AC 01.09.23 ITEM NO: 2.2

Deccan Education Society's

Kirti M. Doongursee College of Arts, Science and Commerce (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Masters of Science
Course: First Year
Subject: Information Technology

Choice Based Credit System (CBCS)
with effect from
Academic Year 2023-2024

PROGRAM OUTCOMES

PO	Description
A student completing Bachelor's Degree in **Science** Program will be able to	
PO1	Ability to apply the knowledge of Information Technology with recent trends aligned with research and industry.
PO2	Ability to apply IT in the field of Computational Research, Soft Computing, Big Data Analytics, Data Science, Image Processing, Artificial Intelligence, Networking and Cloud Computing.
PO3	Ability to provide socially acceptable technical solutions in the domains of Information Security, Machine Learning, Internet of Things and Embedded System, Infrastructure Services as specializations.
PO4	Ability to apply the knowledge of Intellectual Property Rights, Cyber Laws and Cyber Forensics and various standards in interest of National Security and Integrity along with IT Industry.
PO5	Ability to write effective project reports, research publications and content development and to work in a multidisciplinary environment in the context of changing technologies.

Deccan Education Society's

Kirti M. Doongursee College

(Autonomous) Proposed

Curriculum as per NEP-2020

Year of implementation- 2023-2024

Name of the Department-Information Technology

Semester	Course Code	Course Title	Vertical	Credit
I	K23PSITMJ111	Data Science	Major	4
	K23PSITMJP11	Data Science Practical	Major	2
	K23PSITMJ112	Cloud Computing	Major	4
	K23PSITMJP12	Cloud Computing Practical	Major	2
	K23PSITE121	Soft computing Techniques	Elective	4
	K23PSITRM131	Research Methodology	Research Methodology	4
II	K23PSITMJ211	Big Data	Major	4
	K23PSITMJP21	Big Data Analytics– Practical	Major	2
	K23PSITMJ212	Advanced IoT	Major	4
	K23PSITMJP22	Advanced IoT– Practical	Major	2
	K23PSITE221	Modern Networking	Elective	4
	K23PSITFP24	PROJECT IMPLEMENTATION	Field Project	4

SEMESTER- I

Course Code	MAJOR SEM – I - Data Science	Credits	Lectures /Week
K23PSITMJ111	PAPER I	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- To learn the importance of Data and different tools used for data extraction and data mining.
- Recall different types of research fields, theoretical concepts, epistemologies, and qualitative and quantitative methods
- Apply software development methodologies to create efficient, well-structured applications that other programmers can easily understand.
- Analyze critically and speak publicly about field-specific scholarly research, projects executed in class, and data management issues.

Unit	Topics	No of Lectures
I	Data Science Technology Stack: Rapid Information Factory Ecosystem, Data Science Storage Tools, Data Lake, Data Vault, Data Warehouse Bus Matrix, Data Science Processing Tools ,Spark, Mesos, Akka , Cassandra, Kafka, Elastic Search, R ,Scala, Python, MQTT, The Future Layered Framework: Definition of Data Science Framework, CrossIndustry Standard Process for Data Mining (CRISP-DM), Homogeneous Ontology for Recursive Uniform Schema, The Top Layers of a Layered Framework, Layered Framework for High-Level Data Science and Engineering Business Layer: Business Layer, Engineering a Practical Business Layer Utility Layer: Basic Utility Design, Engineering a Practical Utility Layer.	15
II	Three Management Layers: Operational Management Layer, Processing-Stream Definition and Management, Audit, Balance, and Control Layer, Balance, Control, Yoke Solution, Cause-and-Effect, Analysis System, Functional Layer, Data Science Process Retrieve Superstep : Data Lakes, Data Swamps, Training the Trainer Model, Understanding the Business Dynamics of the Data Lake, Actionable Business Knowledge from Data Lakes, Engineering a Practical Retrieve Superstep, Connecting to Other Data Sources	15

