VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI) MATUNGA, MUMBAI 400 019
(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)
For
Third Year of Four Year Undergraduate Programme Leading to

Bachelor of Technology (B Tech) Degree in
in
Information Technology

Department of Computer Engineering and Information Technology,
2025

BTech Information Technology
Scheme of Instruction and Evaluation
SEMESTER V

Table 1: Course Structure with Examination Weightage

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	TA (%)	MST (%)	ESE (%)	Ownership
1	PCC	R5IT3001T	Machine Learning	3	0	0	3	3	20	30	50	CE & IT
2	PCC	R5IT3002T	Software Engineering	3	0	0	3	3	20	30	50	CE & IT
3	PCC	R5IT3003T	Parallel Computing	3	0	0	3	3	20	30	50	CE & IT
4	PCC	R5IT3004T	Cloud Computing	3	0	0	3	3	20	30	50	CE & IT
5	PCC	R5IT3005T	Cryptography	2	0	0	2	2	20	30	50	CE & IT
6	MDM	R5IT3201T*	Multi-disciplinary Minor-III	3	0	0	3	3	20	30	50	Institute
7	PEC	R5IT3101T*	Program Elective –I	3	0	0	3	3	20	30	50	CE & IT
8	PCC	R5IT3003L	Machine Learning Lab	0	0	2	2	1	ISCE:	60	40	CE & IT
9	PCC	R5IT3002L	Software Engineering Laboratory	0	0	2	2	1	ISCE:	60	40	CE & IT
10	PEC	R5IT3101L*	Program Elective –I Laboratory	0	0	2	2	1	ISCE:	60	40	CE & IT
11	VSEC	R5IT3001L	Parallel Programming Laboratory	0	0	2	2	1	ISCE:	60	40	CE & IT
Total				20	0	8	28	24				

Multi-disciplinary Minor-III			
S.No	Course Code	Minor Name	Course Title
1.	R5IT3201T	Minor in AI ML	Deep Learning Neural Network
2.	R5IT3202T	Minor in HPCA	High Performance Computing Systems
3.	R5IT3203T	Minor in IoT	Data Communication Networking
4.	R5IT3204T	Minor In Geo-Spatial Data Science	Geospatial Data Analysis Python Libraries

Program Elective -I		
S.No	Course Code	Course Title
1.	R5IT3104T	Complier Construction
2.	R5IT3102T	Image Processing
3.	R5IT3103T	NO SQL database
4.	R5IT3105T	Distributed Database
5.	R5IT3106T	Human Computer Interaction
5.	R5IT3101T	Optimization Techniques

BTech Information Technology
Scheme of Instruction and Evaluation
SEMESTER VI

Table 2: Course Structure with Examination Weightage

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	TA (%)	MST (%)	ESE (%)	Ownership
1	PCC	R5IT3006T	System Security	3	0	0	3	3	20	30	50	CE & IT
2	PCC	R5IT3007T	Wireless Network	3	0	0	3	3	20	30	50	CE & IT
3	PCC	R5IT3008T	Research Methodology	2	0	0	2	2	20	30	50	CE & IT
4	OE	R5IT3301T	Open Elective	3	1	0	4	4	20	30	50	CE & IT
5	HSSM	-	Financial Management	2	0	0	2	2	20	30	50	CE & IT
6	MDM	R5IT3205T*	Multi-disciplinary Minor-IV	3	0	0	3	3	20	30	50	Institute
7	PEC	R5IT3107T*	Program Elective – II	3	0	0	3	3	20	30	50	CE & IT
8	VSEC	R5IT3004L	Devops	0	0	2	2	1	ISCE	60	40	CE & IT
9	PCC	R5IT3005L	System Security Lab	0	0	2	2	1	ISCE	60	40	CE & IT
10	PEC	R5IT3006L	Wireless Network Laboratory	0	0	2	2	1	ISCE	60	40	CE & IT
11	PEC	R5IT31067L*	Program Elective – II Laboratory	0	0	2	2	1	ISCE	60	40	CE & IT
Total				19	1	8	28	24				

Open Elective - I		
S.No	Course Code	Course Title
1.		
2.		
3.		
4.		

Multi-disciplinary Minor-IV			
S.No	Course Code	Minor Name	Course Title
1.	R5IT3205T	Minor in AI ML	Deep Neural Networks
2.	R5IT3206T	Minor in IoT	Hardware Software Co-Design
3.	R5IT3207T	Minor in HPCA	Algorithms High Performance Computing
4.	R5IT3208T	Minor In Geo-Spatial Data Science	Introduction To Remote Sensing

Program Elective –II		
S.No	Course Code	Course Title
1.	R5IT3107T	Blockchain Technology
2.	R5IT3111T	Information Storage Management System
3.	R5IT3108T	Object Oriented Analysis and Design
4.	R5IT3109T	Geospatial Technique
5.	R5IT31010T	Computer Vision

BTech Information Technology
Exit Courses Syllabus

Table 3: Exit Courses Structure with Examination Weightage

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	TA (%)	MST (%)	ESE (%)	Ownership
1	PCC	R5IT3901L	Cloud Training (Google ,Puppet, Azure)	0	0	4	4	2	ISCE	60	40	CE & IT
2	PCC	R5IT3901L	Salesforce beginners Training	0	0	4	4	2	ISCE	60	40	CE & IT
3	PCC	R5IT3901L	System Administrator	0	0	4	4	2	ISCE	60	40	CE & IT
4	PCC	R5IT3901L	Unity development tutorials	0	0	4	4	2	ISCE	60	40	CE & IT
5	PCC	R5IT3801L	Project / Mini-Project	0	0	12	12	6	20	30	50	CE & IT
6	EC	R5IT3701L	Internship (6-8 weeks)	0	0	0	0	6	20	30	50	CE & IT
Total				0	0	24	24	24				

Programme Name	B. Tech. Information Technology
Course Code	R5IT3001T
Course Title	Machine Learning
Course Type	PCC

Prerequisites: Linear Algebra, Probability, Statistics

Course Outcomes: At the end of the course student will be able to:

CO1. Demonstrate fundamentals of different Machine Learning Techniques.
CO2. Apply regression, classification, and clustering methods for problem solving.
CO3. Demonstrate the usages of supervised and unsupervised learning methods.
CO4. Apply advanced techniques of machine learning to solve complex problems.

	Course Contents	Hrs.	CO
1.	**Introduction:** Learning Problems , Perspectives and Issues , Concept Learning , Version Spaces and Candidate Eliminations , Inductive bias , Decision Tree learning , Representation , Algorithm , Heuristic Space Search	5	CO1
2.	**Instant Based Learning:** K- Nearest Neighbour Learning, Locally weighted Regression, Radial Bases Functions , Case Based Learning. Association Rule Learning: Apriori, FP Growth ,Clustering: Centroid based , K-means, Distribution based , EM, Density based ,DBScan ,Regression: Linear Regression, Interpolation and Extrapolation, Nonlinear regression Artificial Neural Networks: Network Function, Cost, Learning Paradigms, Gradient Descent ,SVM: Classifier, Kernel, Parameter Selection	8	CO2
3.	**Bayesian And Computational Learning:** Bayes Theorem , Concept Learning , Maximum Likelihood , Minimum Description Length Principle , Bayes Optimal Classifier , Gibbs Algorithm , Naïve Bayes Classifier , Bayesian Belief Network , EM Algorithm , Probability Learning , Sample Complexity , Finite and Infinite Hypothesis Spaces , Mistake Bound Model	8	CO2
4.	**Neural Networks And Genetic Algorithms:** Neural Network Representation , Problems ,Perceptron, Multilayer Networks and Back Propagation Algorithms , Advanced Topics , Genetic Algorithms , Hypothesis Space Search , Genetic Programming , Models of Evaluation and Learning Softmax Function , One Hot Encoding , Cross Entropy , Stochastic Gradient Descent , Learning Rate Decay , Parameter Hyperspace ,ReLU - Regularization , Deep NN Architectures , Back propagation, CNN, RNN, LSTM, Deep Boltzmann Machine	6	CO3
5.	**Advanced Learning:** Learning Sets of Rules ,Sequential Covering Algorithm ,Learning Rule Set , First Order Rules, Sets of First Order Rules , Induction on Inverted Deduction , Inverting Resolution , Analytical Learning , Perfect Domain Theories , Explanation Base Learning , FOCL Algorithm ,Reinforcement Learning , Task , QLearning , Temporal Difference Learning	7	CO4
6.	**Advances in the domain:** -	6	CO4

Text Books	
1.	Tom M. Mitchell, Machine Learning, McGraw-Hill, 1st edition, 1997 Ethem Alpaydin
2.	Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004
3.	Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar
4.	Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989
Reference Books	
1.	Hastie. T, Tibshirani. R, Friedman. J. H, The Elements of Statistical Learning, Springer,1st edition, 2001
2.	William W.Hsieh, "Machine Learning Methods in the Environmental Sciences", Cambridge
3.	Han Kamber, "Data Mining Concepts and Techniques", Morgann Kaufmann Publishers.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3002T
Course Title	Software Engineering
Course Type	PCC
Prerequisites: Programming, basics of software engineering	
Course Outcomes: At the end of the course student will be able to: **CO1.** Illustrate software development process and best practice for software development. **CO2.** Demonstrate agile development principles and techniques to manage agile software developments. **CO3.** Investigate requirements to generate software requirement document. **CO4.** Apply component based design to real life applications. **CO5.** Illustrate skills of software testing to projects. **CO6.** Estimate cost of the project.	

	Course Contents	Hrs.	CO
1.	**Fundamentals of Software Engineering:** software life-cycle process models, industry-standard software engineering tools.	3	CO1
2.	**Agile Methods for Software Development Method:** Extreme Programming (XP), Scrum, Lean, Crystal, Dynamic Systems Development Method and Feature-Driven Development.	8	CO2
3.	**Software Requirements Analysis and Engineering:** Identification of stakeholders, the elicitation and verification of requirements from them, and translation into detailed requirements	6	CO3
4.	**Software Architecture and Component-Based Design:** software design process and it's models; software architectures and design plans; design methods; design state assessment; design quality assurance; and design verification.	8	CO4
5.	**Software Testing and Quality Assurance:** systematic testing of software systems, software verification, symbolic execution, software debugging, quality assurance, measurement and prediction of software reliability.	8	CO5
6.	**Cost Estimation and Measurement:** industry-standard software sizing metrics as Function, Feature, and Object Points and their relationship to the lines-of-code metric.	6	CO6

Text Books	
1.	Roger Pressman. Software Engineering: A Practitioner's Approach (7th. ed.). McGraw-Hill, Inc., USA. 2009.
Reference Books	
1.	Jalote, Pankaj. An integrated approach to software engineering. Springer Science & Business Media, 2012.
2.	Sommerville, Ian. Software Engineering, 9/E. Pearson Education India, 2011.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3003T
Course Title	Parallel Computing
Course Type	PCC

Prerequisites: DAA.

Course Outcomes: At the end of the course student will be able to: **CO1:** Analyze and comprehend the fundamental principles of parallel algorithms and architectures.
CO2: Analyze and model the performance of parallel systems.
CO3: Develop parallel programs using advanced programming models and architectures.
CO4: Apply parallel processing techniques to solve numerical, non-numerical, and emerging computing challenges.

	Course Contents	Hrs.	CO
1	Principles of Parallel Algorithm Design: Parallel Architectures: Architecture classification scheme, Pure parallel algorithms and data dependencies, Decomposition Techniques, Characteristics of task and interactions, Mapping technique for load balancing, Method for containing Interaction overhead, Parallel algorithm model, Top 500, Green 500	6	CO1
2	Analytical Modeling and Parallel Program: Performance matrices of processor, Performance Metrics for Parallel Systems, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time, Asymptotic Analysis of Parallel Programs	4	CO3
3	Parallel Programming Models: Parallel programming with message passing using MPI, Directives based parallel programming models, OpenMP, OpenACC, Hybrid Programming Models: MPI+OpenMP, Thread-level parallelism, Communication Patterns	4	CO1,4
4	Multi-core/many-core Architecture: Introduction to multi-core/many-core architecture and programming, AMD/ATI GPU architectures, GPU Hardware: Streaming Multiprocessors, Kernel, Thread Blocks, Threads, GPU Memory Model: Synchronization, Barrier, Memory access, Coalesce, Atomics. Heterogeneous computing (CPU-GPU collaboration), MPI+CUDA	6	CO4
5	Numerical and Non-numerical Algorithms: Interconnection networks, Sorting, graphs, dynamic programming, dense matrix algorithms, sparse matrix algorithms, Advances in the domain	3	CO3, 4
6	Recent Trends in Parallel Processing: Introduction to Petascale Computing, GPU accelerated Deep Learning, High Performance Computing in Data Analytics, Quantum Computing, Energy Efficient Parallel Computing, Parallelization tools	6	CO1,3

Text Books	
1.	Ananth Grama, "An Introduction to Parallel Computing: Design and Analysis of Algorithms," Pearson Publication, 2009.
2.	David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach," Second Edition, Elsevier, 2013.
Recommended Reading	
1.	Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," Tata McGraw-Hill, 2011.
2.	Barbara Chapman, "Using OpenMP: Portable Shared Memory Parallel Programming," The MIT Press, Cambridge, Massachusetts, London, England, 2008.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3004T
Course Title	Cloud Computing
Course Type	PCC

Prerequisites: NIL

Course Outcomes: At the end of the course student will be able to:

CO1: Understand and formulate the basics of cloud computing with its benefits, architecture, and measure its value.

CO2: Analyse the underlying virtualization technology for cloud and implement the same using open-source cloud environment tools.

CO3: Explore the services offered by cloud computing like IaaS, PaaS, SaaS, and storage using various application frameworks like MapReduce, Hadoop, etc.

