Hindi Vidya Prachar Samiti's

# Ramniranjan Jhunjhunwala College of Arts, Science & Commerce (Autonomous), Ghatkopar (W)

Affiliated to

## University of Mumbai

## Syllabus for M.Sc. IT Part I (Semester I & Semester II)

## Program: M.Sc. Information Technology
## Program Code: RJSPIT

## Choice Based Credit System Syllabus

***(With effect from academic year 2021-22)***

# Course Structure

## Semester I

| Course Code | Course Name | Group | Teaching Scheme (Hrs/Week) | | Credits |
|---|---|---|---|---|---|
| | | | Lectures | Practical | |
| **RJSPIT101** | Foundation of Data Science | CC | 4 | - | 4 |
| **RJSPIT102** | Cloud Computing | CC | 4 | - | 4 |
| **RJSPIT103** | Advanced Artificial Intelligence | CC | 4 | - | 4 |
| **RJSPIT1P1a**<br>**RJSPIT1P1b** | **Professional Elective – I**<br>Microservice Architecture<br>Modern Networking | PE | 3 | - | 3 |
| **RJSPIT1C1** | **Career Advancement Course**<br>Cyber Security - I | CAC | 1 | - | 1 |
| **RJSPIT1L1** | **PG Lab – I**<br>Foundation of Data Science | PGL | - | 2 | 2 |
| **RJSPIT1L2** | **PG Lab – II**<br>Cloud Computing | PGL | - | 2 | 2 |
| **RJSPIT1R1** | **Mini Project – I** | MNP | - | 2 | 2 |
| **RJSPIT1S1** | **Seminar – I** | SE | - | 2 | 2 |
| | **Total** | | **16** | **8** | **24** |

## Semester II

| Course Code | Course Name | Group | Teaching Scheme (Hrs/Week) | | Credits |
|---|---|---|---|---|---|
| | | | Lectures | Practical | |
| **RJSPIT201** | Big Data Analytics | CC | 4 | - | 4 |
| **RJSPIT202** | Virtualization | CC | 4 | - | 4 |
| **RJSPIT203** | Image and Vision Processing | CC | 4 | - | 4 |
| **RJSPIT2P2a**<br>**RJSPIT2P2b** | **Professional Elective – II**<br>Blockchain Technology<br>Soft Computing | PE | 3 | - | 3 |
| **RJSPIT2C2** | **Career Advancement Course**<br>Cyber Security II | CAC | 1 | - | 1 |
| **RJSPIT2L3** | **PG Lab – III**<br>Big Data Analytics | PGL | - | 2 | 2 |
| **RJSPIT2L4** | **PG Lab – IV**<br>Virtualization | PGL | - | 2 | 2 |
| **RJSPIT2R2** | **Mini Project – II** | MNP | - | 2 | 2 |
| **RJSPIT2S2** | **Seminar – II** | SE | - | 2 | 2 |
| | **Total** | | **16** | **8** | **24** |

**Note:** Student have to register for the program as per the following guidelines:

| Sr. No. | Category | Credits | | | | Total Credits |
|---|---|---|---|---|---|---|
| | | Semester I | Semester II | Semester III | Semester IV | |
| 1 | Core Courses (CC) | 12 (3 Courses) | 12 (3 Courses) | 12 (3 Courses) | - | 36 |
| 2 | Professional Electives (PE) | 3 | 3 | 3 | - | 09 |
| 3 | Career Advancement Course (CAC) | 1 | 1 | 1 | - | 03 |
| 4 | PG Labs (PGL) | 4 (2 Courses) | 4 (2 Courses) | 4 (2 Courses) | - | 12 |
| 5 | Mini Project (MNP) | 2 | 2 | - | - | 4 |
| 6 | Seminar (SE) | 2 | 2 | - | - | 4 |
| 7 | Dissertation – I (Major Project) (DES) | - | - | 4 | - | 4 |
| 8 | Dissertation – II (Major Project) (DES) | - | - | - | 12 | 12 |
| 9 | Industrial Internship (II) | - | - | - | 12 | 12 |
| **Total Credits** | | 24 | 24 | 24 | 24 | **96** |

# Semester I – Core Courses

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required (60 Minutes/ Lecture) | Credits |
|---|---|---|---|---|---|
| **RJSPIT101** | **Foundation of Data Science** | **CC** | **4** | **40** | **4** |

**Course Objectives**

1. To develop in depth understanding of the key technologies in data science.
2. To provide the basic knowledge of Python libraries like NumPy, Pandas, Matplotlib and Seaborn.
3. To provide the foundation and hands-on-practice on topics in statistical methods and applied probability that forms the basis for data science.
4. To address the issues and the principals of estimation theory, testing hypothesis and regression and prediction.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction to Data Science**<br>Era of data science, business intelligence, Business Intelligence vs. Data Science, Life cycle of Data Science, Tools of Data Science, Big data and Hadoop, business analytics, machine learning and artificial intelligence<br>**Data Pre-processing**<br>Basics of NumPy, Pandas, Matplotlib and Seaborn Libraries, Data Loading, Data Cleaning and Preparation, Data Wrangling, Plotting and Visualization, Data aggregation and Grouping<br>**Exploratory Data Analysis** | 10 |

| | | |
|---|---|---|
| | Elements of structured data, rectangular data: Data frames and indexes, non-rectangular data structures, estimates of location: Mean, Median and Robust, estimates of variability: Standard deviation and related estimates, Exploring the data distribution: Percentiles and Boxplots, Frequency table and Histograms, density estimates. | |
| **Unit II** | **Exploring Binary and categorical data**<br>Mode, expected value, Correlation: Scatterplots, exploring two or more variables: hexagonal binning and Counters, two categorical variables, Categorical and numeric data, Visualizing multiple variables. **Data Transformations and quality analysis**<br>Merge, Rollup, Transpose and Append, Missing Analysis and Treatment, Outlier analysis and treatment.<br>**Data and Sampling Distributions**<br>Random sampling and sample bias: Bias, Random selection, Selection Bias: Regression to mean, Sampling distributions of a statistic: Central limit theorem, Standard error, Bootstrap, Resampling, Confidence Intervals. | 10 |
| **Unit III** | **Distributions**<br>Normal distribution: Standard normal and QQ plots, Long-tailed distributions, Student's t-distribution, Binomial distribution, Poisson distribution, Exponential distribution and Weibull distributions. **Basic Probability and Terms**<br>Events and their Probabilities, Rules of Probability, Conditional probability and independence, Permutations and combinations, Bayer's Theorem, Descriptive Statistics, Compound probability, Conditional probability.<br>**Advance Statistics**<br>Point estimates, Null hypothesis, Alternative hypothesis, One sample t test, Type I and type II errors, Hypothesis test for categorical variables, Chi-square goodness of fit test. | 10 |
| **Unit IV** | **Machine Leaning Essentials**<br>Types of machine Learning: Supervised, Unsupervised and | 10 |

| | | |
|---|---|---|
| | Reinforcement Learning, Linear Regression, Linear Regression predictors, Regression metrics, Logistic Regression, Dummy Variables.<br>**Predictions**<br>Naïve Bayes classification, Decision Trees, Unsupervised Learning, K Means clustering, Choosing an optimal number for k and cluster validation, Feature extraction and principal component analysis. The bias variance trade-off, two extreme cases of bias/variance trade off: under fitting, overfitting, K folds cross-validation, grid searching, Ensembling techniques: Random Forests. | |

**References:**

1. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython", O'Reilly, 2nd Edition.
2. Sinan Ozdemir, "Principles of Data Science", PACKT, 2016
3. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Science", O'Reilly, 2017.
4. Jose Unpingco, "Python for Probability, Statistics and Machine Learning", Springer.
5. Allen B. Downey, "Think Stats – Probability and Statistics for Programmers", Green Tea Press.