III	Assess Superstep: Assess Superstep, Errors, Analysis of Data, Practical Actions, Engineering a Practical Assess Superstep Process Superstep : Data Vault, Time-Person-Object-Location-Event Data Vault, Data Science Process, Data Science, Transform Superstep : Transform Superstep, Building a Data Warehouse, Transforming with Data Science, Hypothesis Testing, Overfitting and Underfitting, Precision-Recall, Cross-Validation Test	**15**
IV	Transform Superstep: Univariate Analysis, Bivariate Analysis, Multivariate Analysis, Linear Regression, Logistic Regression, Clustering Techniques, ANOVA, Principal Component Analysis (PCA), Decision Trees, Support Vector Machines, Networks, Clusters, and Grids, Data Mining, Pattern Recognition, Machine Learning, Bagging Data,Random Forests, Computer Vision (CV) , Natural Language Processing (NLP), Neural Networks, TensorFlow. Organize and Report Supersteps : Organize Superstep, Report Superstep, Graphics, Pictures, Showing the Difference	**15**

REFERENCE BOOKS:

1.Practical Data Science Andreas François Vermeulen APress 2018

2. Principles of Data Science Sinan Ozdemir PACKT 2016

3. Data Science from Scratch Joel Grus O'Reilly 2015

4. Data Science from Scratch first Principle in python Joel Grus Shroff Publishers 2017

Course Code	Data Science Practical – Practical	Credits	Lectures /Week
K23PSITMJP11	**Paper I**	**2**	**4**

Course Outcome: -

- Apply quantitative modeling and data analysis techniques to the solution of real world business problems, communicate findings, and effectively present results using data visualization techniques.
- Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy
- Apply ethical practices in everyday business activities and make well reasoned ethical business and data management decisions
- Demonstrate knowledge of statistical data analysis techniques utilized in business decision making
- Apply principles of Data Science to the analysis of business problems.
- Use data mining software to solve real-world problems.
- Employ cutting edge tools and technologies to analyze Big Data.
- Apply algorithms to build machine intelligence. Demonstrate use of teamwork, leadership skills, decision making and organization theory.

	10 Practical based on above syllabus, covering entire syllabus

Course Code	MAJOR SEM – I - Cloud Computing	Credits	Lectures /Week
K23PSITMJ112	Paper II	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- To learn the basic concepts and need of Cloud Computing
- Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.
- Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost.
- Analyze various cloud programming models and apply them to solve problems on the cloud.

Unit	Topics	No of Lectures
I	Introduction to Cloud Computing: Introduction, Historical developments, Building Cloud Computing Environments, Principles of Parallel and Distributed Computing: Eras of Computing, Parallel v/s distributed computing, Elements of Parallel Computing, Elements of distributed computing, Technologies for distributed computing. Virtualization: Introduction, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples. Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud usage monitor, Resource replication, Ready-made environment	15
II	Cloud Computing Architecture: Introduction, Fundamental concepts and models, Roles and boundaries, Cloud Characteristics, Cloud Delivery models, Cloud Deployment models, Economics of the cloud, Open challenges. Fundamental Cloud Security: Basics, Threat agents, Cloud security threats, additional considerations. Industrial Platforms and New Developments: Amazon Web Services, Google App Engine, Microsoft Azure.	15
III	Specialized Cloud Mechanisms: Automated Scaling listener, Load Balancer, SLA monitor, Pay-per-use monitor, Audit monitor, failover system, Hypervisor, Resource Centre, Multi Device broker, State Management Database. Cloud	15