CO4: Evaluate cloud administration, management, and various cloud service providers, and explore the security aspects concerning the cloud.

	Course Contents	Hrs.	CO
1	Introduction to Cloud Computing: Roots of Cloud Computing: From mainframe to Cloud, Benefits of Cloud Computing, SOA, Web services, Web 2.0, Mashups, Grid computing, Utility computing, Hardware virtualization, Essentials of Cloud characteristics, Challenges, Cloud economics, Role of Networks in Cloud Computing: Cloud types and service models, Introduction to Cloud computing platforms: Openstack, Open Nimbus, Eucalyptus, Primary Cloud Service models, Cloud Services brokerage, Primary cloud deployment models, Cloud Computing reference model, The greenfield and brownfield deployment options	4	CO1, CO2
2	Virtualization Concepts and Architecture: Introduction, Characteristics of virtualized environments, Taxonomy of Virtualization techniques, Pros and Cons of Virtualization, Technology examples: Xen, KVM, VMware, Microsoft Hyper-V	6	CO2
3	Cloud Computing Platforms: Exploring cloud computing stack – Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Defining Infrastructure as a Service (IaaS), Defining Software as a Service (SaaS), Defining Platform as a Service (PaaS), Defining Identity as a Service (IDaaS), Defining Compliance as a Service (CaaS). Software as a Service – Overview, advantages, limits, Platform as a Service – overview, advantages and functionalities, PaaS application frameworks	8	CO3
4	Accessing the Cloud: Platforms, WEB applications, WEB APIs, WEB Browsers, Google Cloud Platform (GCP) Cloud Storage: Overview, Storage providers, Cloud Standards, and cloud storage techniques like MAPREDUCE, HDFS, GFS	4	CO1, CO3
5	Cloud Computing at Work/Deploying of Cloud: Deployment of cloud, Introduction to cloud environment deployment, Concept of Datacenter, Cloud Datacenter, Deployment of private/public cloud Datacenter using open-source tools like Openstack, Open Nebula. Deployment of various cloud services using open-source tools, Amazon Web Services (AWS), Google Cloud Platform (GCP), and various others. Exploring SaaS, PaaS, IaaS, Company offerings, Industries, Software + services: Overview, Mobile Device Integration, Providers, Microsoft Online Application development: Google, Microsoft, Development Platforms: Google, Sales Force, Azure, Troubleshooting, Application management	7	CO2, CO3
6	Cloud Administration: Performance prediction for HPC on Cloud, SLA management: Types of SLA, Life cycle of SLA, Traditional approaches of SLA, Service catalog, service ordering process, management and functional interfaces of services, cloud portal and its functions, Management responsibilities, lifecycle management, cloud management products, Cloud management standards	4	CO4
7	Security in Cloud Computing: Technologies for Data security, Data security risk, Cloud computing and identity, Digital identity and access management, Content level security, Security-As-A-Cloud Service, Cloud security, Identity and presence protocol standards, Availability management in SaaS, IaaS, PaaS, Access Control, Security, Vulnerability, Patch and Configuration Management, Security as a Service of cloud, Future of Security in Cloud computing	4	CO4
8	Advances in the Domain	4	CO4

Recommended Reading	
1.	Dorothy Elizabeth Robling Denning, "Cryptography and Data Security," Addison-Wesley Publishing Company.
2.	Charles P. Pfleeger, "Security in Computing," Fifth Edition, Prentice Hall Publication.
3.	Matt Bishop, "Introduction to Computer Security," Addison-Wesley Publication.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3005T
Course Title	Cryptography
Course Type	PCC
Prerequisites: NIL	
Course Outcomes: At the end of the course student will be able to: **CO1:** Understand the fundamental principles and goals of cryptography and Analyze classical and modern cryptographic algorithms. **CO2:** Implement symmetric and asymmetric encryption techniques.. **CO3:** Apply hashing and digital signatures for data integrity and authentication and Understand key management and public key infrastructure.	

	Course Contents	Hrs.	CO
1	Introduction to Cryptography: Security Goals: Confidentiality, Integrity, Authentication, Non-repudiation , Cryptographic Terminology and Types: Symmetric, Asymmetric, Hashing , Classical Cryptography: Caesar Cipher, Monoalphabetic, Vigenère Cipher, Hill Cipher, Playfair Cipher, Cryptanalysis Techniques	4	CO1
2	Symmetric Key Cryptography: Concepts: Block vs Stream Cipher, Substitution and Transposition Feistel Network Structure DES Algorithm: Structure and Key Scheduling Triple DES and its Limitations AES Algorithm: Rounds and Transformations Comparison of DES, 3DES, and AES	4	CO2
3	Number Theory for Cryptography: Introduction to Modular Arithmetic Greatest Common Divisor (GCD), Euclidean and Extended Euclidean Algorithm Prime Numbers, Relatively Prime Numbers Modular Inverse, Fermat's Little Theorem, Euler's Theorem	4	CO1
4	Asymmetric Key Cryptography: Public Key Cryptography Basics RSA Algorithm: Key Generation, Encryption, and Decryption Mathematical Foundations of RSA, RSA Security and Attacks, Diffie–Hellman Key Exchange, Elliptic Curve Cryptography (ECC): Concepts and Advantages	4	CO2
5	Hash Functions and Authentication and Digital Signatures and Key Management: Hash Function Properties: Preimage Resistance, Collision Resistance, MD5 and SHA Family: Overview HMAC and MAC Mechanisms Birthday Attack, Avalanche Effect, Digital Signature Concepts and RSA-based Implementation, ElGamal Digital Signature Key Distribution Methods, Public Key Infrastructure (PKI), Certificate Authority (CA), X.509 Certificates and Their Applications	4	CO3

Text Books	
1.	Stallings William , "Cryptography and Network Security - Principles and Practice, Pearson, 2017
Reference Books	
1.	Forouzan, "Cryptography And Network Security," McGraw-Hill, 2015.
2.	Wen Bo Mao, "Modern Cryptography - Theory and Practice," Prentice Hall, USA, 2003. (Indian edition available).

Programme Name	B. Tech. Information technology
Course Code	R5IT3003L
Course Title	Machine Learning Lab
Course Type	PCC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Demonstrate the usage of preparation of data sets for implementation of machine learning algorithms. **CO2.** Implement the machine learning concepts and algorithms in any suitable language of choice. **CO3.** Evaluate the machine learning algorithms which are more appropriate for various types of learning tasks in various domains related to data set. **CO4.** Apply and analyse deep learning algorithms to solve research problems.	

Sr. No.	Course Contents
1.	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2.	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
3.	Write a program to demonstrate the working of the decision tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4.	Build an Artificial Neural Network by implementing the Back-propagation algorithm and test the same using appropriate data sets.
5.	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering a few test data sets.
6.	Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7.	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using the standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8.	Apply the EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using the k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9.	Write a program to implement the k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
10.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select an appropriate data set for your experiment and draw graphs.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3002L
Course Title	Software Engineering Lab
Course Type	PCC
Prerequisites: Computer & Software Fundamentals Laboratory	
Course Outcomes: At the end of the course student will be able to: **CO1:** Carry out different umbrella activities of a software development project such as cost and time estimation. **CO2:** Identify issues in risk management, project scheduling, and tracking. **CO3:** Assure software quality and manage software configuration. **CO4:** Carry out different framework activities of a software development project such as requirements gathering, analysis, design, coding, and testing.	

	Course Contents	Hrs.	CO
1.	**Give Detailed Problem Statement:** Define and document the problem statement with a clear understanding of project requirements and objectives.	01	CO1
2.	**Prepare Software Scope:** Identify the boundaries and scope of the software, including functionalities, constraints, and user expectations.	01	CO1
3.	**Estimate Required Resources:** Assess the necessary hardware, software, and human resources required for successful project execution.	01	CO1
4.	**Perform Software Cost and Time Estimation:** Apply estimation techniques to predict the cost and time required for project completion.	01	CO1
5.	**Perform Risk Analysis and Prepare RMMM Plan:** Identify potential risks, assess their impact, and develop a Risk Mitigation, Monitoring, and Management (RMMM) plan.	02	CO2
6.	**Prepare Project Schedule:** Develop a timeline and task allocation for various software development phases using scheduling techniques.	01	CO2
7.	**Prepare Software Quality Assurance Plan (SQA Plan):** Define quality standards, testing strategies, and quality control measures for software development.	02	CO3
8.	**Prepare Project Plan:** Document the complete project plan, including milestones, deliverables, and development strategies.	01	CO3
9.	**Carry out Requirement Analysis Modeling:** Develop requirement models using data flow diagrams, use case diagrams, and entity-relationship models.	03	CO4
10.	**Prepare Software Requirements Specification (SRS):** Create a detailed document specifying functional and non-functional requirements for the software.	01	CO4
11.	**Carry out Software Design:** Perform data design, architecture design, interface design, and component-level design to define system structure.	05	CO4
12.	**Write Code and Implement the Software:** Develop and integrate software components according to the design specifications.	03	CO4
13.	**Develop Test Cases and Perform Software Testing:** Create and execute test cases to validate software functionality and correctness.	03	CO4
14.	**Change Specifications and Create Software Versions:** Modify software specifications and manage different versions through version control.	02	CO3

Text Books	
1.	Roger Pressman, "Software Engineering," McGraw Hill, Eighth Edition.
2.	Ian Somerville, "Software Engineering," Pearson Education, Sixth Edition.
Reference Books	
1.	W. S. Jawadekar, "Software Engineering," TMH, First Edition.
2.	R. Mall, "Fundamentals of Software Engineering," Prentice Hall of India, Second Edition.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3001L
Course Title	Parallel Programming Lab
Course Type	VSEC

Prerequisites: C/C++ programming, Python
.

Course Outcomes: At the end of the course student will be able to:
CO1: Understand multi-core shared memory programming and demonstrate the ability to implement and optimize parallel algorithms using OpenMP for fundamental computational problems.
CO2: Develop and execute MPI-based programs for distributed computing tasks.
CO3: Apply GPU programming techniques to design and optimize GPU-accelerated solutions for computational problems.
CO4: Integrate hybrid parallel programming models (MPI + OpenMP or MPI + CUDA) to solve real-time complex computational problems.

	Course Contents	Hrs.	CO
1	Write an OpenMP program for matrix multiplication, measure the performance with a 1000 x 1000 matrix using a sequential program, and determine the speedup of the parallel program	2	CO1
2	Write the OpenMP program to find prime numbers between 2 and the given number and store all the prime numbers in an array	1	CO1
3	Write an OpenMP program to print the largest element in an array using OMP_critical section call and PARALLEL FOR DIRECTIVE	1	CO1
4	Write an OpenMP program for ring topology	1	CO1
5	Write an OpenMP program for PI calculation	1	CO1
6	Write a simple MPI program for calculating rank and number of processors	1	CO2
7	Write an advanced MPI program with 4 processes. The process with rank 0 should send 'VJTI' to all processes using MPI_Scatter call	1	CO2
8	Write an advanced MPI program to find the maximum value in an array of six integers with 6 processes and print the result in the root process using MPI Reduce call	1	CO2
9	Write an MPI program for PI calculation	1	CO2
10	Write a numerical computing program to implement the Trapezoid Rule with MPI	1	CO2
11	Write a numerical computing program for implementing a Gaussian filter with MPI	1	CO2
12	Write a simple CUDA program for 'Hello World'	1	CO3
13	Write a CUDA program for Matrix addition	1	CO3
14	Write a CUDA program for prefix Sum	1	CO3
15	Write a CUDA program for Matrix Transpose	1	CO3
16	Write a CUDA program for vector addition	1	CO3
17	Write a CUDA program for vector multiplication	1	CO3
18	Hybrid Parallel Matrix Multiplication using MPI and CUDA	2	CO4
19	Parallel Hyper Quick Sort Algorithm using MPI+OpenMP	2	CO4
20	Mini Project	6	CO1-4

Text Books	
1.	Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," Tata McGraw-Hill, 2011.
2.	Barbara Chapman, "Using OpenMP: Portable Shared Memory Parallel Programming," The MIT Press, Cambridge, Massachusetts, London, England, 2008.
3.	David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach," Second Edition, Elsevier, 2013.
4.	Ananth Grama, "An Introduction to Parallel Computing: Design and Analysis of Algorithms," Pearson Publication, 2009.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3201T
Course Title	Deep Learning and Neural Network
Course Type	MDM
Prerequisites: Introduction to Computer & Software	
Course Outcomes: At the end of the course student will be able to: **CO1.** Learn the basics of Artificial Neural Networks (ANN). **CO2.** Understand the different layers of ANN and other neural network models. **CO3.** Apply the knowledge to understand deep learning models.	

	Course Contents	Hrs.	CO
1.	**Information Flow in a Neural Network:** Understanding Basic Structure and Artificial Neural Networks (ANN)	8	CO1
2.	**Training a Neural Network:** How to Determine Hidden Layers, Recurrent Neural Network (RNN)	6	CO2
3.	**Convolutional Neural Networks:** Image Classification and CNN	5	CO3
4.	**RNN and LSTMs:** Applications of RNN in Real-World Scenarios	5	CO4

Text Books	
1.	Andreas C. Müller and Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists".

Programme Name	B. Tech. Information Technology
Course Code	R5IT3202T
Course Title	High Performance Computing Systems
Course Type	MDM
Prerequisites: Discrete Structure	
Course Outcomes: At the end of the course student will be able to: **CO1.** Understand parallel algorithm design and computation. **CO2.** Implement normal algorithms and hypercubic networks. **CO3.** Analyze and optimize message routing techniques. **CO4.** Apply HPC in real-world applications.	