**Learning Outcomes:**

1. The students will get in-depth knowledge of data science related Mathematical and statistical computing concepts.
2. The students will be able to implement the basic machine learning algorithms.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | To Understand and Describe the various concepts of Data Science and Artificial Intelligence Technology. | 1, 2 |
| | CO2 | To Understand and Apply the concepts of Python libraries like NumPy, Pandas, Matplotlib and Seaborn to various types of data. | 2, 3 |

| | | | |
|---|---|---|---|
| | CO3 | To Understand and Apply the Data Pre-processing, Data Exploration and Data Analysis techniques. | 2, 3 |
| | CO4 | To Describe, Summarize and Analyse the various statistical measures for the given rectangular and non-rectangular data/dataset. | 1, 2, 4 |
| II | CO5 | To Describe, Summarize and Analyse the binary & Categorical Data/ Dataset. | 1, 2, 4 |
| | CO6 | To Understand and Apply Data Transformation techniques. | 2, 3 |
| | CO7 | To Understand and Apply the various statistical concepts to the Sampling Distributions and Evaluate the shape of distribution. | 2, 3, 5 |
| III | CO8 | To Understand and Apply the various statistical concepts to the Probability Distributions. | 2, 3 |
| | CO9 | To Understand, Generate and Visualise the Probability and Probability Distributions. | 2, 4, 6 |
| | CO10 | To Understand and Apply the concepts of probability to data sets and Predict the outcome. | 2,3 |
| | CO11 | To Identify, Evaluate and Conclude the Hypothesis. | 1, 5 |
| IV | CO12 | To Understand and Apply the various Machine Learning algorithms to datasets and Predict the output. | 2, 3 |
| | CO13 | To Understand, Apply and Analyse the various machine learning algorithms of classification and Clustering and Evaluate the Results. | 2, 3, 4, 5 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT102** | **Cloud Computing** | **CC** | **4** | **40** | **4** |

**Course Objective**

1. Illustrate the fundamentals of Cloud Computing and its challenges.
2. Analyse different virtualization techniques and their role in enabling the cloud computing system model.
3. Assess cloud characteristics and service attributes, for compliance with enterprise Objectives.
4. Exposure to various cloud architecture based on feature implementation.
5. Insight into various security related issues in cloud computing.
6. Impart knowledge on the various cloud delivery models from both the provider and consumer perspectives based on Cost metrics and Pricing model.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction to Cloud Computing**<br>Introduction, Historical developments, Building Cloud Computing Environments.<br>**Principles of Parallel and Distributed Computing**<br>Eras of Computing, Parallel v/s distributed computing, Elements of Parallel Computing, Elements of distributed computing, Technologies for distributed computing.<br>**Virtualization**<br>Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology Examples.<br>**Cloud Infrastructure Mechanism**<br>Logical Network Perimeter, Virtual Server, Cloud Storage Device, | 10 |

| | | |
|---|---|---|
| | Cloud usage monitor, Resource replication, Ready-made environment | |
| **Unit II** | **Cloud Computing Architecture:**<br>Introduction, Fundamental concepts and models, Roles and boundaries, Cloud Characteristics, Cloud Delivery models, Cloud Deployment models, Economics of the cloud, Open challenges<br>**Cloud Platforms in Industry:** Amazon Web Services, Google App Engine, Microsoft Azure.<br>**Specialized Cloud Mechanisms:** Automated Scaling listener, Load Balancer, SLA monitor, Pay-per-use monitor, Audit monitor, fail over system, Hypervisor, Resource Centre, Multidevice broker, State Management Database<br>**Cloud Management Mechanisms:** Remote administration system, Resource Management System, SLA Management System, Billing Management System | 10 |
| **Unit III** | **Fundamental Cloud Architectures**<br>Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture.<br>**Advanced Cloud Architectures**<br>Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture, Cloud Balancing Architecture, Resource Reservation Architecture, Dynamic<br>Failure Detection and Recovery Architecture, Bare-Metal Provisioning Architecture, Rapid Provisioning Architecture, Storage Workload Management Architecture. | 10 |
| **Unit IV** | **Cloud Security Mechanisms**<br>Identity and Access Management (IAM), Single Sign-On (SSO), Cloud Based Security Groups, Hardened Virtual Server Images. | 10 |

| | | |
|---|---|---|
| | **Cloud Delivery Model Considerations**<br>Cloud Delivery Models: The Cloud Provider Perspective, Cloud Delivery Models: The Cloud Consumer Perspective<br>**Cost Metrics and Pricing Models**<br>Business Cost Metrics, Cloud Usage Cost Metrics, Cost management Considerations.<br>**Service Quality Metrics and SLAs**<br>Service Quality Metrics, SLA Guidelines. | |

**References:**

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing Foundations and Applications Programming" Morgan Kaufmann Publishers,2013 2. Thomas Erl, Zaigham Mahood, Ricardo Puttini, "Cloud Computing, Concept, Technology and Architecture", Prentice Hall, 2013.

3. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. 4. John W. Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.

**5.** V.K Pachgare, "Cloud Computing",PHI Learning,2016.

**Learning Outcomes:**

Students will be able to:

1. Understand distributed models and enabling technologies.
2. Design of computer clusters for scalable parallel computing skillfully.
3. Introduction to distributed system environment and programming models along with Performance, Security, and Energy-Efficiency factors.
4. Virtualization of clusters and Data centers along with various cloud computing and Service models-PaaS, SaaS, IaaS.
5. Elaboration of cloud programming, its Software environments features of Cloud and Grid Platforms.
6. Learning of programming on Google app engine Amazon AWS and Microsoft Azure.
7. Performance of Distributed Systems Quality of Service in Cloud computing and its Applications of Social Networks- Facebook.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| I | CO1 | Understand and Describe the core concepts of the cloud computing paradigm its characteristics, advantages and its challenges. | 1, 2 |
| | CO2 | Understand and Describe the principles of parallel and distributed computing. | 1, 2 |
| | CO3 | Analyse different virtualization techniques and their role in enabling the cloud computing system model. | 4 |
| | CO4 | Describe the Cloud Platform Mechanism. | 1 |
| II | CO5 | Describe different deployment models available and Understand and differentiate between various cloud computing models. | 1, 2 |
| | CO6 | Understand and Evaluate the various cloud platforms like AWS, Google App Engine and Microsoft Azure. | 2, 3 |
| | CO7 | Understand and Identity Cloud Mechanisms that enable the hand-on administration and management of cloud-based IT resources. | 2, 3 |
| III | CO8 | Understand the various cloud architectures based on feature implementations. | 1 |
| | CO9 | Explain, Describe and Compare the frontier areas of Cloud Computing Architectures. | 1,2 |
| IV | CO10 | Identify and Apply the various cloud security mechanisms. | 1, 3 |
| | CO11 | Apply and Analyse various Cloud Delivery Models and Evaluate cost for cost metric systems for cloud service pricing. | 3, 4, 5 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT103** | **Advance Artificial Intelligence** | **CC** | **4** | **40** | **4** |

**Course Objectives**

1. To introduce the concepts of artificial intelligence, related components of artificial intelligence, Knowledge representations, non-monotonic reasoning, statistical technique, semantic network, frame and scripts.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction**<br>Introduction to AI problems, Introduction to AI Technique, Level of the Model, Criteria for Success.<br>**Problems, Problem Spaces and Search**<br>Defining the Problem as a State Space Search, Introduction to Production Systems, Problem Characteristics, Production System Characteristics.<br>**Heuristic Search Techniques**<br>Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis. | 10 |
| **Unit II** | **Knowledge Representation Issues**<br>Introduction to Representations and Mappings, Approaches to Knowledge Representation, Issues in Knowledge Representation, Frame Problem.<br>**Using Predicate Logic**<br>Representing Simple Facts in Logic, Representing Instance and *ISA* Relationships, Introduction to Computable Functions and Predicates | 10 |

| | | |
|---|---|---|
| | Resolution, Natural Deduction.<br>**Representing Knowledge Using Rules**<br>Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning, Matching, Control Knowledge. | |
| **Unit III** | **Symbolic Reasoning Under Uncertainty**<br>Introduction to Non monotonic Reasoning, Logic for Non monotonic Reasoning, Implementation Issues, Augmenting a Problem-solver Implementation of Depth-first Search, Implementation of Breadth-first Search.<br>**Statistical Reasoning**<br>Probability and Bayes' Theorem, Certainty Factors and Rule-based Systems, Introduction to Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic.<br>**Weak Slot-and-Filler Structures**<br>Introduction to Semantic Nets, Introduction to Frames.<br>**Strong Slot-and-Filler Structures**<br>Conceptual Dependency, Scripts, CYC. | 10 |
| **Unit IV** | **Knowledge Representation Summary**<br>Syntactic-semantic Spectrum of Representation, Logic and Slot-and-filler Structures.<br>**Game Playing**<br>Minimax Search Procedure, Adding Alpha-beta Cut-offs, Iterative Deepening.<br>**Planning**<br>An Example Domain: The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems.<br>**Understanding**<br>What Understands? What Makes Understanding Hard? Understanding as Constraint Satisfaction. | 10 |

**References:**

1. Kevin Knight, Elaine Rich, B. Nair "ARTIFICIAL INTELLIGENCE" McGraw Hill 3rd Edition 2017.
2. Stuart Russell and Peter Norvig "Artificial Intelligence 3e: A Modern Approach", 3rd Edition.

