n numbers reading from keyboard
9.	Write an R program uses functions to swap two integers.
10.	Write an R program that use both recursive and non-recursive functions for implementing the Factorial of a given number, n.
11.	Write an R program to reverse the digits of the given number {example 1234 to be written as 4321}
12.	Write an R program to implement (i)Linear search (ii) Binary Search.
13.	Write an R program to implement (i)Bubble sort (ii) selection sort.
14.	Write a R program to implement the data structures (i) Vectors (ii) Array (iii) Matrix (iv) Data Frame (v) Factors
15.	Write a R program to implement scan(), merge(), read.csv() and read.table() commands.

16.	Write an R program to implement "Executing Scripts" written on the note pad, by calling to the R console.
17.	Write a R program, Reading data from files and working with datasets (i) Reading data from csvfiles, inspection ofdata. (ii) Reading data from Excelfiles.
18.	Write a R program to implement Graphs (i) Basic high-level plots (ii)Modifications of scatter plots (iii) Modifications of histograms, parallel boxplots. Suggested Books for Lab: 1. Big data – Black Book: 2015 edition: dreamtechpress. Pg. (490-642) 2. Introducing to programming and problem solving by scala, mark c. lewis, lisal.lacher. CRC press, second edition.

Course Outcomes:

1. Develop proficiency in programming in the R language
2. Gain understanding of various R data types and structures
3. Acquire knowledge of common algorithms and data manipulation techniques in R programming
4. Develop problem-solving and critical thinking skills in R programming
5. Gain experience in working with datasets and data analysis in R programming.

Course Outcomes and their mapping with Programme Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	2								2	2	3
CO2	3	2	3	2	2								3	3	2
CO3	3	2	2	3	2								3	2	3
CO4	2	2	3	2	3								2	2	3
CO5	3	2	3	2	3								3	2	2

Weightage: 1-Sightly, 2-Moderately, 3-Strongly