	Course Contents	Hrs.	CO
1.	**Parallel Algorithm & Computation: Parallel Computer Organization:** Network Model (Fine-Grained, Coarse-Grained Models) **Parallel Algorithm Design:** Fine-Grained Model, Prefix Computation, Simulating Large Trees on Small Trees Simulation Among Different Topologies	4	CO1
2.	**Normal Algorithms and Hypercubic Networks: Normal Algorithms:** Fourier Transforms, Hypercube Implementation, Sorting, Packing **Hypercubic Networks:** Butterfly Network, Omega Network, deBruijn Network, Shuffle Exchange Network	6	CO2
3.	**Message Routing:** Routing Models and Algorithms, Path Selection, Scheduling, Buffer Management **Case Studies:** Hypercube Routing, All-to-All Routing, Permutation Routing on Hypercubes, Queue Size in Random Destination Routing on a Mesh, Existence of Schedules, Lovasz Local Lemma, Routing on Levelled Directed Networks	4	CO3
4.	**Examples and Applications of High-Performance Computing (HPC): Scientific Computing Applications:** Weather Forecasting, Climate Modeling, Biomedical and Pharmaceutical Research , Engineering and Industrial Applications Supercomputing Systems and Case Studies	6	CO4

Text Books	
1.	Ranade, Abhiram. "Foundations of Parallel Computation." 2015.
2.	Grama, Ananth. "An Introduction to Parallel Computing: Design and Analysis of Algorithms." Pearson Publication, 2009.
Recommended Reading	
1.	Hwang, Kai, and Briggs, Faye A. "Computer Architecture and Parallel Processing." McGraw-Hill International Edition.
Online Resources	
1.	`https://www.cse.iitb.ac.in/~ranade/606/`

Programme Name	B. Tech. Information Technology
Course Code	R5IT3203T
Course Title	Data Communication and Networking
Course Type	MDM
Prerequisites: Introduction to Computer & Software	
Course Outcomes: At the end of the course student will be able to: **CO1.** Demonstrate basic knowledge of software measurement. **CO2.** Plan a software project effectively. **CO3.** Assure software quality through systematic processes. **CO4.** Manage software configuration efficiently.	

	Course Contents	Hrs.	CO
1.	**Need of Protocols:** Types of Protocols	6	CO1
2.	**IoT Protocols:** IPv6, 6LoWPAN	5	CO2
3.	**IoT Protocols:** MQTT, CoAP	5	CO3
4.	**Wireless Sensor Networks (WSN):** RFID, Introduction to IoT Boards, WSN	6	CO4

Text Books	
1.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 2017.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3204T
Course Title	Geospatial Data Analysis with Python Libraries
Course Type	MDM
Prerequisites: Introduction to Computer & Software	
Course Outcomes: At the end of the course student will be able to: **CO1.** Learn the basics of Python for geospatial data processing. **CO2.** Understand different techniques available for geospatial analysis. **CO3.** Apply the knowledge to solve geospatial problems.	

	Course Contents	Hrs.	CO
1.	**Python Libraries for Geospatial Data:** Python libraries specifically designed for geospatial data manipulation and analysis	6	CO1
2.	**Python Libraries for Geospatial Data:** Python libraries specifically designed for geospatial data manipulation and analysis	5	CO2
3.	**Python Libraries for Geospatial Data:** Python libraries specifically designed for geospatial data manipulation and analysis	4	CO3
4.	**Geospatial Libraries:** Libraries like Pandas, GeoPandas, and Matplotlib for Geospatial Data Analysis	6	CO4

Text Books	
1.	Christine Garrard, “Geoprocessing with Python”, 2016.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3102T
Course Title	Image Processing
Course Type	PEC

Prerequisites: NIL.

Course Outcomes: At the end of the course student will be able to:

CO1. Understand fundamental concepts, transformations, and enhancement techniques used in digital image processing.

CO2. Utilize color models, transformations, and restoration methods to enhance and reconstruct images.

CO3. Analyze and apply various image compression techniques and morphological operations for image processing tasks.

CO4. Use edge, region-based segmentation, and morphological methods for extracting meaningful information from images.

CO5. Implement neural networks and decision-theoretic approaches for object detection.

CO6. Explore advanced image processing techniques.

	Course Contents	Hrs.	CO
1.	**Fundamentals of image processing & Image Enhancement:** Introduction, Applications, Fundamental steps, Components of an image processing system, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between pixels. **Image Transforms:** Fourier Transform and their properties, Fast Fourier Transform, Other Transforms. **Image Enhancement:** Background, some basic Intensity Transformation, Histogram processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. **Case Study:** Enhancement of Satellite Images.	06	CO1
2.	**Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and sharpening, Image Segmentation based on color, Noise in color images. **Case Study:** Color Segmentation application.	06	CO2
3.	**Image Restoration and Reconstruction:** Introduction to restoration and reconstruction, noise models, Restoration in the presence of Noise only – spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position – Invariant Degradations, Estimating the Degradation Function, Image reconstruction from Projections. **Case Study:** Restoration and reconstruction of Historical Devanagari Manuscripts.	06	CO2
4.	**Image Compression:** Fundamentals: Coding Redundancy, Spatial and Temporal Redundancy, Irrelevant Information, Fidelity Criteria, Measuring Image information, Image compression models, Image formats, Containers and Compression standards. Some Basic compression methods: Huffman Coding, Golomb Coding, Arithmetic Coding, LZW coding, Run-Length coding, Symbol based coding. **Case study:** Image compression using Bandlets and Contourlets.	08	CO3
5.	**Morphological Image Processing and Segmentation:** Morphological Image Processing: Preliminaries, Erosion and dilation, opening and closing operations, basic morphological operations such as region filling, thinning, thickening, skeletons, pruning for binary images. **Image Segmentation:** Fundamentals, Point, Line and Edge detection, Region based segmentation. **Case study:** Applications of Morphological image processing in the domain of forensic, metrology, etc. Medical Image segmentation and its applications.	05	CO3, CO4
6.	**Application of Neural Network for object detection:** Pattern and pattern classes, Recognition based on decision – Theoretic methods: Matching Optimum Statistical Classifiers, Neural Networks and Structural Methods: Matching Shape Numbers, String Matching. **Case Study:** Suspicious Object Detection.	02	CO5
7.	**Advances in Digital Image Processing.**		CO6

Text Books	
1.	Gonzalez, Rafael C., and Woods, Richard E. "Digital Image Processing." 4th Edition, Global Edition, ISBN 978-0-13-335672-4.
2.	Jayaraman, S., Esakkirajan, S., Veerakumar, T. "Digital Image Processing." Tata McGraw Hill Education, 2009.
Recommended Reading	
1.	Jain, Anil K. "Fundamentals of Digital Image Processing." Prentice-Hall of India, 1997, ISBN: 8120309294.
2.	Sonka, Milan, et al. "Image Processing, Analysis, and Machine Vision." Thomson, Austria, 2008.
3.	Dey, Sandipan. "Hands-On Image Processing with Python: Expert Techniques for Advanced Image Analysis and Effective Interpretation of Image Data." Packet Publishing, Germany, 2018.

Programme Name	B. Tech. Computer Engineering
Course Code	R5IT3102L
Course Title	Image Processing Lab
Course Type	Program Elective –I

Prerequisites: Nil

Course Outcomes: At the end of the course student will be able to:

CO1. Install and apply Python libraries for fundamental image manipulations.

CO2. Implement geometric transformations and filtering techniques for noise reduction.

CO3. Perform histogram-based enhancement, edge detection, and morphological operations.

CO4. Apply edge-based and region-based techniques for object separation.

CO5. Implement image compression methods and object detection techniques.

	Course Contents	Hrs.	CO
1.	Set up different image processing libraries in Python. Perform basic image manipulations and transformations.	02	CO1
2.	Perform linear and non-linear filtering for noise smoothing for a noisy image.	02	CO2
3.	Perform histogram equalization and matching.	02	CO2, CO3
4.	Perform edge detection from an image using derivatives and filters.	06	CO2, CO3
5.	Perform various morphological operations on an image. (Erosion, Dilation, Skeletonizing, removing small objects, extracting boundaries etc.)	02	CO2, CO3
6.	Perform edge-based and region-based segmentation.	02	CO4
7.	Perform image compression using any basic algorithm (e.g. Huffman coding, run length coding, symbol-based encoding).	02	CO5
8.	Perform object detection from an image.	02	CO5

Text Books

1. Gonzalez, Rafael C., and Woods, Richard E. "Digital Image Processing." Fourth Edition, Global Edition, ISBN 978-0-13-335672-4.
2. Jayaraman, S., Esakkirajan, S., and Veerakumar, T. "Digital Image Processing." Tata McGraw Hill Education, India, 2009.

Recommended Reading

1. Jain, Anil K. "Fundamentals of Digital Image Processing." Prentice-Hall of India, 1997, ISBN 8120309294.
2. Sonka, Milan, et al. "Image Processing, Analysis, and Machine Vision." Thomson, Austria, 2008.
3. Dey, Sandipan. "Hands-On Image Processing with Python: Expert Techniques for Advanced Image Analysis and Effective Interpretation of Image Data." Packet Publishing, Germany, 2018.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3101T
Course Title	Optimization Techniques
Course Type	PEC

Prerequisites: Basic Linear Algebra

Course Outcomes: At the end of the course student will be able to:

CO1. Apply linear programming techniques for problem solving.

CO2. Analyze and implement unconstrained and constrained Non-Linear optimization techniques.

CO3. Design and optimize Multi-Objective Problems Using Single-objective Meta-heuristic optimization algorithm.

CO4. Integrate Optimization Techniques in Machine Learning Applications.

	Course Contents	Hrs.	CO
1.	**Linear Programming:** Introduction, Simplex Method, Duality, Non-simplex Method.	06	CO1
2.	**Unconstrained Optimization:** Condition for Local Minimizer, One-Dimensional Search Methods, Gradient Methods, Newton's Method.	06	CO2
3.	**Non-linear Constrained Optimization:** Problems with Equality Constraints, Optimization Problems, Algorithms for Constrained Optimization, Single-objective heuristic optimization algorithm.	06	CO2
4.	**Single-objective optimization:** Simulated Annealing, Evolutionary Algorithms, Teaching-Learning-Based Optimization (TLBO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC), Grey Wolf Optimizer (GWO), Bat Algorithm, Hybrid Optimization Techniques.	08	CO3
5.	**Multiobjective Optimization:** Non-Elitist Multi-Objective Evolutionary Algorithms, Elitist Multi-Objective Evolutionary Algorithms, Constrained Multi-Objective Evolutionary Algorithms.	08	CO3
6.	**Optimization in Machine Learning and Parallel Programs:** Continuous Optimization, Discrete optimization, Submodular Functions, Load balancing techniques, data Locality optimization, synchronization and communication optimization, Optimization strategy selection.	08	CO4

Text Books	
1.	Nocedal, Jorge, and Wright, Stephen J. "Numerical Optimization." Springer, 2000.
2.	Chong, Edwin K. P., and Zak, Stanislaw H. "Introduction to Optimization." Wiley, 2013.
Recommended Reading	
1.	Nayak, Sukanta. "Fundamentals of Optimization Techniques with Algorithms." Academic Press, 2020.
2.	Deb, Kalyanmoy. "Multi-Objective Optimization Using Evolutionary Algorithms." Wiley, 2009.
3.	Bubeck, Sebastien. "Convex Optimization: Algorithms and Complexity." Now Publishers, 2015.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3101L
Course Title	Optimization Techniques Lab
Course Type	PEC

Prerequisites: Basic Linear Algebra

Course Outcomes: At the end of the course student will be able to:

CO1. The student will be able to apply optimization techniques to real-world problems using advanced modeling tools.

CO2. Students will be able to design and implement single-objective heuristic optimization algorithms using programming languages.

CO3. Students will be able to develop multi-objective optimization solutions for complex engineering challenges.

CO4. The student will be able to integrate optimization algorithms into mini-projects addressing engineering problems.

	Course Contents	Hrs.	CO
1.	**Linear, nonlinear, and discrete optimization problem:** Problem solved using Generalized Algebraic Modelling System (GAMS) software.	04	CO1
2.	**Linear, nonlinear, and discrete optimization problem:** Problem solved using IBM ILOG Optimization Studio.	04	CO1
3.	Write a MATLAB or Python program for Teaching Learning-Based Optimization.	02	CO2
4.	Write a MATLAB or Python program for Particle Swarm Optimization.	02	CO2
5.	Write a MATLAB or Python program for the Artificial Bee Colony Algorithm.	02	CO2
6.	Write a MATLAB or Python program for the Gray Wolf Optimization Algorithm.	02	CO2
7.	Write a MATLAB or Python program for the Non-Dominated Sorting Genetic Algorithm 2 (NSGA-II).	04	CO3
8.	Write a multi-objective MATLAB or Python program for the Artificial Bee Colony Algorithm.	04	CO3
1.	**Mini Project:** Integrate optimization algorithms into mini-projects addressing engineering design, scheduling, machine learning problems.	06	CO4

Text Books

1. Nocedal, Jorge, and Wright, Stephen J. "Numerical Optimization." Springer, 2000.
2. Chong, Edwin K. P., and Zak, Stanislaw H. "Introduction to Optimization." Wiley, 2013.
3. Deb, Kalyanmoy. "Multi-Objective Optimization Using Evolutionary Algorithms." Wiley, 2009.
4. Bubeck, Sebastien. "Convex Optimization: Algorithms and Complexity." Now Publishers, 2015.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3103T
Course Title	NO SQL database
Course Type	Program Elective –I

Prerequisites: Database Management System.

Course Outcomes: At the end of the course student will be able to:

CO1. Compare relational databases with No SQL databases with the knowledge of the principles of distributed databases.