**Learning Outcomes:**

1. The students will learn the concepts of artificial intelligence, algorithms and related components of artificial intelligence.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Understand the Various AI problems, AI techniques, AI models and criteria of success. | 2 |
| | CO2 | Understand and Identify the AI Problems and their space. | 1, 2 |
| | CO3 | Understand and Apply AI Search Algorithms. | 1, 3 |
| II | CO4 | Understand and Analyse various concepts of knowledge representation and predicate logic. | 1, 4 |
| III | CO5 | Understand and Analyse various concepts of Symbolic and Statistical Reasoning | 2, 4 |
| | CO6 | Understand and Apply weak and strong slot-and-filter structures. | 2, 3 |
| IV | CO7 | Understand and Use the Game Playing techniques and Planning techniques. | 2, 6 |
| | CO8 | Conclude the spectrum of Knowledge Representation. | 5 |

# Semester I - Professional Electives

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT1P1a** | **Microservice Architecture** | **PE** | **4** | **40** | **3** |

**Course Objectives**

1. Gain a thorough understanding of the philosophy and architecture of Web applications using ASP.NET Core MVC.
2. Gain a practical understanding of.NET Core.
3. Acquire a working knowledge of Web application development using ASP.NET Core MVC 6 and Visual Studio.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Microservices**<br>Understanding Microservices, Adopting Microservices, The Microservices Way.<br>**Microservices Value Proposition**<br>Deriving Business Value, defining a Goal-Oriented, Layered Approach, Applying the Goal-Oriented, Layered Approach.<br>**Designing Microservice Systems**<br>The Systems Approach to Microservices, A Microservices Design Process,<br>**Establishing a Foundation**<br>Goals and Principles, Platforms, Culture. | 10 |
| **Unit II** | **Service Design**<br>Microservice Boundaries, API design for Microservices, Data and | 10 |

| | | |
|---|---|---|
| | Microservices, Distributed Transactions and Sagas, Asynchronous Message-Passing and Microservices, dealing with Dependencies.<br>**System Design and Operations**<br>Independent Deployability, More Servers, Docker and Microservices, Role of Service Discovery, Need for an API Gateway, Monitoring and Alerting.<br>**Adopting Microservices in Practice**<br>Solution Architecture Guidance, Organizational Guidance, Culture Guidance, Tools and Process Guidance, Services Guidance. | |
| **Unit III** | **ASP.NET Core Primer**<br>Introduction, Installing .NET Core, Building a Console App, Building ASP.NET Core App.<br>**Delivering Continuously**<br>Introduction to Docker, Continuous integration with Wrecker, Continuous Integration with Circle CI, Deploying to Dicker Hub.<br>**Building Microservice with ASP.NET Core**<br>Microservice, Team Service, API First Development, Test First Controller, creating a CI pipeline, Integration Testing, Running the team service Docker Image.<br>**Backing Services**<br>Microservices Ecosystems, Building the location Service, Enhancing Team Service. | 10 |
| **Unit IV** | **Creating Data Service**<br>Choosing a Data Store, building a Postgres Repository, Databases are Backing Services, Integration Testing Real Repositories, Exercise the Data Service.<br>**Event Sourcing and CQRS:**<br>Event Sourcing, CQRS pattern, Event Sourcing and CQRS, Running the samples.<br>**Building an ASP.NET Core Web Application**<br>ASP.NET Core Basics, Building Cloud-Native Web Applications. | 10 |

| | | |
|---|---|---|
| | **Service Discovery**<br>Cloud Native Factors, Netflix Eureka, Discovering and Advertising ASP.NET Core Services. DNS and Platform Supported Discovery. | |

**References:**

1. Irakli Nadareishvili, Ronnie Mitra, Matt McLarty, and Mike Amundsen, "Microservice Architecture: Aligning Principles, Practices, and Culture", O'Reilly, First Edition, 2016.
2. Kevin Hoffman, "Building Microservices with ASP.NET Core", O'Reilly, First Edition, 2017.
3. Sam Newman, "Building Microservices: Designing Fine-Grained Systems", O'Reilly, First Edition.
4. Susan J. Fowler, "Building Microservices: Designing Fine-Grained Systems", O'Reilly, First Edition,
5. Susan J. Fowler, "Production-ready Microservices", O'Reilly, 2016.

**Learning Outcomes:**

The students will be able to

1. Understand the basic concept and design of microservice.
2. Implement web API using ASP.NET Core MVC.
3. Use Docker as a container to store microservice images.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Understand and Apply the concepts of Microservice and Microservice Systems. | 2, 3 |
| II | CO2 | Identify, Understand and Apply the Service design concepts. | 1, 2, 3 |
| III | CO3 | Identify, Design and Apply the Microservice with ASP.NET core and Backing services. | 1, 3, 6 |
| IV | CO4 | Create and Apply Data Service and ASP.NET core Web Application. | 3, 6 |
| | CO5 | Create HTTP Services using ASP.NET core Web API. | 6 |
| | CO6 | Understand and Discover the ASP.NET core services. | 1,2 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT1P1b** | **Modern Networking** | **PE** | **4** | **40** | **3** |

**Course Objectives**

1. To understand the state-of-the-art in network protocols, architectures and applications.
2. Analyse existing network protocols and networks.
3. Develop new protocols in networking.
4. To understand how networking research is done.
5. To investigate novel ideas in the area of Networking via term-long research projects.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Modern Networking**<br>**Elements of Modern Networking**<br>The Networking Ecosystem, Example Network Architectures: Global Network Architecture, A Typical Network Hierarchy, Ethernet: Applications of Ethernet Standards Ethernet Data Rates, Wi-Fi: Applications of Wi-Fi, Standards Wi-Fi Data Rates, 4G/5G Cellular: First Generation Second Generation, Third Generation Fourth Generation Fifth Generation, Cloud Computing: Cloud Computing Concepts, The Benefits of Cloud Computing Cloud Networking Cloud Storage, Internet of Things: Things on the Internet of Things, volution Layers of the Internet of Things, Network Convergence, Unified Communications.<br>**Requirements and Technology**<br>Types of Network and Internet Traffic, Elastic Traffic, Inelastic Traffic, Real-Time Traffic Characteristics Demand: Big Data, Cloud computing, and Mobile Traffic. Big Data Cloud Computing, Mobile Traffic, Requirements: QoS and QoE, Quality of Service, Quality of | 10 |

| | | |
|---|---|---|
| | Experience, Routing Characteristics, Packet Forwarding, Congestion Control, Effects of Congestion, Congestion Control Techniques, SDN and NFV Software Defined Networking, Network Functions Virtualization Modern Networking Elements. | |
| **Unit II** | **Software-Defined Networks**<br>**SDN: Background and Motivation**<br>Evolving Network Requirements: Demand Is Increasing, Supply Is Increasing, Traffic Patterns Are More Complex Traditional Network Architectures are Inadequate, The SDN Approach: Requirements, SDN Architecture Characteristics of Software Defined Networking, SDN- and NFV-Related Standards Standards: Developing Organizations, Industry Consortia, Open Development Initiatives.<br>**SDN Data Plane and OpenFlow**<br>SDN Data Plane: Data Plane Functions, Data Plane Protocols. OpenFlow Logical Network Device: Flow Table Structure, Flow Table Pipeline, The Use of Multiple Tables, Group Table. OpenFlow Protocol.<br>**SDN Control Plane**<br>SDN Control Plane Architecture: Control Plane Functions, Southbound Interface Northbound Interface Routing, ITU-T Model, Open Daylight: Open Daylight Architecture Open Daylight Helium, REST: REST Constraints, Example REST API, Cooperation and Coordination Among Controllers: Centralized Versus Distributed Controllers, High-Availability Clusters Federated SDN Networks, Border Gateway Protocol Routing and QoS Between Domains, Using BGP for QoS Management, IETF SDNi, Open Daylight SNDi,<br>**SDN Application Plane**<br>SDN Application Plane Architecture: Northbound Interface, Network Services Abstraction Layer Network, Applications, User Interface, Network Services Abstraction Layer: Abstractions in SDN, Frenetic,<br>Traffic Engineering: Policy Cop, Measurement and Monitoring, Security: Open Daylight DDoS Application, Data Center Networking: Big Data over SDN, Cloud Networking over SDN, Mobility and Wireless Information-Centric Networking CCNx, Use of an Abstraction Layer | 10 |
| **Unit III** | **Virtualization**<br>**Network Functions Virtualization: Concepts and Architecture** | 10 |