	Management Mechanisms: Remote administration system, Resource Management System, SLA Management System, Billing Management System, Cloud Security Mechanisms: Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single 12 11 Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images	
IV	Fundamental Cloud Architectures: 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. Advanced Cloud Architectures: Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture, Cloud Balancing Architecture, Resource Reservation Architecture, Dynamic Failure Detection and Recovery Architecture, Bare-Metal Provisioning Architecture, Rapid Provisioning Architecture, Storage Workload Management Architecture Cloud Delivery Model Considerations: Cloud Delivery Models: The Cloud Provider Perspective, Cloud Delivery Models: The Cloud Consumer Perspective, Cost Metrics and Pricing Models: Business Cost Metrics, Cloud Usage Cost Metrics, Cost Management Considerations, Service Quality Metrics and SLAs: Service Quality Metrics, SLA Guidelines	**15**

REFERENCE BOOKS:

1. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi Elsevier - 2013

2. Cloud Computing Concepts, Technology & Architecture Thomas Erl, Zaigham Mahmood, and Ricardo Puttini Prentice Hall - 2013

3. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things Kai Hwang, Jack Dongarra, Geoffrey Fox MK Publishers -- 2012

Course Code	**Cloud Computing– Practical**	Practicals/Week
K23PSITMJP12	**Paper II**	**2 credit= 4 lectures**
Course Outcome: - ● Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures. ● Design different workflows according to requirements and apply map reduce programming model. Apply and design suitable Virtualization concepts, Cloud Resource Management and design scheduling algorithms. ● Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds ● Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application ● Broadly educate to know the impact of engineering on legal and societal issues involved in addressing the security issues of cloud computing		
	10 Practical based on above syllabus, covering entire syllabus	

Course Code	ELECTIVES SEM – I – Soft computing Techniques	Credits	Lectures /Week
K23PSITE121	Paper I	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- Recognize the feasibility of applying a soft computing methodology for a particular problem
- Implement, evaluate and compare solutions by various soft computing approaches for finding the optimal solutions.
- Apply the methodology to solve optimization problems using fuzzy logic, genetic algorithms and neural networks.
- Analyze hybrid system to revise the principles of soft computing in various applications

Unit	Topics	No of Lectures
I	Introduction of soft computing, 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	15
II	Artificial Neural Network: Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloch-Pitts Neuron, Linear Separability, Hebb Network. Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, Backpropagation Network, Radial Basis Function, Time Delay Network, Functional Link Networks, Tree Neural Network. Associative Memory Networks: Training algorithm for pattern Association, Autoassociative memory network, hetero associative memory network, bi-directional associative memory, Hopfield networks, iterative autoassociative memory networks, temporal associative memory networks	15
III	UnSupervised Learning Networks: Fixed weight competitive nets, Kohonen self-organizing feature maps, learning vectors quantization, counter propagation networks, adaptive resonance theory networks. Special Networks: Simulated annealing, Boltzmann machine, Gaussian Machine, Cauchy Machine, Probabilistic neural net, cascade correlation network, cognition network, neo-cognition network, cellular neural network, optical neural network Third Generation	15

	Neural Networks: Spiking Neural networks, convolutional neural networks, deep learning neural networks, extreme learning machine model.	
IV	Introduction to Fuzzy Logic, Classical Sets and Fuzzy sets: Classical sets, Fuzzy sets. Classical Relations and Fuzzy Relations: Cartesian Product of relation, classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. Membership Function: features of the membership functions, fuzzification, methods of membership value assignments. Defuzzification: 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. Fuzzy Rule base and Approximate reasoning: Fuzzy proportion, formation of rules, decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, Fuzzy logic control systems, control system design, architecture and operation of FLC system, FLC system models and applications of FLC System. Genetic Algorithm: Biological Background, Traditional optimization and search techniques, genetic algorithm and search space, genetic algorithm vs. traditional algorithms, basic terminologies, simple genetic algorithm, general genetic algorithm, operators in genetic algorithm, stopping condition for genetic algorithm flow, constraints in genetic algorithm, problem solving using genetic algorithm, the schema theorem, classification of genetic algorithm, Holland classifier systems, genetic programming, advantages and limitations and applications of genetic algorithm. Differential Evolution Algorithm, Hybrid soft computing techniques – neuro – fuzzy hybrid, genetic neuro-hybrid systems, genetic fuzzy hybrid and fuzzy genetic hybrid systems.	**15**