CO2. Identify the type of No SQL database to be applied on an application.

CO3. Design a key-value database, document database, column family database, or graph database for an application.

CO4. Understand the significance of partitioning of data, hash functions, query processing, and indexing in No SQL databases.

	Course Contents	Hrs.	CO
1.	**Unit 1: Relational Database Management System and its limitations, Motivation for No SQL databases:** Characteristics of NoSQL databases: Scalability, Cost, Flexibility, Availability, Data Management with Distributed Databases, Managing Persistent Data, Consistency, and Availability in Distributed Databases, Consistency, Availability, and Partitioning: The CAP Theorem, ACID and BASE, Types of Eventual Consistency.	06	CO1
2.	**Unit 2: Key Value Databases:** Arrays, Essential Features of key-value databases: Simplicity, Speed and Scalability, Properties of keys, Key value data modeling, Key-value architecture, Key-value implementation, Design of key value databases: key design and Partitioning, Designing Structured values, Limitations of key-value databases, Design Patterns for key-value databases.	06	CO2
3.	**Unit 3: Document Databases:** Documents and Collections, Types of Partitions, Modeling and Query Processing, Balancing Normalization and Denormalization, Mutable Documents, Indexes, Modeling common relations.	06	CO3
4.	**Unit 4: Column Family Databases:** Google BigTable, Differences and similarities to key-value and Document Databases, Architecture: HBase Architecture, Cassandra Architecture, When to use column family databases, Components of Column family databases, Implementing Column Family Databases, Processes and Protocols: Anti Entropy, Gossip Protocol, Guidelines for designing column family database and indexing, Tools for working with Big Data.	06	CO4
5.	**Unit 5: Graph Databases:** Graphs and Network Modeling, Advantages of Graph Databases, Graph database terms: Elements, Operations, Properties of graphs and nodes, Types of graphs, Designing Graph Database, Querying: Declarative Querying, Query by Traversal, Indexing, Scalability of graph.	06	CO5
6.	**Unit 6: Case study for each type of No SQL database, Guidelines for choosing NoSQL database.**	06	CO6

Text Books	
1.	Sullivan, Dan. "No SQL for Mere Mortals." Addison-Wesley.
2.	McCreary, Dan, and Kelly, Ann. "Making Sense of NoSQL: A Guide for Managers and the Rest of Us." Manning Shelter Island.
Recommended Reading	
1.	White, Tom. "Hadoop: The Definitive Guide." O'Reilly.
2.	George, Lars. "HBase: The Definitive Guide: Random Access to Your Planet-Size Data." O'Reilly.
3.	Robinson, Ian, Webber, Jim, and Eifrem, Emil. "Graph Database." O'Reilly.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3103L
Course Title	NO SQL database Lab
Course Type	Lab

Prerequisites: Database Management System.

Course Outcomes: At the end of the course student will be able to:

CO1. Build and maintain reliable, scalable, distributed systems with Apache Hadoop.

CO2. Develop key-value, document database, column databases for real-time database operations.

CO3. Apply partitioning and replication principles of distributed database for real-time operations on unstructured and semi-structured data.

CO4. Apply distributed database design principles to analyse query retrieval by applying partitioning and replication.

CO5. Apply Hadoop ecosystem components to solve real-world problems.

CO6. Develop critical thinking and problem-solving skills by analysing database requirements for a case study, designing appropriate solutions, and implementing efficient database structures and operations using relational and non-relational data models.

	Course Contents	Hrs.	CO
1.	Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop distributed file system, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster (one master and multiple slaves).	1	2
2.	To develop a No SQL database for the given case study using Mongo DB and perform database operations.	2	2
3.	Implement a Multimedia database in MongoDB.	2	4
4.	To implement partitioning algorithm using Mongo DB.	3	2
5.	To develop a No SQL database for the given case study using Cassandra and perform database operations.	3	2
6.	To implement MongoDB replication.	3	2
7.	To develop Recommendation system using Graph Analytics for Big Data on Graph Databases.	3	4
8.	To develop map reduce application using Hadoop Cluster.	4	4
9.	Mini Project.	5	6

Text Books	
1.	Sullivan, Dan. "No SQL for Mere Mortals." Addison-Wesley.
2.	McCreary, Dan, and Kelly, Ann. "Making Sense of NoSQL: A Guide for Managers and the Rest of Us." Manning Shelter Island.
Recommended Reading	
1.	Acharya, Seema, and Chellappan, Subhashini. "Big Data and Analytics." Wiley, 2016.
2.	White, Tom. "Hadoop: The Definitive Guide." O'Reilly.
3.	George, Lars. "HBase: The Definitive Guide: Random Access to Your Planet-Size Data." O'Reilly.
4.	Robinson, Ian, Webber, Jim, and Eifrem, Emil. "Graph Database." O'Reilly.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3106T
Course Title	Human Computer Interaction
Course Type	PCE
Prerequisites: Nil	
Course Outcomes: At the end of the course student will be able to: **CO1.** Apply concepts and guidelines of HCI. **CO2.** Design and examine interfaces and the interactions among them. **CO3.** Estimate and apply models and empirical data for system development. **CO4.** Develop and evaluate interactive systems.	

	Course Contents	Hrs.	CO
1.	**Introduction:** Objective, Overview and historical evolution of HCI, Guidelines for HCI: Shneiderman's eight golden rules, Norman's seven principles, Norman's model of interaction, Nielsen's ten heuristics with example of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough.	06+02	CO1
2.	**Interactive System Design:** Concept of usability: definition and elaboration, HCI and software engineering, GUI design and aesthetics, Prototyping techniques.	07+02	CO2
3.	**Model based design and evaluation:** Fundamental concepts, basic idea, different types of models, GOMS family of models (KLM and CMN- GOMS), Fitts' law and Hick-Hyman's law, Model-based design case studies.	07+02	CO3
4.	**Empirical research methods in HCI:** Motivation, issues, research question formulation techniques, experiment design and data analysis.	07+02	CO3
5.	**Task modeling and analysis:** Hierarchical Task Analysis (HTA), Engineering task models and Concur Task Tree (CTT).	06+02	CO4
6.	**Dialog Design:** Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and (classical) Petri Nets in dialog design.	05+02	CO4
7.	**Advances in the domain**	03	CO4

Text Books	
1.	Dix, A., Finlay, J., Abowd, G. D., and Beale, R. "Human Computer Interaction." Pearson Education, 3rd Edition, 2005.
2.	Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., and Carey, T. "Human Computer Interaction: Concepts and Design." Addison-Wesley, 1994.
Recommended Reading	
1.	Shneiderman, B., and Catherine, P. "Designing the User Interface." Addison-Wesley, 6th Edition, 2017.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3104T
Course Title	Compiler Construction
Course Type	PCE
Prerequisites: C/C++ Programming, Computer Organization, Operating System.	
Course Outcomes: At the end of the course student will be able to: **CO1.Understand Compiler basics and lexical analysis phase of compiler.** **CO2.Analyze Syntax analysis and semantic analysis phase of compiler.** **CO3.Illustrate Code optimizations, code generation and error detection.** **CO4.Apply parallelization in compiler.**	

	Course Contents	Hrs.	CO
1.	**Introduction to Compilers:** Overview of compilers, difference between compilers and interpreters, structure of a compiler. **Lexical Analysis:** Role of lexical analyzer, input buffering, specification and recognition of tokens	04	CO1
2.	**Syntax Analysis:** Context-free grammars, parsing techniques (LL, LR, SLR, LALR). Operator Precedence Parser **Semantic Analysis:** Syntax-directed definitions, evaluation orders, type checking.	08	CO2
3.	**Intermediate Code Generation:** Intermediate languages, declarations, assignments, procedure calls. **Code Optimization:** Sources of optimization, optimization of basic blocks, loops, dataflow analysis.	06	CO3
4.	**Code Generation:** Design of a code generator, run-time storage management, target machine architecture. **Error Detection and Recovery:** Lexical, syntactic, and semantic errors; error recovery strategies.	06	CO3
5.	**Parallel Compiler:** Parallel compilation, parallel parsing, semantic analysis, and optimization techniques **Parallel Code Generation:** Code generation for parallel architectures, synchronization, instruction scheduling.	04	CO4
6.	**Parallel Intermediate Representations:** Dependence analysis, loop transformations for parallel execution. **Optimizations for Parallel Execution:** Compiler transformations for parallelism, loop unrolling, software pipelining. **Advanced Topics in Parallel Compilation:** Just-in-time parallel compilation, GPU-based compilation, cloud-based optimization	08	CO4

Reference Books	
1.	Aho, A. V., Sethi, R., & Ullman, J. D. "Compilers: Principles, Techniques, and Tools." Addison-Wesley, 2007.
2.	Holub, A. I. "Compiler Design in C." Prentice Hall, 1990.
3.	Wolfe, M. "High-Performance Compilers for Parallel Computing." Addison-Wesley, 1995.
4.	Banerjee, U. "Loop Transformations for Restructuring Compilers." Springer, 1993.
5.	Allen, R., & Kennedy, K. "Optimizing Compilers for Modern Architectures: A Dependence-Based Approach." Morgan Kaufmann, 2001.
6.	Manoj B Chandak and Khushboo P Khurana, "Compiler Design," ISBN: 9789386235640, Year: 2018.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3104L
Course Title	Compiler Construction Lab
Course Type	PEC
Prerequisites:C/C++ Programming, Computer Organization, Operating System	
Course Outcomes: At the end of the course student will be able to: **CO1.** Understand compiler basics and the lexical analysis phase of a compiler. **CO2.** Analyze the syntax analysis and semantic analysis phases of a compiler. **CO3.** Illustrate code optimizations, code generation, and error detection. **CO4.** Apply parallelization in a compiler.	

	Course Contents	Hrs.	CO
1.	**Implement a Lexical Analyzer using Lex:** Develop a lexical analyzer to recognize tokens such as keywords, identifiers, operators, and literals.	02	CO1
2.	**Classify Tokens using Regular Expressions and Automata Theory:** Use formal methods to classify tokens for lexical analysis.	02	CO1
3.	**Develop a Symbol Table:** Implement a data structure to store variable names, types, and scopes for efficient semantic analysis.	02	CO1
4.	**Construct a Recursive Descent Parser:** Build a parser for a given arithmetic expression grammar using recursive descent techniques.	02	CO2
5.	**Implement an LL(1) Parser:** Develop an LL(1) parser using a parsing table for syntactic analysis.	02	CO2
6.	**Implement Syntax-Directed Translation using YACC:** Use YACC to evaluate arithmetic expressions with syntax-directed translation techniques.	02	CO2
7.	**Generate TAC for Expressions and Control Flow Statements:** Create three-address code (TAC) representations for expressions and control flow structures.	02	CO3
8.	**Implement Optimization Techniques:** Perform constant folding, dead code elimination, and common subexpression elimination to optimize the code.	02	CO3
9.	**Use YACC to Generate Assembly-like Code:** Develop an assembly-like code generator for arithmetic expressions using YACC.	02	CO1
10.	**Implement Error Detection and Recovery Strategies:** Develop mechanisms to detect and recover from lexical, syntax, and semantic errors.	02	CO3
11.	**Implement Loop Optimization Techniques:** Perform loop unrolling and loop-invariant code motion for efficient execution.	02	CO3
12.	**Simulate Parallel Parsing:** Implement multi-threaded parsing to divide input processing into parallel tasks.	02	CO4
13.	**Develop a Simple JIT Compiler:** Implement a Just-In-Time (JIT) compiler to optimize execution at runtime.	02	CO4

Recommended Reading	
1.	Aho, A. V., Sethi, R., & Ullman, J. D., "Compilers: Principles, Techniques, and Tools," Addison-Wesley, 2007.
2.	Holub, A. I., "Compiler Design in C," Prentice Hall, 1990.
3.	Wolfe, M., "High-Performance Compilers for Parallel Computing," Addison-Wesley, 1995.
4.	Banerjee, U., "Loop Transformations for Restructuring Compilers," Springer, 1993.
5.	Allen, R., & Kennedy, K., "Optimizing Compilers for Modern Architectures: A Dependence-Based Approach," Morgan Kaufmann, 2001.
6.	Manoj B. Chandak and Khushboo P. Khurana, "Compiler Design," ISBN: 9789386235640, Year: 2018.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3105T
Course Title	Distributed Database
Course Type	PEC
Prerequisites:	
Course Outcomes: At the end of the course student will be able to: **CO1:** Understand distributed database principles, architecture, data fragmentation, and integrity constraints for efficient system design. **CO2:** Apply query translation and optimization techniques for efficient query processing in distributed databases. **CO3:** Implement transaction management and concurrency control to ensure atomicity, consistency, and reliability. **CO4:** Evaluate advanced architectures and integration technologies for scalable, interoperable distributed systems.	