| | | |
|---|---|---|
| | Background and Motivation for NFV, Virtual Machines: The Virtual Machine Monitor, Architectural Approaches, Container Virtualization, NFV Concepts: Simple Example of the Use of NFV, NFV Principles, High-Level NFV Framework, NFV Benefits and Requirements: NFV Benefits, NFV Requirements, NFV Reference Architecture: NFV Management and Orchestration, Reference Points, Implementation. NFV Functionality<br>NFV Infrastructure: Container Interface, Deployment of NFVI Containers, Logical Structure of NFVI Domains, Compute Domain, Hypervisor Domain, Infrastructure Network Domain, Virtualized Network Functions: VNF Interfaces, VNFC to VNFC Communication, VNF Scaling, NFV Management and Orchestration: Virtualized Infrastructure Manager, Virtual Network Function Manager, NFV Orchestrator, Repositories, Element Management, OSS/BSS, NFV Use Cases: Architectural Use Cases, Service-Oriented Use Cases, SDN and NFV.<br>**Network Virtualization**<br>Virtual LANs: The Use of Virtual LANs, Defining VLANs, Communicating VLAN Membership, IEEE 802.1Q VLAN Standard, Nested VLANs, OpenFlow VLAN Support; Virtual Private Networks: IPsec VPNs, MPLS VPNs, Network Virtualization: Simplified Example, Network Virtualization Architecture, Benefits of Network Virtualization, Open Daylight's Virtual Tenant Network; Software-Defined Infrastructure, Software-Defined Storage, SDI Architecture. | |
| **Unit IV** | **Defining and Supporting User Needs**<br>**Quality of Service**<br>Background, QoS Architectural Framework: Data Plane, Control Plane, Management Plane, Integrated Services Architecture: ISA Approach ISA Components, ISA Services, Queuing Discipline, Differentiated Services: Services, DiffServ Field, DiffServ Configuration and Operation, Per-Hop Behavior, Default Forwarding PHB, Service Level Agreements; IP Performance Metrics; OpenFlow QoS Support: Queue Structures, Meters.<br>**QoE: User Quality of Experience**<br>Why QoE?: Online Video Content Delivery, Service Failures Due to Inadequate QoE Considerations; QoE-Related Standardization Projects; Definition of Quality of Experience: Definition of Quality, Definition of Experience, Quality Formation Process, Definition of Quality of | 10 |

| | | |
|---|---|---|
| | Experience, QoE Strategies in Practice: The QoE/QoS Layered Model, Summarizing and Merging the ,QoE/QoS Layers, Factors Influencing QoE; Measurements of QoE: Subjective Assessment, Objective Assessment, End-User Device Analytics, Summarizing the QoE Measurement Methods, Applications of QoE. | |

**References:**

1. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Addison Wesley Professional, October 2015.
2. Jim Doherty, SDN and NFV Simplified A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization, Pearson Education, Inc.
3. Rajendra Chayapathi Syed Farrukh Hassan, "Network Functions Virtualization (NFV) with a Touch of SDN", AddisonWesley.
4. Brad dgeworth, Jason Gooley, Rami, "CCIE and CCDE Evolving Technologies Study Guide", Pearson Education, Inc, 2019.

**Learning Outcomes:**

The student will be able to
1. Understand modern networking elements.
2. Implement SDN concept.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Describe and Remember the importance and history of Modern Networking. | 1, 2 |
| | CO2 | Understand and Describe the basic concepts of Modern Networking and Internet of Things. | 2 |
| | CO3 | Recognise and Understand the requirements and technology of Modern Networks. | 1, 2 |
| II | CO4 | Understand and Describe SDN concepts, applications and standards across data, control and application plane. | 2, 3 |
| | CO5 | Understand and Use open flow devices and protocols. | 2, 3 |

| | | | |
|---|---|---|---|
| III | CO6 | Recognise, Understand and Explore the Concepts, Architectures, Functionality and Applications of Network Function Virtualization (NFV). | 2, 6 |
| IV | CO7 | Understand, Analyse and Evaluate the Quality of Service (QoS) Architectural Frameworks, Services, Service Level Agreements, Performance Metric, and OpenFlow QoS Support. | 2, 4, 5 |
| | CO8 | Understand, Analyse and Evaluate the Quality of Experience (QoE), Service Failure, Standards, QoE Strategies in Practice, Factors and Measurement and Applications., | 2, 4, 5 |

# Semester I - Career Advancement Course

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT1C1** | **Cyber Security – I** | **CC** | **2** | **20** | **1** |

**Course Objectives**

1. To get the insight of the security loopholes in every aspect of computing.
2. To understand the threats and different types of attacks that can be launched on computing systems.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction to Security Breaching**: Overview of Information Security, Threats and Attack vectors, Concepts of Hacking – Ethical and Unethical, Information Security Controls, Concepts of penetration Testing, Information Security Laws and Standards. **Evaluation Security of IT Organisation:** Concepts, Methodology, Tools, Countermeasures, Penetration Testing. | 05 |
| **Unit II** | **Network Scanning:** Concepts, scanning beyond IDS and firewalls, Tools, Banner Grabbing, Scanning Techniques, Network Diagrams, penetration testing. **Enumeration:** Concepts, Different types of enumeration: Netbios, SNMP, LDAP, NTP, SMTP, DNS, other enumeration techniques, Countermeasures, Penetration Testing | 05 |
| **Unit III** | **Analysis of Vulnerability:** Concepts, Assessment Solutions, Scoring Systems, Assessment Tools, Assessment Reports. | 05 |

| | | |
|---|---|---|
| | **Breaching System Security:** Concepts, Cracking passwords, Escalating privileges, Executing Applications, Hiding files, covering tracks, penetration testing. | |
| **Unit IV** | **Threats due to malware:** Concepts, Malware Analysis, Trojan concepts, countermeasures, Virus and worm concepts, anti-malware software, penetration testing.<br>**Network Sniffing:** Concepts, countermeasures, sniffing techniques, detection techniques, tools, penetration testing. | 05 |

**References:**

**1.** Ric Messier, "CEHv10, Certified Ethical Hacker Study Guide", Sybex – Wiley, 2019. **2.** Matt Walker, "All in One, Certified Ethical Hacker", Tata McGraw Hill, 2012. **3.** I.P. Specialist, "CEH V10: EC-Council Certified Ethical Hacker Complete Training Guide", IPSPECIALIST, 2018.

**Learning Outcomes:**

The students will be able to

1. Understand basic concept of Ethical and Unethical Hacking
2. Execute and analyze system secure measures.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Describe and Execute the concepts of Ethical and Unethical Hacking. | 1, 2 |
| | CO2 | Describe, Execute and Apply the concepts of Penetration Testing and Countermeasures. | 1, 2, 3 |
| II | CO3 | Describe, Execute and Apply the concepts of Network Scanning and Enumeration. | 1, 2, 3 |
| III | CO4 | Describe, Execute, Apply and Analyze the Vulnerability and Assessments Tools. | 1, 2, 3, 4 |
| | CO5 | Describe, Execute and Use the concepts of System Security breaching. | 1, 2, 3 |
| IV | CO6 | Describe, Execute, Apply and Analyze the Malware Threats and | 1, 2, 3, 4 |

| | | | |
|---|---|---|---|
| | | Anti Malware Software. | |
| | CO7 | Describe, Execute and Apply the concepts and Tools of Network Sniffing and to Execute the Counter Measures. | 1, 2, 3, 5 |

# Semester I - PG Labs

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| RJSPIT1L1 | PG Lab I Foundation of Data Science | PGL | 2 | 20 | 2 |

**Course Objectives**

1. To introduce data analysis and visualization using mathematical and statistical computing concepts using Python Libraries.

**Practical List**

1. NumPy, Pandas, Matplotlib and Seaborn Basics
2. Data Collection and Pre-processing
3. Descriptive Statistical Analysis
4. Exploratory Data Analysis
5. Generation of Random Variable
6. Probability Distributions
7. Data and Sampling Distributions
8. Inferential Statistics and Probability
9. Significance and Hypothesis Testing
10. Supervised and Unsupervised Learning Algorithms

**Learning Outcomes:**

1. The students will be able to analyze data using mathematical and statistical models using R studio / Python.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | CO1 | Collect and Organise the data and Create the Dataset. | 4 |
| | CO2 | Perform Descriptive Statistics and Exploratory Data Analysis for the given Dataset. | 3 |
| | CO3 | Generate random number and data distribution of discrete and continuous type as well and Apply Sampling Methods. | 3 |
| | CO4 | Evaluate Distribution and Find the Point Estimates. | 3, 5 |
| | CO5 | Perform Hypothesis Testing using various tests. | 6 |
| | CO6 | Build the model and Predict the Outcome. | 6 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT1L2** | **PG Lab II Cloud Computing** | **PGL** | **2** | **20** | **2** |

**Course Objectives**

1. To Impart knowledge, practical training and insight into the implementation and Management of various Virtualization technologies with a focus towards applying these technologies in migrating from a traditional network infrastructure to a Cloud based solution.