REFERENCE BOOKS:

1. Artificial Intelligence and Soft Computing Anandita Battacharya Das SPD 3rd 2018

2. Principles of Soft computing S.N.Sivanandam S.N.Deepa Wiley 3 rd 2019.

3. Neuro-Fuzzy Computing and Soft J.S.R.Jang, C.T.Sun and E.Mizutani Prentice Hall of India 2004

4. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications S.Rajasekaran, G. A. Vijayalakshami Prentice Hall of India 2004

Course Code	RESEARCH METHODOLOGY SEM-I – Research Methodology	Credits	Lectures /Week
K23PSITRM131	**Paper I**	**4**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- To learn the application of Research in different Business Sectors
- To be able to conduct business research with an understanding of all the latest theories.
- To develop the ability to explore research techniques used for solving any real world or innovate problem.
- Analyze the data to help the decision makers in innovative Business process

Unit	Topics	No of Lectures
I	**Introduction:** Role of Business Research, Information Systems and Knowledge Management, Theory Building, Organization ethics and Issues Beginning Stages of Research Process: Problem definition, Qualitative research tools, Secondary data research	**15**
II	Research Methods and Data Collection: Survey research, communicating with respondents, Observation methods, Experimental research	**15**
III	Measurement Concepts, Sampling and Field work: Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size.	**15**
IV	Data Analysis and Presentation: Editing and Coding, Basic Data Analysis, Univariate Statistical Analysis and Bivariate Statistical analysis and differences between two variables. Multivariate Statistical Analysis.	**15**

REFERENCE BOOKS-

1. Business Research Methods William, G.Zikmund, B.J, Babin, J.C. Carr, Atanu Adhikari, M.Griffin Cengage 8e 2016
2. Business Analytics, Albright Winston, Cengage 5e 2015
3. Research Methods for Business Students Fifth Edition, Mark Saunders 2011

SEMESTER- II

Course Code	MAJOR SEM – II - **Big Data**	Credits	Lectures/Week
K23PSITMJ211	**Paper I**	**4**	**4**

Course Outcomes:

After successful completion of this course, students would be able to

- Learn the basics of Big Data and its technologies.
- Understand an overview of an exciting growing field of big data analytics.
- Apply the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce

Unit	Topics	No of Lectures
I	ıtroduction to Big Data, Characteristics of Data, and Big Data Evolution of Big Data, Definition of Big Data, Challenges with big data, Why Big data? Data Warehouse environment, Traditional Business Intelligence versus Big Data. State of Practice in Analytics, Key roles for New Big Data Ecosystems, Examples of Big Data Analytics. Big Data Analytics, Introduction to big data analytics, Classification of Analytics, Challenges of Big Data, Importance of Big Data, Big Data Technologies, Data Science, Responsibilities, Soft state eventual consistency. Data Analytics Life Cycle ..	**15**
II	Analytical Theory and Methods: Clustering and Associated Algorithms, Association Rules, Apriori Algorithm, Candidate Rules, Applications of Association Rules, Validation and Testing, Diagnostics, Regression, Linear Regression, Logistic Regression, Additional Regression Models.	**15**
III	Analytical Theory and Methods: Classification, Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods, Time Series Analysis, Box Jenkins methodology, ARIMA Model, Additional methods. Text Analysis, Steps, Text Analysis Example, Collecting Raw	**15**