	Course Contents	Hrs.	CO
1.	**Introduction to Compilers:** Overview of compilers, difference between compilers and interpreters, structure of a compiler. **Lexical Analysis:** Role of lexical analyzer, input buffering, specification and recognition of tokens	04	CO1
2.	**Syntax Analysis:** Context-free grammars, parsing techniques (LL, LR, SLR, LALR). Operator Precedence Parser **Semantic Analysis:** Syntax-directed definitions, evaluation orders, type checking.	08	CO2
3.	**Intermediate Code Generation:** Intermediate languages, declarations, assignments, procedure calls. **Code Optimization:** Sources of optimization, optimization of basic blocks, loops, dataflow analysis.	06	CO3
4.	**Code Generation:** Design of a code generator, run-time storage management, target machine architecture. **Error Detection and Recovery:** Lexical, syntactic, and semantic errors; error recovery strategies.	06	CO3
5.	**Parallel Compiler:** Parallel compilation, parallel parsing, semantic analysis, and optimization techniques **Parallel Code Generation:** Code generation for parallel architectures, synchronization, instruction scheduling.	04	CO4
6.	**Parallel Intermediate Representations:** Dependence analysis, loop transformations for parallel execution. **Optimizations for Parallel Execution:** Compiler transformations for parallelism, loop unrolling, software pipelining. **Advanced Topics in Parallel Compilation:** Just-in-time parallel compilation, GPU-based compilation, cloud-based optimization	08	CO4

Text Books	
1.	Stefano Ceri and Giuseppe Pelagatti, "Distributed Database Principles & Systems," Tata McGraw Hill, 1988.
Reference Books	
1.	M. Tamer Ozsu and Patrick Valduriez, "Principles of Distributed Database Systems," Pearson Education, 2011.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3105L
Course Title	Distributed Database Lab
Course Type	PEC
Prerequisites:	
Course Outcomes: At the end of the course student will be able to: **CO1:** Understand the architecture, principles, and data fragmentation techniques in distributed databases for efficient system design. **CO2:** Apply query translation, optimization, and execution strategies to improve distributed query performance. **CO3:** Implement transaction management, concurrency control, and recovery techniques to ensure data consistency and reliability. **CO4:** Analyze advanced distributed database architectures and integration technologies for scalable, interoperable systems.	

	Course Contents	Hrs.	CO
1.	**Setting Up a Distributed Database Environment:** Configure and establish a distributed database system, including network setup, node configuration, and database connectivity.	02	CO1
2.	**Implementing Data Fragmentation Techniques:** Apply horizontal, vertical, and hybrid fragmentation techniques to optimize data distribution across multiple sites.	02	CO1
3.	**Translating Global Queries into Fragment Queries:** Develop methods to translate global queries into fragment-specific queries, ensuring efficient data retrieval in distributed databases.	02	CO2
4.	**Optimizing and Executing Distributed Queries:** Implement optimization strategies for distributed query processing, focusing on minimizing data transfer and execution time.	02	CO2
5.	**Managing Distributed Transactions:** Design mechanisms to manage distributed transactions, ensuring atomicity, consistency, isolation, and durability (ACID properties) across multiple databases.	02	CO3
6.	**Applying Concurrency Control in Distributed Databases:** Utilize concurrency control techniques, including locking protocols and timestamp ordering, to manage simultaneous access to distributed data.	02	CO3
7.	**Implementing Failure Recovery Mechanisms:** Develop recovery strategies to handle system failures, including checkpointing, logging, and rollback mechanisms in distributed environments.	02	CO4
8.	**Detecting and Resolving Distributed Deadlocks:** Implement techniques to detect, prevent, and resolve deadlocks in distributed databases, ensuring smooth transaction processing.	02	CO4
9.	**Exploring Object-Oriented Features in Distributed Databases:** Integrate object-oriented concepts, such as object identifiers, inheritance, and encapsulation, into distributed database systems for enhanced functionality.	02	CO4
10.	**Integrating Multiple Databases for Interoperability:** Design and implement strategies for integrating heterogeneous databases, ensuring seamless interoperability and data consistency.	02	CO4

Text Books	
1.	Stefano Ceri and Giuseppe Pelagatti, "Distributed Database Principles & Systems," Tata McGraw Hill, 1988.
Reference Books	
1.	M. Tamer Ozsu and Patrick Valduriez, "Principles of Distributed Database Systems," Pearson Education, 2011.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3006T
Course Title	System Security
Course Type	PCC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Identify cybercrimes, and respective cyber laws. **CO2.** Build the secure network infrastructure and reduce the risk of attacks. **CO3.** Reduce the risk of data theft and web application attacks. **CO4.** Explore the Security and Forensic Best Practices in the Advanced Domain.	

	Course Contents	Hrs.	CO
1	Cyber Threats and Attacks and laws: What is Cyber Security, its needs, Security Parameters, Vulnerabilities, cybercrimes and stalking, Hacking Phases, Investigation of Cyber Crimes and evidential aspects of cyber laws, IT Acts-2000 and cybercrimes, IPR, Media Law, IPC for cyber-crimes, CrPC and IT Act 2000, International cyber laws, Cyber-crime case studies	4	CO1, CO2
2	TCP/IP Stack: Vulnerabilities and attacks on TCP/IP stack-DOS: R2L, U2R, probing, Vulnerabilities and Attack on Application Layer Protocols, Transport Layer (TCP/UDP), Internet Layer, Data communication/ Link Layer Attacks and Defense Mechanisms, Cryptanalysis Techniques and building robust algorithms of cryptography	7	CO1, CO2
3	TCP/IP Routing and security Protocols: Vulnerabilities and Attacks On TCP/IP routing protocols and security protocols and their defense mechanisms	7	CO1, CO2
4	Secure Network Design: Networking Scanning, secure Network Architecture design, Network Security Devices - firewalls, intrusion prevention systems, router attacks and defense mechanisms, network analysis Tools - Wireshark and NMAP, Case Studies	7	CO2, CO3
5	Web Application Attacks and Security: Web program security, OWASP and Defense Mechanism, access control, hardening LINUX OS for cyber security, Web Server and database servers' attacks and security, forensic, digital payments and dangers to credit cards on Net-SET	7	CO3
6	Advances in the domain: Handheld Devices and cloud attacks, security and forensic, Security and Forensic Best practices, Case Studies	7	CO3

Text Books	
1.	Dr. B.B. Meshram, Ms. K.A. Shirsath, "TCP/IP and Network Security: Attacks and Defense Mechanisms with Open-Source Tools," Shroff Publishers & Distributors PVT. LTD, 1st edition, 2017.
2.	William Stallings, "Cryptography and Network Security," Pearson Education/PHI, 2006.
Recommended Reading	
1.	Digital Forensics, DSCI - Nasscom, 2012.
2.	Cyber Crime Investigation, DSCI - Nasscom, 2013.
3.	Charles Pfleeger, "Security in Computing," 4th Edition, Prentice Hall of India, 2006.
4.	Joakim Kävrestad, "Fundamentals of Digital Forensics: Theory, Methods, and Real-Life Applications," Springer.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3007T
Course Title	Wireless Networks
Course Type	PCC
Prerequisites: Operating system	
Course Outcomes: At the end of the course student will be able to: **CO1.** Demonstrate the fundamentals of wireless technology. **CO2.** Apply the layered protocols and fundamentals for the design of wireless Scenario. **CO3.** Apply resource optimization techniques for better performance. **CO4.** Design and evaluate the working of different wireless networks.	

	Course Contents	Hrs.	CO
1.	Introduction: History of wireless communication, Frequency spectrum, Applications.	2	CO1
2.	Wireless Transmission: Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, modulation, Spread spectrum, Cellular systems.	4	CO1, CO2
3.	Medium Access Control: Motivation for a specialized MAC: Hidden and Exposed terminals. Near and Far terminals, multiplexing techniques.	4	CO1, CO2
4.	Wireless LAN: Infrared vs. Radio transmission, Infrastructure and Ad hoc Networks, IEEE 802.11: System architecture, Protocol architecture, Physical layer, Medium access control layer, MAC management, Overview of 3G, 4G, 5G, HIPERLAN, Bluetooth.	7	CO2, CO3
5.	Mobile Network Layer: Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunnelling and Encapsulation, Optimizations, Reverse tunnelling, Ipv6; Dynamic host configuration protocol, Ad hoc networks: Routing, Destination sequenced distance vector, Dynamic source routing, Hierarchical algorithms, Alternative metrics.	7	CO2, CO3
6.	Mobile Transport Layer: Traditional TCP, indirect TCP, Snooping TCP, Fast retransmit/fast recovery, transmission/time out freezing, selective retransmission, transaction oriented TCP.	7	CO2, CO3
7.	Support for Mobility: File system, World Wide Web, Wireless application protocol.	5	CO2, CO3, CO4
9.	Wireless network case study: WSN, WiMax, Cellular network.	4	CO3
10.	Advances in the domain.	2	CO3, CO4

Text Books	
1.	Schiller, J. "Mobile Communications," Addison Wesley, Pearson Education, 2nd Edition, 2002.
Recommended Reading	
1.	Stallings, W. "Wireless Communication Networks and Systems," Cory Beard, 1st Edition, 2015.
2.	Rappaport, T. S. "Wireless Communications Principles and Practices," 2nd Edition, Pearson Education Pvt. Ltd, 2003.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3008T
Course Title	Research Methodology
Course Type	PCC

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:
CO1. Design and formulation of research problem.
CO2. Analyze research related information and statistical methods in research.
CO3. Carry out research problem individually in a perfect scientific method.
CO4. Understand the filing patent applications processes, Patent search, and various tools of IPR, Copyright, and Trademarks.

	Course Contents	Hrs.	CO
1.	Introduction to research: Definitions and characteristics of research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Quantitative vs. Qualitative Approach, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs. Theoretical Research, Importance of reasoning in research.	2	CO1
2.	Problem Formulation, Understanding Modeling & Simulation, Literature Review, Referencing, Information Sources, Information Retrieval, Indexing and abstracting services, Citation indexes, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Interpretation of Results.	3	CO1
3.	Statistics: Probability & Sampling distribution, Estimation, Measures of central Tendency, Arithmetic mean, Median, Mode, Standard deviation, Coefficient of variation (Discrete series and continuous series), Hypothesis testing & application, Correlation & regression analysis, Orthogonal array, ANOVA, Standard error, Concept of point and interval estimation, Level of significance, Degree of freedom, Analysis of variance, One-way and two-way classified data, 'F' test.	4	CO2
4.	Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents.	2	CO3

Text Books	
1.	Bordens, K. S., and Abbott, B. B. "Research Design and Methods – A Process Approach," 8th Edition, McGraw Hill, 2011.
2.	Montgomery, D. C., and Runger, G. C. "Applied Statistics & Probability for Engineers," Wiley, 2007.
Reference Books	
1.	Marder, M. P. "Research Methods for Science," Cambridge University Press, 2011.

Programme Name	B. Tech. Information Technology
Course Code	
Course Title	Financial Management
Course Type	HSSM

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Identify and understand issues in financial technologies.
CO2. Design and apply models using R programming of financial technologies.
CO3. Demonstrate and summarize stock market trends.
CO4. Apply the knowledge of cryptocurrency market.

Text Books	
1.	Chishti, S., and Barberis, J. "The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries," 2016.
2.	Würtz, D., Setz, T., Chalabi, Y., Lam, L., and Ellis, A. "Basic R for Finance," 2015.
3.	Jeet, P., and Vats, P. "Learning Quantitative Finance with R," 2017.
Recommended Reading	
1.	Archarya, S. "Data Analytics Using R," 2018.
2.	Clifford, A. "Analyzing Financial Data and Implementing Financial Models Using R."
3.	Magee, J. "Technical Analysis of Stock Trends," 2009.

	Course Contents	Hrs.	CO
1.	Introduction to FinTech: Introduction to finance and technologies, current trends in financial technologies, Fintech ecosystems, emerging markets and social impact.	4	CO1
2.	Financial Solutions: Predictive Algorithms – Building Innovative Online Banking Solutions, Big Data is the Cornerstone of Regulatory Compliance Systems, FinTech Solutions in Complex Contracts Optimization, FinTech Solutions for Small Businesses.	4	CO1
3.	Capital, Investment and Innovations: Investment and Capital – Back to Basics, Angel Investing, Access to "Smart Money" to Fund the Best FinTech Companies. Crowd funding and Marketplace (P2P) Lending – Online Capital Marketplaces as New Asset Classes to Access Funding. The Digital Investment Space, Spanning from Social Trading to Digital Private Banking – A FinTech Sector Made for Disruption?, Leading the Way with an Investor-led Approach to Crowd funding.	4	CO1
4.	Financial Technology in R: Computation, Programming, plotting, statistics and Inference, utility functions, assets management, option valuation, and portfolio design.	4	CO2
5.	Stock Market analysis: Introduction to stock market, equity, derivatives, put options and call options, trading algorithms implementation using R.	2	CO3
6.	Crypto-currencies & Blockchain: Digital currencies, convergence and collisions, Blockchain technology.	4	CO4
7.	Advances in the domain.	2	CO4

Programme Name	B. Tech. Information Technology
Course Code	R5IT3004L
Course Title	Devops
Course Type	VSEC

Prerequisites: Software Engineering, Web Development, Cloud, Networking.

Course Outcomes: At the end of the course student will be able to:
CO1. Track the changes in the software application development and maintenance.
CO2. Demonstrate continuous integration and development of the software application.
CO3. Design continuous deployment strategy for the software application.
CO4. Apply test automation to the software application.
CO5. Perform configuration management and monitoring of the software application.
CO6. Develop and deploy a software application in the cloud environment.

It is expected to conduct 8-10 experiments in the field of knowledge. One hour shall be tutored about theory and relevant tools to the students, and students shall perform the experiment. This is continuous evaluation, hence all experiments shall be evaluated in the same week. A sample list of experiments is given it may be altered as and when required.

Sr. No.	Course Contents
1.	Practice source code management using Git and GitHub.
2.	Jenkins installation and setup, explore the environment. Demonstrate continuous integration and development using Jenkins.
3.	Explore Docker commands for content management. Develop a simple containerized application using Docker.
4.	Integrate Kubernetes and Docker. Automate the process of running containerized applications developed in exercise 3 using Kubernetes.
5.	Install and Explore Selenium for automated testing. Write a simple program in JavaScript and perform testing using Selenium.
6.	Install Ansible in the VM. Setup the inventory, run Ansible AdHoc commands. Also run a playbook in Ansible.
7.	Monitor systems, networks and infrastructure using Nagios application.
8.	Design an application using Cloud Services to apply DevOps concepts.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3005L
Course Title	System Security
Course Type	PCC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Identify cybercrimes, and respective cyber laws. **CO2.** Build the secure network infrastructure and reduce the risk of attacks. **CO3.** Reduce the risk of data theft and web application attacks. **CO4.** Explore the security, defense mechanisms, and forensic best practices in the advanced domain.	