**Practical List**

1. Implement Client Server communication model using TCP.
2. Implement Client Server communication model using UDP.
3. Implementation of web services.
4. Implement cluster on Windows Server.
5. Develop a cloud application for Microsoft Azure.
6. Implement virtualization with Xen Server and manage with Xen centre.

7. Develop application for Google App Engine.
8. Implement virtualization using VMWare ESXi Server and managing with vSphere Client.
9. Implement virtualization using Hyper-V.
10. Configuring IAAS using Open Nebula.

**Learning Outcomes:**

1. They will learn to implement private cloud, search engine, server cluster, Mapreduce and Hadoop, social networking site, blog site, grid computing, and various types of clouds.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| | CO1 | Configure and Manage the Virtual servers and Virtual Machines. | 3, 4 |
| | CO2 | Design client server Application using TCP and UDP protocol. | 6 |
| | CO3 | Understand Design, Deploy and Implement Web services. | 2, 6 |
| | CO4 | Design clusters on Windows. | 6 |
| | CO5 | Build Applications on Azure Cloud platform and Google App Engine. | 6 |
| | CO6 | Implement virtualization with Xen Server, ESXi Server and Hyper-V platforms. | 6 |
| | CO7 | Configure and Use Iaas on Open Nebula Cloud Platform. | 4, 6 |

# Semester II – Core Courses

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT201** | **Big Data Analytics** | **CC** | **4** | **40** | **4** |

**Course Objectives**

**1.** To introduce the big data technology, Hadoop framework, data analysis of big data, data mining of big data and big data frameworks.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction to Big Data**<br>Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools. | 10 |
| **Unit II** | **Hadoop Framework**<br>Distributed File Systems - Large-Scale File System Organization – HDFS concepts - MapReduce Execution, Algorithms using MapReduce, Matrix Vector Multiplication – Hadoop YARN. | 10 |
| **Unit III** | **Data Analysis**<br>Statistical Methods: Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data | 10 |

| | | |
|---|---|---|
| | - Predictive Analytics – Data analysis using R. | |
| **Unit IV** | **Mining Data Streams**<br>Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.<br>**Big Data Frameworks**<br>Introduction to NoSQL, Aggregate Data Models, HBase: Data Model and Implementations, HBase Clients Examples, Cassandra: Data Model – Examples – Cassandra Clients, Hadoop Integration. Pig – Grunt, Pig Data Model, Pig Latin – developing and testing Pig Latin scripts. Hive Data Types and File Formats, HiveQL Data Definition, HiveQL Data Manipulation, HiveQL Queries. | 10 |

**References:**

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley and SAS Business Series, 2012. 2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
2. Learning R – A Step-by-step Function Guide to Data Analysis, Richard Cotton, O'Reilly Media, 2013.
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
5. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
6. Sridhar Alla, "Big Data Analytics with Hadoop3", Packt, 2018.
7. Simon Walkowiak, "Big Data Analytics with R: Utilize R to uncover hidden patterns in your Big Data", Packt, 2016.

**Learning Outcomes:**

The students will be able to:

1. Understand how to leverage the insights from big data analytics.
2. Analyze data by utilizing various statistical and data mining approaches.
3. Perform analytics on real-time streaming data.
4. Understand the various NoSql alternative database models.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Discuss and Describe the Big Data concepts, Big Data Applications, Various Analytical Processes and Tools. | 2 |
| II | CO2 | Discuss, Install and Configure Hadoop Framework, MapReduce and Hadoop Yarn. Discuss and Implement the various MapReduce Algorithms as Well. | 2, 3, 6 |
| III | CO3 | Describe, Apply and Analyse various methods to Big Data. | 2, 3, 4 |
| | CO4 | Perform Predictive Analysis using R/Python. | 3 |
| IV | CO5 | Understand and Describe the Stream Data Model, NoSQL Models and its Architecture. | 2 |
| | CO6 | Understand, Apply and Use various Big Data Frameworks and leverage the insights from Big Data Insights. | 2, 3 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT202** | **Virtualization** | **CC** | **4** | **40** | **4** |

**Course Objectives**

1. Understanding the basics of virtualization and VMware vSphere product suite.
2. Identify the need for Server Virtualization

3. Describe the components and features of vSphere 6.7 and ESXi
4. Describe how VMware's products help solve business and technical challenges with regard to Server Virtualization

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Understanding Virtualization**<br>Describing Virtualization, Microsoft Windows Drives Server Growth, Explaining Moore's Law, Understanding the Importance of Virtualization, Examining Today's Trends, Virtualization and Cloud Computing Understanding Virtualization, Software Operation, Virtualizing Servers Virtualizing Desktops Virtualizing Applications.<br>**Understanding Hypervisors**<br>Describing a Hypervisor, Exploring the History of Hypervisors, Understanding Type 1 Hypervisors, Understanding Type 2 Hypervisors, Understanding the Role of a Hypervisor, Holodecks and Traffic Cops, Resource Allocation, Comparing, Today's Hypervisors, ESX, Citrix Xen, Microsoft Hyper-V.<br>**Understanding Virtual Machines**<br>Describing a Virtual Machine, Examining CPUs in a Virtual Machine, Examining Memory in a Virtual Machine, Examining Network Resources in a Virtual Machine, Examining Storage in a Virtual Machine, Understanding How a Virtual, Machine Works, Working with Virtual Machines, Understanding Virtual Machine Clones, Understanding Templates, Understanding Snapshots, Understanding OVF, Understanding Containers, understanding VMware Tools<br>**Introducing VMware vSphere**<br>Exploring VMware vSphere 6.7, Why Choose vSphere? | 10 |
| **Unit II** | **Planning and Installing VMware ESXi**<br>Planning a VMware vSphere Deployment, Deploying VMware ESXi, Performing, Post installation Configuration. **Installing and** | 10 |

| | | |
|---|---|---|
| | **Configuring vCenter Server**<br>Introducing vCenter Server, Choosing the Version of vCenter Serve, Planning and Designing a vCenter Server Deployment, installing vCenter Server in a Linked Mode Group, Deploying the vCenter Server Virtual Appliance, exploring vCenter Server, exploring vCenter Server's Management Features, Managing vCenter Server Settings, vSphere Web Client Administration.<br>**vSphere Update Manager and the vCenter Support Tools**<br>vSphere Update Manager, Configuring vSphere Update Manager, Routine Updates, Performing an Orchestrated Upgrade, Investigating Alternative Update Options, vCenter Support Tools<br>**Creating and Configuring vSphere Networks**<br>Putting Together a Virtual Network, working with vSphere Standard Switches, working with vSphere Distributed Switches, Examining Third Party Distributed Virtual Switches, Configuring Virtual Switch Security. | |
| **Unit III** | **Creating and Configuring Storage Devices**<br>Reviewing the Importance of Storage Design, Examining Shared Storage Fundamentals, Implementing vSphere Storage Fundamentals, Leveraging SAN and NAS Best Practices.<br>**Ensuring High Availability and Business Continuity**<br>Understanding the Layers of High Availability, Clustering VMs, Implementing vSphere High Availability, Introducing vSphere SMP Fault Tolerance, Planning for Business Continuity.<br>**Securing VMware vSphere**<br>Overview of vSphere Security, Securing ESXi Hosts, securing vCenter Server, Securing Virtual Machines.<br>**Using VM, Templates and vApps**<br>Creating and Managing Virtual Machines, Modifying Virtual Machines, Cloning VMs, Creating Templates and Deploying Virtual Machines, Using OVF Templates, Using Content Libraries, working with vApps, Importing Machines from Other Environments. | 10 |

| | | |
|---|---|---|
| **Unit IV** | **Managing Resource Allocation**<br>Reviewing Virtual Machine Resource Allocation, Working with Virtual Machine Memory, Managing Virtual Machine CPU Utilization, Using Resource Pools, Regulating Network I/O Utilization, Controlling Storage I/O Utilization.<br>**Balancing Resource Utilization**<br>Comparing Utilization with Allocation, exploring vMotion, Using Storage vMotion, combining vMotion with Storage vMotion, Introducing Cross vCenter vMotion, Exploring vSphere Distributed, Resource Scheduler, Working with Storage DRS.<br>**Monitoring VMware vSphere Performance**<br>Overview of Performance Monitoring, Using Alarms, Working with Performance Charts, Working with resxtop, Monitoring CPU Usage, Monitoring Memory Usage, Monitoring Network Usage, Monitoring Disk Usage.<br>**Automating VMware vSphere**<br>Why Use Automation? vSphere Automation Options, Automating with PowerCLI, using vCLI from vSphere Management Assistant, Using vSphere, Management Assistant for Automation with vCenter, ESXCLI and PowerCLI, Leveraging the Perl Toolkit with vSphere Management Assistant, Automating with vRealize Orchestrator. | 10 |

**References:**

1. Nick Marshall, Scott Lowe (Foreword by) with Grant Orchard, Josh Atwell, "Mastering VMware vSphere 6.7", Publisher: Sybex, Wiley 2019
2. Matthew Portnoy, "Virtualization Essentials", 2nd Edition, Wiley India Pvt. Ltd.