	Text, Representing Text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments	
IV	Data Product, Building Data Products at Scale with Hadoop, Data Science Pipeline and Hadoop Ecosystem, Operating System for Big Data, Concepts, Hadoop Architecture, Working with Distributed file system, Working with Distributed Computation, Framework for Python and Hadoop Streaming, Hadoop Streaming, MapReduce with Python, 12 18 Advanced MapReduce. In-Memory Computing with Spark, Spark Basics, Interactive Spark with PySpark, Writing Spark Applications, V Distributed Analysis and Patterns, Computing with Keys, Design Patterns, Last-Mile Analytics, Data Mining and Warehousing, Structured Data Queries with Hive, HBase, Data Ingestion, Importing Relational data with Sqoop, Ingesting stream data with flume. Analytics with higher level APIs, Pig, Spark's higher level APIs.	**15**

REFERENCE BOOKS-

1. Big Data and Analytics Subhashini Chellappan Seema Acharya Wiley First

2. Data Analytics with Hadoop An Introduction for Data Scientists Benjamin Bengfort and Jenny Kim O'Reilly 2016

3. Big Data and Hadoop V.K Jain Khanna Publishing First 2018

Course Code	**Big Data Analytics– Practical**	**Credit**	**Lectures /Week**
K23PSITMJP21	**Paper II**	**2**	**4**

Course Outcome: -

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

	10 Practical based on above syllabus, covering entire syllabus

Course Code	MAJOR SEM – II - Advanced IoT	Credits	Lectures /Week
K23PSITMJ212	Paper II	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- To provide an overview of an exciting growing field of big data analytics
- To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
- To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- To enable students to have skills that will help them to solve complex real world problems in for decision support

Unit	Topics	No of Lectures
I	The Artificial Intelligence 2.0, IoT and Azure IoT Suite, Creating Smart IoT Application	15
II	Cognitive APIs, Consuming Microsoft Cognitive APIs, Building Smarter Application using Cognitive APIs.	15
III	Implementing Blockchain as a service, Capturing, Analyzing and Visualizing real-time data, Making prediction with machine learning	15
IV	IoT and Microservices, Service Fabric, Build your own IoT platform: Introduction, Building blocks for IoT solution, Essentials for building your own platform, Platform requirements, building the platform by initializing cloud instance, installing basic software stacks, securing instance and software, installing node.js and Node-RED, Message broker. 12 CO4 V Building Critical components, configuring message broker, creating REST interface, Rule engine and authentication, documentation and testing, Introspection on what we build and deliverables	15

REFERENCE BOOKS:

1. —IoT, AI, and Blockchain for .NET- Building a Next-Generation Application from the Ground Up Nishith Pathak Anurag Bhandari Apress -- 2018 .

2. Microservices, IoT and Azure Bob Familiar Apress -- 2015

3. —Build your own IoT Platform Anand Tamboli Apress -- 2019

4. Internet of Things Architectures, Protocols and Standards Simone Cirani Gianluigi Ferrari Marco Picone Luca Veltri Wiley 1 2019

Course Code	**Advanced IoT– Practical**	**Credits**	**Lectures/Week**
K23PSITMJP22	**Paper II**	**2**	**4**
Course Outcomes: - ● Build smart IoT applications on Azure. ● Use Microsoft cognitive APIs to build IoT applications. ● Implement Blockchain in IoT. ● Install and use microservices in IoT. ● Build your own IoT platform and use it in a customized way..			
	10 practicals covering the entire syllabus must be performed. The detailed list of practical will be circulated later in the official workshop		

Course Code	ELECTIVES SEM – II – Modern Networking	Credits	Lectures /Week
K23PSITE221	Paper I	4	4

Course Outcomes:

After successful completion of this course, students would be able to

- Learn the networking concepts and protocols.
- Understand the state-of-the-art in network protocols, architectures and applications.
- Investigate novel ideas in the area of Networking via term-long research projects.
- Analyze existing network protocols and networks.