Text Books	
1.	Dr. B.B. Meshram, Ms. K.A. Shirsath, "TCP/IP and Network Security: Attacks and Defense Mechanisms with Open-Source Tools," Shroff Publishers & Distributors PVT. LTD, 1st edition, 2017.
2.	John Sammons, "The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics," Elsevier, 1st Edition, 2012.
Recommended Reading	
1.	Charles Pfleeger, "Security in Computing," 4th Edition, Prentice Hall of India, 2006.
2.	Roberta Bragg, M.R. Ousley, Keith Strassberg, "Network Security - The Complete Reference," Tata McGraw-Hill.

	Course Contents: Experiments on	Hrs.	CO
1	Cyber Crime	2	CO1
2	TCP/IP Security Model	2	CO1, CO2
3	Secure Network Design for Organization	2	CO1, CO2, CO3
4	Practical Experiment on Firewall	2	CO1, CO3
5	Implement Intrusion Detection Systems:	2	CO2
6	Protocol Analysis Tools	2	CO1, CO3
7	The Attacks On Web Application and Defense Mechanism	2	CO1, CO3
8	Hardening Linux and Database for Cyber Security	2	CO2
9	Defense Mechanism Against Hackers Methodology	2	CO3, CO4
10	GROUP PROJECTS	2	CO3

Programme Name	B. Tech. Information Technology
Course Code	R5IT3005L
Course Title	Wireless Networks Lab
Course Type	PCC

Prerequisites: Operating system

Course Outcomes: At the end of the course student will be able to:

CO1. Demonstrate wireless fundamentals and build the topologies for wireless networks.

CO2. Implement to demonstrate the working of protocols of wireless networks.

CO3. Analysis of protocols in wireless networks.

CO4. Evaluate the performance of wireless networks.

	Course Contents	Hrs.	CO
1	Study of Simulators for wireless networks.	2	CO1
2	Build and configure Ad-hoc networks for various topologies.	2	CO1, CO2
3	Study of working Physical MAC, Network, Transport Layer parameters.	4	CO1, CO2
4	Analysis of protocols at different layers.	2	CO2, CO3
5	Implement and Study star topology for wireless sensor networks.	2	CO2, CO3
6	Implement and Study Multi-hop topology for wireless sensor networks.	2	CO2, CO3
7	Study and analyse protocols for wireless sensor networks.	2	CO2, CO3
8	Comparative analysis of IEEE 802.11a/b/g etc using network simulation software.	2	CO3
9	Set up a Wi-Fi network and analyze IEEE 802.11 protocol parameters using Wireshark.	2	CO2
10	Analysis of power consumption and energy optimization.	2	CO4

Text Books

1. Schiller, Jochen. "Mobile Communications," Addison Wesley, Pearson Education, 2nd Edition, 2002.

Recommended Reading

1. Stallings, William. "Wireless Communication Networks and Systems," Cory Beard, 1st Edition, 2015.
2. Rappaport, Theodore S. "Wireless Communications Principles and Practices," 2nd Edition, Pearson Education Pvt. Ltd, 2003.

Programme Name	B. Tech. Computer Engineering
Course Code	R5IT3205T
Course Title	Data visualization
Course Type	MDM
Prerequisites: Nil	
Course Outcomes: At the end of the course student will be able to: **CO1.** Learn the basics of Python for data visualization. **CO2.** Understand different models and techniques used for visualization. **CO3.** Apply the knowledge to solve various data visualization problems.	

	Course Contents	Hrs.	CO
1.	**Data Import and Visualization:** Introduction to various plots, Implementing data visualization techniques using Python libraries such as Matplotlib and Seaborn	4	CO1, CO2
2.	**Chart and Plot Creation:** Line, area, histograms, bar, pie, box, scatter, and bubble charts	6	CO3
3.	**Correlation Visualization and Analysis:** Dimensionality Reduction Algorithms, PCA Analysis	7	CO4
4.	**APIs for Advanced Processing:** APIs for various learning models	7	CO5, CO6

Text Books	
1.	Joel Grus, "Data Science from Scratch: First Principles with Python", 2nd Edition, O'Reilly Publication.
2.	Andreas C. Müller and Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists".

Programme Name	B. Tech. Information Technology
Course Code	R5IT3206T
Course Title	Hardware Software Co-Design
Course Type	MDM
Prerequisites: Introduction to Computer & Software	
Course Outcomes: At the end of the course student will be able to: **CO1.** Learn the basic knowledge of IoT (Arduino) and Raspberry Pi. **CO2.** Understand the architecture of Arduino. **CO3.** Apply the knowledge to perform programming on Arduino and Raspberry Pi.	

	Course Contents	Hrs.	CO
1.	**IoT Deployment for Raspberry Pi**	8	CO1
2.	**Arduino Platform:** Architecture	5	CO2
3.	**Arduino Platform Programming:** Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins	5	CO3
4.	**Arduino Platform Programming:** Accessing GPIO Pins – Display Output on LCD Board	5	CO4

Text Books	
1.	Pratik Desai, "Python Programming for Arduino", 2015.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3207T
Course Title	Algorithms High Performance Computing
Course Type	MDM

Prerequisites: Discrete Structure

Course Outcomes: At the end of the course student will be able to:

CO1. Analyze the complexity of parallel algorithms.

CO2. Implement parallel graph and numerical algorithms.

CO3. Apply linear algebra concepts and load balancing techniques in HPC.

CO4. Optimize and tune parallel algorithms for performance improvement.

	Course Contents	Hrs.	CO
1.	**Complexity Analysis of Parallel Algorithms:** Understanding time and space complexity in parallel computing, Performance metrics (Speedup, efficiency, scalability), Complexity analysis of Parallel Sorting Algorithms (Parallel Merge Sort, Bitonic Sort), Parallel Searching Algorithms (Parallel Binary Search, Hash-based Search), Examples and case studies of parallel sorting and searching	6	CO1
2.	**Parallel Graph Algorithms & Numerical Methods: Graph Algorithms in Parallel:** Parallel BFS and DFS, Minimum Spanning Tree (Prim's & Kruskal's in parallel), Shortest Path Algorithms (Dijkstra's, Floyd-Warshall in parallel) **Numerical Methods in HPC:** Parallel Computation of Matrix Operations, Iterative Methods (Jacobi, Gauss-Seidel), Finite Difference Methods in Parallel Computing	6	CO2
3.	**Linear Algebra for HPC, Load Balancing & Scalability: Linear Algebra for HPC:** Vector and Matrix Operations in Parallel, Parallel LU, QR, and Cholesky Decomposition **Load Balancing in Parallel Computing:** Static vs. Dynamic Load Balancing, Load balancing techniques (Work Stealing, Graph Partitioning) **Scalability Analysis:** Strong vs. Weak Scaling, Amdahl's and Gustafson's Law	6	CO3
4.	**Optimization Techniques for Parallel Algorithms:** Code and memory optimization for HPC, Parallelization Techniques (Task Parallelism vs. Data Parallelism, Optimizing Synchronization & Communication Overhead), Cache Optimization & Data Locality, Case studies on performance tuning in HPC	6	CO4

Text Books

1. Ananth Grama, "An Introduction to Parallel Computing: Design and Analysis of Algorithms," Pearson Publication, 2009.

Recommended Reading

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP," Tata McGraw-Hill, 2011.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3208T
Course Title	Introduction to Remote Sensing
Course Type	MDM
Prerequisites: NIL	
Course Outcomes: At the end of the course student will be able to: **CO1.** Learn the basics of different OS security mechanisms. **CO2.** Understand various OS security features and their vulnerabilities. **CO3.** Apply the knowledge to analyze OS security threats and mitigation strategies.	

	Course Contents	Hrs.	CO
1.	**Satellite and Aerial Data Analysis:** Capturing and analyzing data collected from satellites and aerial platforms	6	CO1
2.	**Satellite and Aerial Data Analysis:** Capturing and analyzing data collected from satellites and aerial platforms	4	CO2
3.	**Remote Sensing Data Interpretation:** Different types of imagery, image interpretation techniques, and extracting valuable information from remote sensing data	8	CO3
4.	**Remote Sensing Data Interpretation:** Different types of imagery, image interpretation techniques, and extracting valuable information from remote sensing data	4	CO4

Text Books	
1.	Christine Garrard, "Geoprocessing with Python", 2016.
2.	Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, "Remote Sensing and Image Interpretation", 2004.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3107T
Course Title	Blockchain Technology
Course Type	PEC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Understand blockchain architecture and requisite crypto foundations and resolve security concerns in blockchain. **CO2.** Demonstrate various consensus protocols and their usage for specific applications. **CO3.** Explore blockchain advances and upcoming platforms. **CO4.** Analyze smart contracts and distributed applications and design use-cases.	

	Course Contents	Hrs.	CO
1	Introduction and Crypto foundations: Elliptic curve cryptography, ECDSA, Cryptographic hash functions, SHA-256, Merkle Trees, Cryptocurrencies	4	CO1
2	Bitcoin: Bitcoin addresses, Bitcoin's blockchain, block header, mining, proof of work (PoW) algorithms, difficulty adjustment algorithm, mining pools, transactions, double spending attacks, the 51% attacker, block format, pre-SegWit transaction formats, Bitcoin script, transaction malleability, SegWit transaction formats, smart contracts (escrow, micropayments, decentralized lotteries), payment channels, Lightning network	8	CO1, CO3
3	Ethereum: Overview of differences between Ethereum and Bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, Solidity language, decentralized applications using Ethereum	4	CO1, CO2
4	Smart Contracts	4	CO4
5	Different Blockchains and Consensus mechanisms	4	CO2
6	Blockchain and Security: Attacks and countermeasures	4	CO1
7	R3, CORDA and Hyperledger: System architecture, ledger format, chain code execution, transaction flow and ordering, private channels, membership service providers, case studies	8	CO3
8	Advances in the domain	3	CO4

Text Books	
1.	Antonopoulos, Andreas. "Mastering Bitcoin: Unlocking Digital Cryptocurrencies," O'Reilly Media, Inc., 2014.
2.	Narayanan, Arvind. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction," Princeton University Press, 2016. ISBN-10: 0691171696.
Recommended Reading	
1.	Hyperledger Fabric Documentation: http://hyperledger-fabric.readthedocs.io/en/latest/
2.	Ethereum Documentation: http://www.ethdocs.org/en/latest/
3.	Narayanan, Arvind. "Bitcoin and Cryptocurrency Technologies," Princeton University Press, 2016. ISBN-10: 0691171696.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3107L
Course Title	BlockChain Technology Lab
Course Type	PEC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Demonstrate the basic concepts of cryptography in Blockchain technology. **CO2.** Implement Ethereum contracts. **CO3.** Analyze distributed applications. **CO4.** Implement consensus algorithms.	

	Course Contents	Hrs.	CO
1	Understanding ECDSA	2	CO1
2	Implement a program to chain the message using hash functions	2	CO1
3	Analyze the bitcoin blockchain and ethereum blockchain	2	CO1, CO2
4	Write a program to implement proof-of-work consensus algorithm	2	CO4
5	Implement a smart contract to creation of Token	3	CO2, CO3
6	Implement a smart contract to election	3	CO2, CO3
7	Design a Distributed Application	4	CO3
8	Configure hyperledger Blockchain	3	CO4

Text Books	
1.	Saravanan, V. "An Introduction to Bitcoin," Lecture Notes.
2.	Antonopoulos, Andreas. "Mastering Bitcoin: Unlocking Digital Cryptocurrencies," O'Reilly Media, Inc., 2014.
Recommended Reading	
1.	Narayanan, Arvind. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction," Princeton University Press, 2016. ISBN-10: 0691171696.
2.	Antonopoulos, Andreas M., and Wood. "Mastering Ethereum," O'Reilly Media, Inc., 2018.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3111T
Course Title	Information Storage Management System
Course Type	PEC

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Understand today's storage needs, the type of data, its value, and key management requirements of a storage system.

CO2. Describe the importance of data, information, and storage infrastructure.

CO3. Implement different data protection techniques like RAID levels and disaster recovery techniques.

CO4. Design data center infrastructure through network storage architecture like DAS, NAS, CAS, and SAN.