**Learning Outcomes:**

Student will be able to:

1. Implementing vmwareESXi server virtualization.
2. Managing vmwareESXi with vCentre server.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| I | CO1 | Understand and Describe the Concepts of Virtualization, Hypervisor, Virtual Machines and VMWare vSphere 6.7. | 2 |
| II | CO2 | Describe, Install and Configure ESXi and vCenter Server. | 2, 3 |
| | CO3 | Demonstrate the use of vSphere Update Manager and Create a vSphere Network. | 2 |
| III | CO4 | Understand and Apply VMware vSphere Security. | 2, 3 |
| | CO5 | Configure the Virtual servers and Virtual Machines and Manage Resources to ensure Business Continuity. | 3 |
| | CO6 | Allocate and Configure Storage Devices. | 3 |
| | CO7 | Create and Manage Virtual Machines and Use the Templates. | 3, 4 |
| IV | CO8 | Configure and Monitor the resources. | 3, 4 |
| | CO9 | Monitor performance and Understand the Automation of vSphere. | 2, 5 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT203** | **Image and Vision Processing** | **CC** | **4** | **40** | **4** |

**Course Objectives**

1. To study the image fundamentals and mathematical transforms necessary for image processing.
2. To study the image enhancement techniques
3. To study image restoration procedures. To study the image compression procedures.

| Unit | Topics | Lectures |
|---|---|---|

| | | |
|---|---|---|
| **Unit I** | **Introduction to Image Processing**<br>Example of fields that uses image processing, Steps of image processing, Components, Applications, Image sensors and Image formats.<br>**Visual Preliminaries**<br>Brightness adaptation and contrast, Acuity and contour, Texture and pattern discrimination, Shape detection and recognition, perception of color, Computational model of perceptual processing, Image sampling and quantization, Basic relationship between pixels.<br>**Intensity transformations**<br>Introduction, Basic intensity transformation functions, Histogram equalization, Local histogram processing, Using histogram statistics for image enhancement. | 10 |
| **Unit II** | **Spatial filtering**<br>Fundamentals of spatial filtering, Smoothing and sharpening spatial filters, combining spatial enhancement methods, Using fuzzy techniques for intensity transformations and spatial filtering.<br>**Colour Image Processing**<br>Colour fundamentals, Colour models, Pseudo colour image processing, Basic of full-color image processing, colour transformations, Smoothing and sharpening, Image segmentation bases on colour, Noise in colour images, Colour image compression. | 10 |
| **Unit III** | **Image compression**<br>Fundamentals, Basic methods, Digital image watermarking, Full motion video compression.<br>**Morphological Image Processing**<br>Introduction, Erosion and Dilation, Opening and closing, Histor-Miss transformation, Basic morphological algorithms, gray scale morphology. **Segmentation**<br>Fundamentals, Point, Line and Edge detection, Thresholding, Region based segmentation, Segmentation using morphological watersheds Use of motion in segmentation – Spatial techniques. | 10 |

| | | |
|---|---|---|
| **Unit IV** | **Content-Based Image Retrieval**<br>Image database examples, Image database queries, Query-by-example, Image distance measures, Database organization.<br>**Motion from 2D Image Sequences**<br>Motion phenomena and applications, Image subtraction, Computing motion vectors, Computing the paths of moving points, Detecting significance changes in video.<br>**Image Segmentation**<br>Identifying regions, representing regions, identifying contours, Fitting model to segments, identifying higher level structure, Segmentation using motion coherence. | 10 |

**References:**

1. Digital Image Processing, Gonzalez and Woods, 3rd Edition, Pearson Education. 2. Digital Image Processing and Analysis, Bhabatosh Chanda, Dwijesh Dutta Majumder, 2nd Edition, PHI.
3. Fundamentals of Digital Image Processing, Anil K Jain, 1st Edition, PHI.

**Learning Outcomes:**

Student will be able to:

1. Review the fundamental concepts of a digital image processing system.
2. Analyze images in the frequency domain using various transforms.
3. Evaluate the techniques for image enhancement and image restoration.
4. Categorize various compression techniques.
5. Interpret Image compression standards.
6. Interpret image segmentation and representation techniques.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Explain and understand the fundamental concepts of a digital image processing system and various application areas of image processing. To Understand the various Steps in image processing starting from acquisition of the image. | 2 |

| | | | |
|---|---|---|---|
| | CO2 | Understand the basic relationship between the pixels and analyse the distance measures. Understand, Apply, Compare and analyse the basic intensity techniques for image enhancement, Understand and solve histogram equalization concept for image enhancement. | 2, 3, 4 |
| II | CO3 | Understand, apply and analyse Smoothing and sharpening spatial filters, Understand and describe color fundamentals. Understand and compare different color models. Understand Pseudo colour image processing and full-color image processing, | 1, 2, 3, 4 |
| III | CO4 | Understand and calculate data redundancy and compression ratio using variable length coding. Understand and describe general image compression system. Understand, Analyse and evaluate Compression Methods, like- Huffman Coding, LZW Compression. Understand and apply Morphological Image Processing. Understand Point, Line and Edge detection, and Apply gradient operators for edge detection. | |
| IV | CO5 | Understand and compare text-based image retrieval and CBIR and analyse Image distance measures in CBIR. Understand Motion phenomena, image field and Describe change detection using image subtraction method. Computing motion vectors and the paths of moving points. | |

## Semester II – Professional Electives

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT2P2a** | **Blockchain Technology** | **PE** | **4** | **40** | **3** |

**Course Objective**

1. Develop a thorough understanding of the fundamentals of Block chain Technology.
2. To cover the technological underpinnings of block chain operations as distributed data structures and decision-making systems, their functionality and different architecture types.
3. To provide a critical evaluation of existing "smart contract" capabilities and platforms, and examine their future directions, opportunities, risks and challenges.
4. Exposure to Decentralized App development, its application areas, current practices, and research activity.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Blockchain:**<br>Introduction, History, centralised versus Decentralised systems, layers of blockchain, Importance of blockchain, Blockchain uses and use cases.<br>**Working of Blockchain:**<br>Blockchain foundation, Cryptography, Game Theory, Computer Science Engineering, Properties of blockchain solutions, | 10 |
| | blockchain transactions, distributed consensus mechanisms, Blockchain mechanisms, Scaling blockchain<br>**Working of Bitcoin:**<br>Money, Bitcoin, Bitcoin blockchain, bitcoin network, bitcoin scripts, Full Nodes and SVPs, Bitcoin wallets | |

| | | |
|---|---|---|
| **Unit II** | **Ethereum:**<br>Three parts of blockchain, Ether as currency and commodity, Building trustless systems, Smart contracts, Ethereum Virtual Machine.<br>**The Mist browser:**<br>Wallets as a Computing Metaphor, The Bank Teller Metaphor, Breaking with Banking History, How Encryption Leads to Trust, System Requirements, Using Parity with Geth, Anonymity in Cryptocurrency, Central Bank Network, Virtual Machines, EVM Applications, State Machines, Guts of the EVM, Blocks, Mining's Place in the State Transition Function, Renting Time on the EVM, Gas, Working with Gas, Accounts, Transactions, and Messages, Transactions and Messages, Estimating Gas Fees for Operations, Opcodes in the EVM.<br>**Solidity Programming:**<br>Introduction, Global Banking Made Real, Complementary Currency, Programming the EVM, Design Rationale, Importance of Formal Proofs, Automated Proofs, Testing, Formatting Solidity Files, Reading Code, Statements and Expressions in Solidity, Value Types, Global Special Variables, Units and Functions. | 10 |
| **Unit III** | **Smart Contracts and Tokens:**<br>EVM as Back End, Assets Backed by Anything, Cryptocurrency Is a Measure of Time, Function of Collectibles in Human Systems, Platforms for High Value Digital Collectibles, Tokens as Category of Smart Contract, creating a Token, Deploying the Contract, Playing with Contracts.<br>**Mining Ether:**<br>Why? Ether's Source, Defining Mining, Difficulty, Self-Regulation, and the Race for Profit, How Proof of Work Helps Regulate Block Time, DAG and Nonce, Faster Blocks, Stale Blocks, Difficulties, Ancestry of Blocks and Transactions, Ethereum and Bitcoin, Forking, Mining, Geth on Windows, Executing Commands in the EVM via the Geth Console, Launching Geth with Flags, Mining on | 10 |