Unit	Topics	No of Lectures
I	Modern Networking Elements of Modern Networking 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, Evolution Layers of the Internet of Things, Network Convergence Unified Communications, Requirements and Technology Types of Network and Internet Traffic,Elastic Traffic,Inelastic Traffic, Real-Time Traffic Characteristics Demand: Big Data, Cloud Computing, and Mobile TrafficBig Data Cloud Computing,,Mobile Traffic, Requirements: QoS and QoE,,Quality of Service,Quality of Experience, Routing Characteristics, Packet Forwarding, Congestion Control ,Effects of Congestion,Congestion Control Techniques, SDN and NFV SoftwareDefined Networking,Network Functions Virtualization Modern Networking Elements	15
II	Software-Defined Networks SDN: Background and Motivation, Evolving Network Requirements Demand Is Increasing,Supply Is IncreasingTraffic Patterns Are More ComplexTraditional Network Architectures are Inadequate, The SDN Approach Requirements SDN Architecture Characteristics of Software12 20 Defined Networking, SDN- and NFV-Related Standards StandardsDeveloping Organizations Industry Consortia Open Development Initiatives, SDN Data Plane and OpenFlow 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, SDN Control Plane SDN Control Plane Architecture Control Plane Functions, Southbound Interface Northbound InterfaceRouting, ITU-T Model, OpenDaylight OpenDaylight Architecture	15

	OpenDaylight Helium, REST REST Constraints Example REST API, Cooperation and Coordination Among Controllers, Centralized Versus Distributed Controllers, HighAvailability Clusters Federated SDN Networks, Border Gateway Protocol Routing and QoS Between Domains, Using BGP for QoS Management IETF SDNi OpenDaylight SNDi SDN Application Plane SDN Application Plane Architecture Northbound Interface Network Services Abstraction Layer Network Applications, User Interface, Network Services Abstraction Layer Abstractions in SDN, Frenetic Traffic Engineering PolicyCop Measurement and Monitoring Security OpenDaylight 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	
III	Virtualization, Network Functions Virtualization: Concepts and Architecture, 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, NFV Infrastructure,Container Interface,Deployment of NFVI Containers,Logical Structure of NFVI Domains,ComputeDomain, 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 Network Virtualization, 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, OpenDaylight's Virtual Tenant Network, Software-Defined Infrastructure,SoftwareDefined Storage, SDI Architecture	**15**
IV	Defining and Supporting User Needs, Quality of Service, 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, ServiceLevel Agreements, IP Performance Metrics, OpenFlow QoS Support, Queue Structures, Meters, QoE: User Quality of Experience, 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 Experience, QoE Strategies in Practice, The QoE/QoS Layered Model Summarizing	**15**

	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 Network Design Implications of QoS and QoE Classification of QoE/ QoS Mapping Models, Black-Box Media-Based QoS/QoE Mapping Models, GlassBox Parameter-Based QoS/QoE Mapping Models,Gray-Box QoS/QoE Mapping Models, Tips for QoS/QoE Mapping Model Selection,IPOriented Parameter-Based QoS/QoE Mapping Models,Network Layer QoE/QoS Mapping Models for Video Services, Application Layer QoE/QoS Mapping Models for Video Services Actionable QoE over IP-Based Networks, The System-Oriented Actionable QoE Solution, The Service-Oriented Actionable QoE Solution, QoE Versus QoS Service Monitoring, QoS Monitoring Solutions, QoE Monitoring Solutions, QoE-Based Network and Service Management, QoE-Based Management of VoIP Calls, QoE-Based Host-Centric Vertical Handover, QoE-Based Network-Centric Vertical Handover 12 V Modern Network Architecture: Clouds and Fog, Cloud Computing, Basic Concepts, Cloud Services, Software as a Service, Platform as a Service, Infrastructure as a Service, Other Cloud Services, XaaS, Cloud Deployment Models, Public Cloud Private Cloud Community Cloud, Hybrid Cloud, Cloud Architecture, NIST Cloud Computing Reference Architecture,ITU-T Cloud Computing Reference Architecture, SDN and NFV, Service Provider Perspective Private Cloud Perspective, ITU-T Cloud Computing Functional Reference Architecture, The Internet of Things: Components The IoT Era Begins, The Scope of the Internet of Things Components of IoT-Enabled Things, Sensors, Actuators, Microcontrollers, Transceivers, RFID, The Internet of Things: Architecture and Implementation, IoT Architecture,ITU-T IoT Reference Model, IoT World Forum Reference Model, IoT Implementation, IoTivity, Cisco IoT System, ioBridge, Security Security Requirements, SDN Security Threats to SDN, SoftwareDefined Security, NFV Security, Attack Surfaces, ETSI Security Perspective, Security Techniques, Cloud Security, Security Issues and Concerns, Cloud Security Risks and Countermeasures, DataProtection 12 22 in the Cloud, Cloud Security As a Service, Addressing Cloud Computer Security Concerns, IoT Security, The Patching Vulnerability, IoT Security and Privacy Requirements Defined by ITU-TAn IoT Security Framework, Conclusion	