	Course Contents	Hrs.	CO
1.	**Introduction to Storage Technology:** Concepts of storage networking, Business applications defined for Storage, Sources of data and states of data creation, Data center requirements and evolution, Managing complexity, I/O and the five pillars of technology, Storage infrastructure, Evolution of storage, Information lifecycle management.	06	CO1
2.	**Storage System Architecture:** Storage architectures, Device overviews, Peripheral connectivity, Components and concepts, Magnetic disk storage, Disk systems, Disk arrays, RAID storage arrays, Magnetic tape storage, Physical vs. Logical disk organization, Caching properties and algorithms, Connectivity options, Differences in bus and network architectures.	07	CO2
3.	**Introduction to Network Storage:** Putting storage on the network, The NAS Hardware, Software architecture, Network connectivity, NAS as a storage system, NAS connectivity options, Connectivity protocols, Management principles. Storage Area Networks: Architecture, Hardware devices, Host bus adaptors, Connectivity. Content Addressable Storage (CAS): Elements, Connectivity options, Standards and Management principles, Hybrid storage solutions overview.	07	CO2
4.	**Storage Area Networks:** Fibre Channel: Overview, The SAN and its evolution, Components of SAN, Node Ports, Cabling, Interconnect Devices, Storage Arrays, SAN Management Software, FC Connectivity, Fibre Channel Architecture, Zoning, Fibre Channel Login Types, FC Topologies, IP SAN.	07	CO3
5.	**Information Availability:** Business continuity and disaster recovery basics: Local business continuity techniques, Remote business continuity techniques, Storage design and implementations of the business continuity plan, Managing availability, Disaster recovery principles & techniques.	07	CO3
6.	**Managing and Storage Virtualization:** Managing availability: Availability metrics, Implementing the plan, Finding the holes, Maintaining serviceability, Capacity planning, Management tools, Overview of information security virtualization, Different virtualization technologies and processes including file and block level virtualization.	07	CO4

Text Books	
1.	G. Somasundaram, Alok Shrivastava, "Information Storage and Management," Wiley Publishing, Inc.
2.	Robert Spalding, "Storage Networks: The Complete Reference," Tata McGraw Hill, 2003.
3.	Marc Farley Osborne, "Building Storage Networks," Tata McGraw Hill, 2000.
Reference Books	
1.	J. Gerald Kowalski and T. Mark Mayburk, "Information Storage and Retrieval Systems," Springer International, 2006.
2.	Ulf Troppens, Rainer Erkens, and Wolfgang Muller, "Storage Networks Explained," Wiley & Sons, 2004.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3111L
Course Title	Information Storage Management System Lab
Course Type	PEC
Prerequisites: Nil.	
Course Outcomes: At the end of the course student will be able to: **CO1.** Design and plan infrastructure for Data Centers, Network-Attached Storage (NAS), and Storage Area Networks (SAN). **CO2.** Implement NAS and SAN using the zoning concept and work on different file systems. **CO3.** Learn storage systems in detail. **CO4.** Implement different RAID levels for data protection and create logical volumes using virtualization techniques.	

	Course Contents	Hrs.	CO
1.	**Study of HP Storage Works EVA8000 Simulator:** Understanding storage hardware and exploring the functionality of the EVA8000 simulator.	02	CO1
2.	**Introduction to RAID:** Discussing different RAID levels and implementing RAID configurations.	02	CO1
3.	**Solution Design for Data Center:** Creating an architecture plan and resource allocation strategy for a data center.	02	CO2
4.	**Implementation of Logical Volumes:** Using Logical Volume Manager (LVM) to create and manage logical volumes on physical disks.	02	CO2
5.	**Implementation of iSCSI Protocol:** Configuring iSCSI protocol for communication between target and initiator.	02	CO3
6.	**Study and Implementation of Zoning:** Understanding the zoning concept in SAN and implementing zoning techniques.	02	CO3
7.	**Implementation of Disaster Recovery:** Developing and testing disaster recovery strategies for storage environments.	02	CO3
8.	**Implementation of Virtualization:** Creating and managing virtual machines for efficient resource utilization.	02	CO4
9.	**Research Paper on Storage Technologies:** Presenting a seminar on Storage Area Network (SAN), Direct Attached Storage (DAS), Network Attached Storage (NAS), CAS, and IP-SAN.	02	CO4

Text Books	
1.	G. Somasundaram, Alok Shrivastava, "Information Storage and Management," Wiley Publishing, Inc.
2.	Robert Spalding, "Storage Networks: The Complete Reference," Tata McGraw Hill, 2003.
3.	Marc Farley Osborne, "Building Storage Networks," Tata McGraw Hill, 2000.
Reference Books	
1.	J. Gerald Kowalski and T. Mark Mayburk, "Information Storage and Retrieval Systems," Springer International, 2006.
2.	Ulf Troppens, Rainer Erkens, and Wolfgang Muller, "Storage Networks Explained," Wiley & Sons, 2004.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3108T
Course Title	Object Oriented Analysis and Design
Course Type	PEC

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to:

CO1. Identify and model the requirement of the software requirement.
CO2. Apply Object-oriented design and development techniques to problems.
CO3. Apply architectural design to the problems.
CO4. Analyze and apply the deployment techniques for the complex problems.

	Course Contents	Hrs.	CO
1	Introduction: Overview Of OOL; Object Classes; Meta Types. Object Oriented Methodologies; The Unified Approach Modeling; Why Modeling? Static And Dynamic Models; Functional Models.	3	CO1
2	Object Modeling: Object. Links. Association. Inheritance. Grouping Constructs; Problems On Object Modeling; Advantages Of Object Modeling.	3	CO1
3	Analysis: Problem Analysis. Problem Domain Classes. Identify Classes And Objects Of Real World Problems. Using Use Case Analysis; Recording Analysis.	3	CO2
4	Basic Object Modeling: Multiplicity. Constraints. Aggregation. Component.	2	CO1,2
5	Sequence Diagram: Modeling Scenarios. Mapping Events To Object. Interfaces. Discovering Attributes. Modeling Simple Collaboration Modeling. Logical Database Schema. Activity Diagram. Modeling Workflow.	2	CO1,2
6	Class Diagram: Test Scenarios. Interfaces. Classes. Methods. Stress Testing. System Testing. Scalability Testing. Regression Testing.	2	CO2,3
7	Behavioral Modeling. State Chart Diagram.	3	CO2,3
8	Design: Architectural Design. Refining The Model. Refactoring. Coupling And Cohesion. Who Should Own The Attribute? Who Should Own The Operations? Process And Threads.	3	CO2,3
9	Design Classes: Classes Visibility; User Interface. Subsystem Interface.	3	CO2,3
10	Deployment Diagram: Modeling deployment diagrams.	3	CO3,4
11	Advances in the domain.	2	CO4

Text Books	
1.	Bahrami, Ali. "Object Oriented System Development," McGraw Hill.
2.	Booch, Grady, Rambaugh, J., Jacobson, Ivar. "The UML Users Guide," Pearson.
3.	Haigh, Andrew. "Object Oriented Analysis and Design," Tata McGraw Hill.
Recommended Reading	
1.	Bennett, Simon, McRobb, Steve, Farmer, Ray. "Object Oriented System Analysis and Design Using UML," McGraw Hill.
2.	Lethbridge, Timothy C., Laganiere, Robert. "Object Oriented Software Engineering," McGraw Hill.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3108L
Course Title	Object Oriented Analysis and Design Lab
Course Type	PEC

Prerequisites: Nil.

Course Outcomes: At the end of the course student will be able to: **CO1.** Demonstrate fundamental knowledge of software development life cycle.
CO2. Design software requirement specification document for a project.
CO3. Analyze and apply object modeling techniques for solving complex problems.
CO4. Evaluate different design artifacts developed to provide solutions to the problem.

	Course Contents	Hrs.	CO
1	Draw software life cycle with phases.	02	CO1
2	SRS Documentation for project.	02	CO1
3	Class Modeling.	02	CO2
4	State Modeling.	02	CO2
5	Interaction Modeling.	02	CO3
6	Analysis and Design.	02	CO3
7	System Design.	02	CO3
8	Class design.	02	CO4
9	Component Diagram.	02	CO4

Text Books	
1.	Bahrami, Ali. "Object Oriented System Development," McGraw Hill.
2.	Booch, Grady, Rambaugh, J., Jacobson, Ivar. "The UML Users Guide," Pearson.
3.	Haigh, Andrew. "Object Oriented Analysis and Design," Tata McGraw Hill. (Page No: 53)
Recommended Reading	
1.	Bennett, Simon, McRobb, Steve, Farmer, Ray. "Object Oriented System Analysis and Design Using UML," McGraw Hill.
2.	Lethbridge, Timothy C., Laganiere, Robert. "Object Oriented Software Engineering," McGraw Hill.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3109T
Course Title	Geospatial Techniques
Course Type	PEC

Prerequisites: Database Management System

Course Outcomes: At the end of the course student will be able to:

CO1. Demonstrate fundamental concepts of PostGIS and QGIS tools.
CO2. Implement geospatial databases using PostGIS and execute spatial queries.
CO3. Apply and evaluate spatial indexing techniques for performance optimization.
CO4. Implement graph queries using Cypher and develop geospatial applications.

	Course Contents	Hrs.	CO
1.	Understanding QGIS, and other GIS mapping tools	02	CO1
2.	Working with QGIS	02	CO1
3.	Creating digital maps using geospatial objects	02	CO2
4.	Understanding digital data, data collection techniques, and various data formats	02	CO2
5.	Importing various data formats to QGIS to build map and features	02	CO2
6.	Working with basics of spatial data analysis	02	CO3
7.	Working with basics of spatial data analysis	02	CO3
8.	Working with multiple layers of digital maps and complex query analysis	02	CO3
9.	Developing web pages for webGIS	02	CO4
10.	Working with scripting languages for dynamic webGIS contents	02	CO4
11.	Working with scripting languages for dynamic MobileGIS contents	02	CO4
12.	Accessing webGIS/Mobile through private/public hosting infrastructure using GeoNode server.	02	CO4

Text Books

1. Bolstad, Paul. "GIS Fundamentals: A First Text on Geographic Information Systems." XanEdu, 2016.
2. Longley, Goodchild, Paul A., et al. "Geographic Information Systems and Science." John Wiley & Sons, 2005.
3. Huisman, Otto. "Principles of GIS."

Programme Name	B. Tech. Information Technology
Course Code	R5IT3109L
Course Title	Geospatial Techniques Lab
Course Type	PEC

Prerequisites: Database Management System

Course Outcomes: At the end of the course student will be able to:
CO1. Demonstrate fundamental concepts of PostGIS and QGIS tools.
CO2. Implement geospatial databases using PostGIS and execute spatial queries.
CO3. Apply and evaluate spatial indexing techniques for performance optimization.
CO4. Implement graph queries using Cypher and develop geospatial applications.

	Course Contents	Hrs.	CO
1.	Understanding QGIS, and other GIS mapping tools	02	CO1
2.	Working with QGIS	02	CO1
3.	Creating digital maps using geospatial objects	02	CO2
4.	Understanding digital data, data collection techniques, and various data formats	02	CO2
5.	Importing various data formats to QGIS to build map and features	02	CO2
6.	Working with basics of spatial data analysis	02	CO3
7.	Working with basics of spatial data analysis	02	CO3
8.	Working with multiple layers of digital maps and complex query analysis	02	CO3
9.	Developing web pages for webGIS	02	CO4
10.	Working with scripting languages for dynamic webGIS contents	02	CO4
11.	Working with scripting languages for dynamic MobileGIS contents	02	CO4
12.	Accessing webGIS/Mobile through private/public hosting infrastructure using GeoNode server.	02	CO4

Text Books

1. Bolstad, Paul. "GIS Fundamentals: A First Text on Geographic Information Systems." XanEdu, 2016.
2. Longley, Goodchild, Paul A., et al. "Geographic Information Systems and Science." John Wiley & Sons, 2005.
3. Huisman, Otto. "Principles of GIS."

Programme Name	B. Tech. Information Technology
Course Code	R5IT3110T
Course Title	Computer Vision
Course Type	PEC
Prerequisites: Database Management System	
Course Outcomes: At the end of the course student will be able to: **CO1.** Apply fundamental recognition methodologies and morphological image processing techniques. **CO2.** Analyze image representation, segmentation, and region-based processing techniques. **CO3.** Implement area extraction, edge detection, and object recognition techniques. **CO4.** Design object recognition and matching models using knowledge-based vision approaches.	

	Course Contents	Hrs.	CO
1.	**Recognition Methodology:** Conditioning, Labeling, Grouping, Extracting and Matching. Morphological Image Processing: Introduction, Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Morphological algorithm operations on binary images, Morphological algorithm operations on gray-scale images, Thinning, Thickening, Region growing, Region shrinking.	06	CO1
2.	**Image Representation and Description:** Representation schemes, Boundary descriptors, Region descriptors. Binary Machine Vision: Thresholding, Segmentation, Connected component labeling, Hierarchical segmentation, Spatial clustering, Split & Merge, Rule-based segmentation, Motion-based segmentation.	07	CO2
3.	**Area Extraction:** Concepts, Data structures, Edge detection, Line-Linking, Hough transform, Line fitting, Curve fitting (Least-square fitting). Region Analysis: Deformable curves and surfaces, Region properties, External points, Spatial moments, Mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers. Level set representations, Fourier and wavelet descriptors, Medial representations, Multiresolution analysis.	07	CO2
4.	**Facet Model Recognition:** Labeling lines, Understanding line drawings, Classification of shapes by labeling of edges, Recognition of shapes, Consistency labeling problem, Backtracking Algorithm. Perspective Projective Geometry, Inverse Perspective Projection, Photogrammetry - from 2D to 3D, Image matching: Intensity matching of 1D signals, Matching of 2D images, Hierarchical image matching.	07	CO3
5.	**Object Models and Matching:** 2D representation, Global vs. Local features. General Frameworks for Matching: Distance relational approach, Ordered structural matching, View class matching, Models database organization. Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems.	07	CO3
6.	**General Frameworks:** Distance-relational approach, Ordered-Structural matching, View class matching, Models database organization. Knowledge-Based Vision: Knowledge representation, Control strategies, Information integration. Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition.	07	CO4

Text Books	
1.	Robert Haralick and Linda Shapiro, "Computer and Robot Vision," Addison-Wesley, 1993.
2.	David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach," Prentice Hall, 2011.
Reference Books	
1.	Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision," Thomson Learning, 2008.
2.	E. Trucco and A. Verri, "Introductory Techniques for 3D Computer Vision," Prentice Hall, 1998.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3110L
Course Title	Computer Vision Lab
Course Type	PEC
Prerequisites: Database Management System	
Course Outcomes: At the end of the course student will be able to: **CO1.** Apply image processing techniques for morphological operations, segmentation, and edge detection. **CO2.** Analyze feature extraction and object recognition methods such as Hough Transform and SIFT. **CO3.** Implement 2D and 3D representation techniques for image reconstruction and depth estimation. **CO4.** Develop practical applications using OCR, optical flow, and motion tracking in real-world scenarios.	