| | | |
|---|---|---|
| | the Testnet, GPU Mining Rigs, Mining on a Pool with Multiple GPUs.<br>**Crypt economics:**<br>Introduction, Usefulness of crypto economics, Speed of blocks, Ether Issuance scheme, Common Attack Scenarios. | |
| **Unit IV** | **Blockchain Application Development:**<br>Blockchain Application Development, interacting with the Bitcoin Blockchain, Interacting Programmatically with Ethereum—Sending Transactions, creating a Smart Contract, Executing Smart Contract Functions, Public vs. Private Blockchains, Decentralized Application Architecture<br>**DApp deployment:**<br>Seven Ways to Think About Smart Contracts, DApp Contract Data Models, EVM back-end and front-end communication, JSON-RPC, Web 3, JavaScript API, Using Meteor with the EVM, Executing Contracts in the Console, Recommendations for Prototyping, Third-Party Deployment Libraries<br>**Use Cases:** Chains Everywhere, The Internet of Ethereum Things Retail and E-Commerce Community and Government Financing, Human and Organizational Behavior, Financial and Insurance Applications, Inventory and Accounting Systems, Software Development, Gaming, Gambling, and Investing. | 10 |

**References:**

1. Bikramaditya Singhal,Gautam Dhameja, Priyansu Sekhar Panda "Beginning Blockchain A Beginner's Guide to Building Blockchain Solutions ",Apress publication , 2018.
2. Chris Dannen ," Introducing Ethereum and Solidity ",Apress publication , 2017.
3. Joseph J. Bambara, Paul R. Allen, Kedar Iyer, Rene Madsen, Solomon Lederer, Michael Wuehler "Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions" 1st Edition.
4. Elad Elrom , The Blockchain Developer , Apress publication , 2019
5. Vikram Dhillon, David Metcalf, Max Hooper, "Blockchain Enabled Applications

"Apress publication 2017

**Learning Outcomes:**

1. Possess the in-demand skills to play an active role in Blockchain revolution.
2. Understand key features, different types of platforms & Languages of Blockchain Technology.
3. Know how to launch Blockchain in a single node and extend to multiple nodes using BAAS architecture.
4. Enable better strategic business decisions and develop solutions to real-life case studies.
5. Be able to confidently use Blockchain Technology in conjunction with other bleeding edge technologies in the domains of Big Data, Artificial Intelligence, Machine Learning, Analytics & IOT.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Understand the technical fundamentals of Blockchain Technology. | 2 |
| | CO2 | Understand and Describe Core components of Blockchain. | 2 |
| | CO3 | Understand and Describe the concepts of Bitcoin as a cryptocurrency use case of Blockchain. | 2, 3 |
| II | CO4 | Demonstrate how Blockchain could be programmed with Ethereum Blockchain. | 2, 3, 6 |
| | CO5 | Understand, Describe and Use the various aspects of Ethereum Client Applications. | 2, 3 |
| | CO6 | Understand the fundamentals of Solidity Programming Language and Apply it to design Smart Contract. | 2, 3 |
| III | CO7 | Describe, Build and Deploy the Smart Contracts and Tokens. | 2, 3, 6 |
| | CO8 | Describe the functionality of mining to reach consensus and Demonstrate the process of Mining Ether. | 2, 3 |
| | CO9 | Describe and Evaluate the various aspects of Crypto | 2, 3 |

| | | | |
|---|---|---|---|
| | | Economics. | |
| IV | CO10 | Develop Blockchain Application, Interact with Bitcoin, Blockchain and Ethereum, Create and Execute Smart Contracts. | 3, 6 |
| | CO11 | Develop and Deploy Decentralised Application DApp and Perform basic transactions in blockchain platforms. | 3 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT2P2b** | **Soft Computing** | **PE** | **4** | **40** | **3** |

**Course Objectives**

1. To learn Soft computing concepts like fuzzy logic, neural networks and genetic algorithm.
2. All these techniques will be more effective to solve the problem efficiently.

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Introduction of soft computing**<br>soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Classification, Clustering, Bayesian Networks, Probabilistic reasoning, applications of soft computing.<br>**Artificial Neural Network**<br>Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloh-Pitts Neuron, Linear Separability, Hebb Network. | 10 |

| | | |
|---|---|---|
| **Unit II** | **Supervised Learning Network**<br>Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, Backpropagation Network, Radial Basis Function, Time Delay Network, Functional Link Networks, Tree Neural Network.<br>**Associative Memory Networks**<br>Training algorithm for pattern Association, Autoassociative memory network, hetroassociative memory network, bi-directional associative memory, Hopfield networks, iterative autoassociative memory networks, temporal associative memory networks. | 10 |
| **Unit III** | **UnSupervised Learning Networks**<br>Fixed weight competitive nets, Kohonen self-organizing feature maps, learning vectors quantization, counter propogation networks, adaptive resonance theory networks.<br>**Special Networks**<br>Simulated annealing, Boltzman machine, Gaussian Machine, Cauchy Machine, Probabilistic neural net, cascade correlation network, cognition network, neo-cognition network, cellular neural network, optical neural network | 10 |
| **Unit IV** | **Introduction to Fuzzy Logic, Classical Sets and Fuzzy sets**<br>Classical sets, Fuzzy sets.<br>**Classical Relations and Fuzzy Relations**<br>Cartesian Product of relation, classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets.<br>**Membership Function**<br>Features of the membership functions, fuzzification, methods of membership value assignments.<br>**Defuzzification**<br>Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods. Fuzzy Arithmetic and Fuzzy measures: fuzzy arithmetic, fuzzy measures, measures of fuzziness, fuzzy integrals. | 10 |

**References:**

1. Anandita Battacharya Das, "Artificial Intelligence and Soft Computing", SPD, Third Edition, 2018.
2. S.N.Sivanandam S.N.Deepa, "Principles of Soft computing", Wiley, Third Edition, 2019.
3. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy Computing and Soft", Prentice Hall of India, 2004.
4. S.Rajasekaran, G. A. Vijayalakshami, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications", Prentice Hall of India, 2004.
5. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGrawHill,1997.
6. Davis E.Goldberg , "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, 1989.
7. Dan W. Patterson, "Introduction to AI and Expert System", Prentice Hall of India, 2009.

**Learning Outcomes:**

The students will be able to

1. Identify and describe soft computing techniques and their roles in building intelligent machines.
2. Apply neural networks for classification and regression problems.
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Understand, Describe and Apply the concepts of Soft Computing and Neural Computing. | 2, 3 |
| | CO2 | Describe and Apply various soft computing techniques like classification, clustering, Bayesian Network and Probabilistic Reasoning. | 2, 3 |
| | CO3 | Understand the working of Artificial Neural Networks. | 2 |
| II | CO4 | Understand, Describe and Design the Supervised Learning Networks and Associative Memory Networks. | 2, 6 |
| III | CO5 | Understand, Describe and Design the Unsupervised Learning Networks and Special Networks. | 2, 6 |

| | | | |
|---|---|---|---|
| IV | CO6 | Understand and Describe the concepts of Fuzzy Logic Fuzzification and Defuzzification. | 2 |

# Semester II – Career Advancement Course

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT2C2** | **Cyber Security II** | **PE** | **2** | **10** | **1** |

**Course Objectives**

1. To know the countermeasures that can be taken to prevent attacks on computing systems.
2. To test the software against the attacks

| Unit | Topics | Lectures |
|---|---|---|
| **Unit I** | **Social Engineering**<br>Concepts, Impersonation on networking sites, Techniques, Identity theft, Insider threats, countermeasures, Pen testing.<br>**Denial of Service and Distributed Denial of service**<br>Concepts, techniques, botnets, attack tools, countermeasures, protection tools, penetration testing. | 8 |
| **Unit II** | **Hijacking an active session**<br>Concepts, tools, application-level session hijacking, countermeasures, network level session hijacking, penetration testing.<br>**Evasion of IDS, Firewalls and Honeypots**<br>Introduction and concepts, detecting honeypots, evading IDS, IDS and Firewall evasion countermeasures, evading firewalls, penetration testing. | 8 |
| **Unit III** | **Compromising Web Servers**<br>Concepts, attacks, attack methodology, attack tools, countermeasures patch management, web server security tools, penetration testing. | 8 |

| | | |
|---|---|---|
| | **Compromising Web Applications**<br>Concepts, threats, methods, tools, countermeasures, testing tools, penetration testing. | |
| **Unit IV** | **Performing SQL Injection**<br>Concepts, types, methodology, tools, techniques, countermeasures.<br>**Compromising Wireless Networks**<br>Concepts, wireless encryption, threats, methodology, tools, compromising Bluetooth, countermeasures, wireless security tools, penetration testing. | 8 |

**References:**

1. Ric Messier, "CEHv10, Certified Ethical Hacker Study Guide", Sybex – Wiley, 2019.
2. Matt Walker, "All in One, Certified Ethical Hacker", Tata McGraw Hill, 2012. 3. I.P. Specialist, "CEH V10: EC-Council Certified Ethical Hacker Complete Training Guide", IPSPECIALIST, 2018.