REFERENCE BOOKS-

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

Course Code	FP SEM – II – PROJECT IMPLEMENTATION	Credits	Lectures /Week
K23PSITFP24		4	4

Course Outcome:

- To learn the process of project implementation
- To understand the system, submit the proposal and implement the same in the semester–II.
- To propose project implementation as part of the semester–II.
- Experimental setup, analysis of results, comparison with results of related works, conclusion, and prospects will be part of the project implementation.
- To make a project implementation report and appear for a project viva

PROJECT IMPLEMENTATION

Students need to spend around 133 hours for the project implementation, which fetches 4 credits.

Guidelines for Project Implementation in Semester - II

● A student is expected to devote at least 3 to 4 months of effort to the implementation.

● Students should submit a detailed project implementation report at the time of viva.

Guidelines for Documentation of Project Proposal in Semester –II

A student should submit a project implementation report with the following details:

● Title: Title of the project.

● Objective: A detailed objective of the proposal is needed.

● Related works: A detailed survey of the relevant works done by others in the domain. The student is expected to refer to at least 15 recent (last five years) research papers in addition to textbooks and web links in the relevant topic.

● Methodology: A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software, and data to be used.

● Implementation details: A description of how the project has been implemented.

● Experimental setup and results: A detailed explanation of how experiments were conducted, what software was used, and the results obtained. Details like screenshots, tables, and graphs can come here.

● Analysis of the results: A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this.

● Conclusion: A conclusion of the project performed in terms of its outcome

● Future enhancement: A small description of what enhancement can be done when more time and resources are available

● Program code: The program code may be given as an appendix.

The project documentation needs to be signed by the teacher in charge and head of the Department. Students should also attach the certified copy of the internal evaluation report (Appendix III) at the time of Project evaluation and viva as part of the University examination.

Evaluation Scheme for First Year (PG) under NEP (4 credits)

I. Internal Evaluation for Theory Courses – 40 Marks

1) Continuous Internal Assessment(CIA) Assignment - Tutorial/ Case Study/ Project / Presentations/ Group Discussion / Ind. Visit. – 20 marks

2) Continuous Internal Assessment(CIA) ONLINE Unit Test – 20 marks

II. External Examination for Theory Courses – 60 Marks

Duration: 2 Hours

Theory question paper pattern:

Question	Based on	Marks
Q.1	Unit I	15
Q.2	Unit II	15
Q.3	Unit III	15
Q.4	Unit IV	15

- All questions shall be compulsory with internal choice within the questions.
- Each Question may be subdivided into sub questions as a, b, c, d, etc. & the allocation of Marks depends on the weightage of the topic.

III. Practical Examination

- Each core subject carries 50 Marks
- Duration: 3 Hours for each practical course.
- Minimum 80% practical from each core subjects are required to be completed.
- Certified Journal is compulsory for appearing at the time of Practical Exam

NOTE: To pass the examination, attendance is compulsory in both Internal & External (Theory + Practical) Examinations.