	Course Contents	Hrs.	CO
1.	**Morphological Operations:** Perform dilation, erosion, opening, and closing on binary and grayscale images to analyze and process image structures.	02	CO1
2.	**Image Segmentation:** Implement thresholding, connected component labeling, and region-growing techniques for segmenting images.	02	CO1
3.	**Edge Detection:** Apply Sobel, Prewitt, Canny, and Laplacian edge detection methods to identify edges and contours in images.	02	CO1
4.	**Hough Transform:** Detect lines, circles, and other geometric shapes using the Hough Transform technique.	02	CO2
5.	**Feature-Based Image Matching:** Use SIFT, SURF, or ORB for object recognition and image feature extraction.	02	CO2
6.	**2D & 3D Image Representation:** Implement perspective and orthographic projections for visualizing 2D and 3D image data.	02	CO2
7.	**PCA for Image Compression:** Reduce image dimensionality and optimize storage using Principal Component Analysis (PCA).	02	CO3
8.	**Optical Character Recognition (OCR):** Develop an OCR system using Tesseract or deep learning techniques for text extraction.	02	CO3
9.	**Stereo Vision & Depth Estimation:** Process stereo image pairs to compute disparity maps and estimate depth.	02	CO3
10.	**Optical Flow & Motion Tracking:** Track moving objects in video sequences using Lucas-Kanade or Horn-Schunck methods.	02	CO4

Texts/References	
1.	A. K. Jain, "Fundamentals of Digital Image Processing," Pearson Education, 2009.
2.	D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach," Pearson Education, 2003.
3.	D. H. Ballard and C. M. Brown, "Computer Vision," Prentice Hall, 1982.
4.	R. O. Duda and P. E. Hart, "Pattern Classification and Scene Analysis," John Wiley, 2006.
5.	R. Jain, R. Kasturi, and B. G. Schunck, "Machine Vision," McGraw-Hill, 1995.
6.	R. C. Gonzalez and R. E. Woods, "Digital Image Processing," Addison-Wesley, 2008.
7.	R. Schalkoff, "Pattern Recognition – Statistical, Structural and Neural Approaches," John Wiley, 2007.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3901L
Course Title	Cloud Practitioner Essentials Training (AWS)
Course Type	PCC

Prerequisites: General IT business knowledge, General IT technical knowledge
General IT technical knowledge

Course Outcomes: At the end of the course student will be able to:
CO1. Understand AWS fundamentals and demonstrate knowledge of AWS cloud computing concepts, global infrastructure, and core services.
CO2. Utilize AWS compute, storage, and database services by identifying appropriate solutions for various use cases.
CO3. Implement networking and security best practices by explaining AWS networking concepts and security models to ensure cloud security compliance.
CO4. Monitor and manage AWS costs using AWS monitoring, analytics, and cost management tools to optimize cloud resources.
CO5. Prepare for AWS certification by developing the knowledge and skills required to pass the AWS Certified Cloud Practitioner exam.

	Course Contents	Hrs.	CO
1.	**Introduction to AWS and Cloud Computing:** Summarize the benefits of AWS, explain cloud computing concepts (on-demand delivery, cloud deployments, and pay-as-you-go pricing), Understand the AWS Global Infrastructure (Regions, Availability Zones, Edge locations), Compare different methods for provisioning AWS services. **Experiments:** 1. Exploring AWS Global Infrastructure & Deploying a Virtual Machine 2. Understanding AWS Pricing with Pay-as-You-Go Model	3	CO1
2.	**Compute, Storage, and Databases:** Describe the benefits and use cases of Amazon EC2, EC2 Auto Scaling, and Elastic Load Balancing, Explain different EC2 instance types and billing options, Summarize additional AWS compute services (such as AWS Lambda and containers). Summarize the concepts of cloud storage and database services, Explain the benefits of Amazon S3, EBS, EFS, RDS, and DynamoDB, Compare various storage and database solutions. **Experiments:** 1. Deploying and Scaling an EC2 Instance with Load Balancing 2. Comparing AWS Storage and Database Solutions	3	CO2
3.	**Networking and Security:** Explain basic networking concepts and AWS networking services (VPC, DirectConnect, VPN), Differentiate between public and private networking resources, Describe hybrid deployments and AWS global network interactions, Explain the AWS shared responsibility model and security best practices, Summarize key security services like IAM, MFA, AWS Organizations, and compliance. **Experiments:** 1. Creating a Secure VPC with Public and Private Subnets 2. Implementing AWS Security Best Practices with IAM and MFA	4	CO3
4.	**Monitoring, Analytics, and Cost Management:** Describe approaches to monitoring AWS environments using CloudWatch, CloudTrail, and Trusted Advisor, Explain AWS pricing models, Free Tier, and cost management tools (Budgets, Cost Explorer, Pricing Calculator), Differentiate AWS Support Plans and their benefits, Summarize AWS Marketplace and its advantages. **Experiments:** 1. Monitoring AWS Resources with CloudWatch, CloudTrail, and Trusted Advisor 2. Managing AWS Costs with Cost Explorer, Budgets & Pricing Calculator	4	CO4
5.	**Migration, Innovation, and Cloud Best Practices:** Explain cloud migration strategies and AWS data migration solutions (Snowcone, Snowball, Snowmobile), Understand the AWS Cloud Adoption Framework (AWS CAF), Describe AWS innovation solutions (AI, ML, IoT, serverless computing), Summarize the six pillars of the AWS Well-Architected Framework. **Experiments:** 1. Simulating a Cloud Migration with AWS S3 and AWS DataSync 2. Implementing the AWS Well-Architected Framework for Serverless Applications	4	CO5
6.	**AWS Certification and Final Assessment:** Describe the benefits of AWS Certification, Identify resources for preparing for the AWS Certified Cloud Practitioner exam, Solve practice questions similar to the AWS Cloud Practitioner Certification exam.	2	CO5

Text Books	
1.	Amazon Cloud Services AWS, `https://aws.amazon.com/training/learn-about/cloud-practitioner/`.
2.	Ben Piper, David Clinton, "AWS Certified Cloud Practitioner Study Guide: CLF-C01 Exam".
3.	Andreas Wittig, Michael Wittig, "Amazon Web Services in Action".
4.	Thomas Erl, Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture".

Programme Name	B. Tech. Information Technology
Course Code	R5IT3902L
Course Title	Salesforce beginners Training
Course Type	PCC

Prerequisites: Salesforce Navigation, Cloud Computing

Course Outcomes: At the end of the course student will be able to:
CO1. Demonstrate an understanding of Salesforce fundamentals, including CRM concepts, cloud computing, and Salesforce platform navigation.
CO2. Apply data management techniques by handling standard/custom objects, implementing security measures, and managing user roles and permissions in Salesforce.
CO3. Utilize Salesforce automation tools like Workflow Rules, Process Builder, and Approval Processes to streamline business operations and enhance productivity.
CO4. Analyze and generate data-driven insights using Salesforce reports, dashboards, and analytics tools to support business decision-making.

	Course Contents	Hrs.	CO
1.	**Introduction & Navigation:** Overview of Salesforce, CRM and Cloud Computing, Salesforce editions and products, navigating the Salesforce interface, understanding standard and custom objects, records, fields, relationships, and tabs, working with apps and search functionality. **Experiments:** 1. Navigating Salesforce and Understanding Objects 2. Utilizing Salesforce's Search Functionality	3	CO1
2.	**Data Management & Security:** Managing standard and custom objects, data import and export techniques, data validation rules, duplicate management, user roles, profiles, permission sets, organization-wide defaults, record-level security, field-level security, and sharing settings. **Experiments:** 1. Managing Data with Import, Export, and Validation Rules 2. Configuring Security Settings with Roles, Profiles, and Sharing Rules	5	CO2
3.	**Automation & Customization:** Workflow rules and actions, Process Builder for automating business processes, approval processes, customizing page layouts and record types, introduction to Lightning App Builder, creating custom fields, formulas, and validation rules, automation best practices. **Experiments:** 1. Automating an Approval Process Using Flow Builder 2. Customizing a Record Page Using Lightning App Builder	4	CO3
4.	**Reports, Dashboards & Analytics:** Creating custom reports (Tabular, Summary, Matrix), filtering and grouping data, using report charts, building dashboards for data visualization, scheduling and exporting reports, key performance indicators (KPIs) in Salesforce, leveraging analytics for business insights. **Experiments:** 1. Creating and Customizing Reports 2. Building Dashboards and Scheduling Reports	4	CO4

Learning Resources	
1.	https://trailhead.salesforce.com
2.	https://focusonforce.com/

Programme Name	B. Tech. Information Technology
Course Code	R5IT3903L
Course Title	System Administrator
Course Type	PCC
Prerequisites: Basic Knowledge of Operating Systems and Networking	
Course Outcomes: At the end of the course student will be able to: **CO1.** Manage users, files, and processes in Windows and Linux systems. **CO2.** Monitor system performance and perform software updates. **CO3.** Configure basic network settings and apply security measures. **CO4.** Set up virtual machines, explore cloud services, and automate tasks.	

	Course Contents	Hrs.	CO
1.	**Introduction to System Administration:** Role of a System Administrator, Overview of Operating Systems (Windows & Linux), File System Management and Permissions, User and Group Management. **Experiments:** 1. Manage files, directories, and permissions on Windows & Linux. 2. Create, modify, and manage users and groups.	4	CO1
2.	**System Maintenance and Monitoring:** Process and Task Management, Software Installation and Updates, System Performance Monitoring (Task Manager, top, htop), Backup and Recovery Basics. **Experiments:** 1. Monitor and manage system processes using system tools. 2. Install, update, and configure software on Windows & Linux.	6	CO2
3.	**Networking and Security:** Basics of Network Configuration, Firewall and Access Control Management, Secure Remote Access (SSH, RDP), System Security Best Practices. **Experiments:** 1. Configure network settings and troubleshoot connectivity. 2. Secure systems with firewalls, SSH, RDP, and security patches.	6	CO3
4.	**Virtualization and Cloud Basics:** Introduction to Virtual Machines (VMware, VirtualBox), Basics of Cloud Platforms (AWS, Azure), Containerization with Docker, Automating Tasks with Scripts. **Experiments:** 1. Set up and manage virtual machines using VMware/VirtualBox. 2. Deploy cloud instances and automate tasks using scripts.	8	CO4

Text Books	
1.	Evi Nemeth et al., "UNIX and Linux System Administration Handbook", Pearson, 2017.
2.	Tom Limoncelli, "The Practice of System and Network Administration", Addison-Wesley, 2016.
Online Resources	
1.	Linux Documentation Project.
2.	Microsoft Learn - Windows Administration.

Programme Name	B. Tech. Information Technology
Course Code	R5IT3904L
Course Title	Unity Development Tutorials
Course Type	PCC

Prerequisites: Basic programming knowledge, understanding of game development concepts, Basic Math and Physics.

Course Outcomes: At the end of the course student will be able to: **CO1.** Students will be able to Master Unity & C Programming
CO2. Students will be able to Develop 2D & 3D Games.
CO3. Students will be able to Implement UI, Audio, & Effects.
CO4. Students will be able to Optimize & Publish Games.

	Course Contents	Hrs.	CO
1.	**Foundations of Unity & C Scripting:** Introduction to Game Development & Unity, Installing and setting up Unity & Visual Studio, Understanding the Unity Editor (Hierarchy, Scene, Inspector, Game, Project, Console), Game Objects & Components, C for Unity: Variables, Methods, Classes, and Objects, Unity Lifecycle Methods (Start, Update, FixedUpdate), Handling User Input (Keyboard, Mouse, Touch), Simple Object Interactions (Transform, Movement, Rotations). **Experiments:** Experiment 1: Creating a Simple Interactive Scene in Unity Experiment 2: Handling User Input for Object Rotation & Interaction	4	CO1
2.	**2D & 3D Game Development:** 2D Development: Sprites, Tilemaps, Sprite Animations, Physics (Rigidbody2D, Colliders, Triggers), Player Movement & Camera Follow System, Simple Enemy AI and Pathfinding. 3D Development: 3D Coordinate System & Models, Rigidbody, Colliders, Gravity, and Forces, Character Controller & Movement, Basic Animations using Animator. **Experiments:** Experiment 1: 2D Player Movement and Enemy AI (Pathfinding) Experiment 2: 3D Character Movement with Physics and Animations	6	CO2
3.	**UI, Audio, and Game Mechanics:** User Interface (UI) Development: Canvas, Panels, Buttons, Text, Health Bars, Scene Management & Transitions. Game Mechanics: Object Pooling for Performance Optimization, Level Progression & Saving Game Data. Audio & Special Effects: Adding Background Music & Sound Effects, Particle Systems (Fire, Smoke, Explosions), Post-Processing Effects. **Experiments:** Experiment 1: UI Development with Health Bar & Scene Transitions Experiment 2: Game Mechanics with Object Pooling & Audio Effects	6	CO3
4.	**Game Deployment:** Game Deployment & Optimization: Performance Optimization Techniques, Publishing to PC, Android, and Web, Introduction to Unity Ads & Monetization. **Experiments:** Experiment 1: Performance Optimization Techniques in Unity Experiment 2: Deploying and Monetizing a Unity Game	4	CO4

Text Books	
1.	Joseph Hocking, "Unity in Action" (3rd Edition).
2.	Harrison Ferrone, "Learning C# by Developing Games with Unity".
3.	Paris Buttfield-Addison, Jon Manning, Tim Nugent, "Unity Game Development Cookbook".
Online Resources	
1.	`https://learn.unity.com`
2.	`https://docs.unity.com`
3.	`https://opengameart.org`