**Learning Outcomes:**

The students will be able to

1. Understand various types of attacks and vulnerabilities, categorize events and perform incident analysis.
2. Understand and analyze various forms of intrusions, threats and perform forensic analysis on them.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| I | CO1 | Understand and Use the various techniques of identifying threats and counter measures for Social Engineering. | 2, 3 |
| II | CO2 | Hijack the Application-level and Network-level sessions, Firewall and Use the counter measure techniques. | 3 |
| III | CO3 | Understand, Describe/Use the Web Servers and Web Applications attack methodologies, Security and Testing Tools. | 2, 3 |
| IV | CO4 | Perform SQL injection technique. | 6 |

| | | | |
|---|---|---|---|
| | CO5 | Understand and Describe Wireless Network Concepts and Security Tools. | 2 |

# Semester II – PG Labs

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT2L3** | **PG Lab III**<br>**Big Data Analytics** | **PGL** | **2** | **20** | **2** |

**Course Objectives**

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

**Practical List**

1. To understand the overall programming architecture using Map Reduce API.
2. Store the basic information about students such as roll no, name, date of birth and address of student using various collection types such as List, Set and Map.
3. Basic CRUD operations in MongoDB.
4. Retrieve various types of documents from student's collection.
5. To find documents from Student's collection.
6. Develop Map Reduce Work Application.
7. Creating the HDFS tables
8. Loading HDFS tables in Hive and learn joining of tables in Hive.
9. Supervised Learning Algorithms
10. Unsupervised Learning Algorithms.

**Learning Outcomes:**

**1.** The students will be able to handle big data and query big data.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|
| | CO1 | Describe and Apply fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics. | 2,3 |
| | CO2 | Execute basic CRUD Operations Using Mongo DB. | 3 |
| | CO3 | Create and Execute the MapReduce Application. | 3, 6 |
| | CO4 | Perform various operations like Create, Load, and Join HDFS table using Hive. | 3, 6 |
| | CO5 | Describe and Apply Supervised and Unsupervised algorithms to Big Data. | 2, 3 |

| Course Code | Course Name | Group | Number of Lectures Per Week | Total Number of Lectures Required | Credits |
|---|---|---|---|---|---|
| **RJSPIT2L4** | **PG Lab III Virtualization** | **PGL** | **2** | **20** | **2** |

**Course Objectives**

1. To implement vmware, vSphere, ESXi and vCenter Server and its various functionality to implement and manage server virtualization.

**Practical List**

1. Implement VMwareESXi for server virtualization.
    a. Install VMwareESXi server and vSphere client.

b. Install vCenter Single Sign-On as Part of a vCenter Server Simple Install

2. Manage VMwareESXi server with vCentre server.
    a. Create a virtual machine in vmwareESXi Server.
    b. Migrate the virtual machine from one ESXi server to another ESXi server.
3. Create a Template in the vSphere Client.
    a. Convert a Virtual Machine to a Template in the vSphere Client.
    b. Clone a Template in the vSphere Client.
    c. Clone Virtual Machine to Template in the vSphere Client.
4. Manage the storage and Security of VMware ESXi server.
    a. Add Virtual storage in VMware ESXi Server with vSphere Client.
    b. Create a one user account of VMware ESXi server using vSphere WebClient application.
    c. Prevent Users from Spying on Remote Console Sessions.
5. Upgrade the VMware ESXi server 6.0 to 6.7 using simple installation.
6. Implement the NFS with the vCenter Server.
7. Implement VLAN concept L2/L3 switches.
8. vSphere Monitoring and Performance.
    a. Monitoring Inventory Objects with different Performance Charts.
    b. Monitoring Guest Operating System Performance.
        i. View Performance Statistics for Windows Guest Operating Systems.
9. Manage Xen Server with Xen center.
10. Implement Hyper-V server virtualization.

**Learning Outcomes:**
The students will be able to
1. Implement server virtualization using VMware ESXi Server and vSphere client.
2. Configure and deploy various features of VMware vSphere.

| Unit | Course Outcome | Description | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | **CO1** | Implement ESXi server and vSphere client Virtual Machine (VM). Deploy vCenter Server with a single sign-on facility. | 3 |
| | **CO2** | Create and migrate VM from one ESXi host to another through vCenter Server. | 6 |
| | **CO3** | Understand to Create a template and clone of the virtual machine. | 2,6 |
| | **CO4** | Create iSCSI storage into the ESXi host. Also they will be able to add users and change or update users' roles and settings to enhance security. | 6 |
| | **CO5** | Understand to upgrade ESXi from version 6.0 to 6.7. | 2 |
| | **CO6** | Implement NFS datastore for ESXi host. | 3 |
| | **CO7** | Create and configure VLAN L2/L3 network. | 2 |
| | **CO8** | Analyse the performance, network statistics of VM, ESXi host and cluster of hosts. | 4 |
| | **CO9** | Install and Deploy XenServer and manage XenClient through XenServer and Hyper-V. | 6 |

# Evaluation Scheme

## Semester I

| Course Code | Course Name | Group | Max Marks (Total 600) | | |
|---|---|---|---|---|---|
| | | | External | Internal | Practical |
| **RJSPIT101** | Foundation of Data Science | CC | 60 | 40 | - |
| **RJSPIT102** | Cloud Computing | CC | 60 | 40 | |
| **RJSPIT103** | Advanced Artificial Intelligence | CC | 60 | 40 | - |
| **RJSPIT1P1a**<br>**RJSPIT1P1b** | Professional Elective – I<br>Microservice Architecture<br>Modern Networking | PE | 60 | 15 | - |
| **RJSPIT1C1** | **Career Advancement Course**<br>Cyber Security - I | CAC | 25 | - | - |
| **RJSPIT1L1** | **PG Lab – I**<br>Foundation of Data Science | PGL | - | - | 50 |
| **RJSPIT1L2** | **PG Lab – II**<br>Cloud Computing | PGL | - | - | 50 |
| **RJSPIT1R1** | **Mini Project – I** | MNP | - | - | 50 |
| **RJSPIT1S1** | **Seminar – I** | SE | - | - | 50 |
| | **Total** | | **265** | **135** | **200** |

## Semester II

| Course Code | Course Name | Group | Max Marks (Total 600) | | |
|---|---|---|---|---|---|
| | | | External | Internal | Practical |
| **RJSPIT201** | Big Data Analytics | CC | 60 | 40 | - |
| **RJSPIT202** | Virtualization | CC | 60 | 40 | |
| **RJSPIT203** | Image and Vision Processing | CC | 60 | 40 | - |
| **RJSPIT2P2a**<br>**RJSPIT2P2b** | **Professional Elective – II**<br>Blockchain Technology<br>Soft Computing | PE | 60 | 15 | - |
| **RJSPIT2C2** | **Career Advancement Course**<br>Cyber Security II | CAC | 25 | - | - |
| **RJSPIT2L3** | **PG Lab – III**<br>Big Data Analytics | PGL | - | - | 50 |
| **RJSPIT2L4** | **PG Lab – IV**<br>Virtualization | PGL | - | - | 50 |
| **RJSPIT2R2** | **Mini Project – II** | MNP | - | - | 50 |
| **RJSPIT2S2** | **Seminar – II** | SE | - | - | 50 |
| | **Total** | | **265** | **135** | **200** |

# Evaluation and Assessment

1. The internal assessment marks shall be awarded as follows:
   A. 30 marks (Any one of the following):
      a. Written Test
         or
      b. SWAYAM NPTEL (Advanced Course) of minimum 20 hours and certification examination completed
         or
      c. Valid International Certifications (Prometric, Pearson, Certiport, Coursera, Udemy, edx and the like).
         or
      d. One certification mark shall be awarded one course only. For four courses, the students will have to complete four certifications.
   B. 10 Marks
      The marks given out of 40 for publishing the research paper should be divided into four course and should awarded out of 10 in each of the four courses.
2. Semester End Examination – 60 marks
   Question paper covering all units
3. Evaluation of Practical 200 marks (50 marks for each practical)

~~~~~
~~~~~