Rajiv Gandhi ProudyogikiVishwavidyalaya Bhopal

M.Tech (IoT and Sensor System)

Second Semester Syllabus

MTIN 201- AI AND MACHINE LEARNING

Course Objectives:
The objective of this course is to provide an introductory and broad overview of the field of AI and ML.

UNIT I
Introduction to Artificial Intelligence: The History of AI, AI and Society, Agents, Knowledge based systems; Fields and Applications of Artificial Intelligence, Propositional Logic: First order Predicate Logic: Limitations of Logic

UNIT II
Search, Games and Problem Solving: Uninformed Search, Heuristic Search, Games with Opponents, Heuristic Evaluation Functions, State of the Art; Reasoning with Uncertainty: Computing with Probabilities, The Principle of Maximum Entropy, Reasoning with Bayesian networks

UNIT III
Machine Learning: Preliminaries, Examples of Machine Learning Applications, Data Analysis, Regression, The Perceptron, A Linear Classifier, The Nearest Neighbor method, Decision Tree Learning, Cross-Validation and Overfitting, Learning of Bayesian networks, The Naïve Bayes Classifier, One-class learning, Clustering

UNIT IV
Neural Networks: From Biology to Simulation, Hopfield Networks, Neural Associative Memory, Linear Networks with Minimal Errors, The Back Propagation Algorithm, Support Vector Machines, Deep Learning, Applications of Neural Networks, Reinforcement Learning

UNIT V
Design and Analysis of Machine Learning Experiments: Factors, response and strategy of experimentation, Guidelines for machine learning experiments, cross-validation and resampling methods, Measuring classifier performance, Hypothesis testing, comparing multiple algorithms, comparison over multiple datasets

Reference Books:

1. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Second Edition, Springer, 2017
2. Nils J. Nilsson, “ Artificial Intelligence: A New Synthesis”, Morgan Kaufmann Publishers
3. David Forsyth, “Applied Machine Learning”, Springer
4. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, The MIT Press, 2014
5. Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, “Machine Learning Algorithms and Applications”, CRC Press Taylor & Francis Group, 2017
6. Zsolt Nagy, “Artificial Intelligence and Machine Learning Fundamentals, Packt Publishing, 2018

Course Outcomes:
On successful completion of this course the students will be able to-

1. Demonstrate fundamental understanding of artificial intelligence (AI)

2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning
3. Demonstrate proficiency in using models of machine learning
4. Apply knowledge of neural networks to solve various problems
5. Perform machine learning experiments

MTIN 202- SECURITY IN IOT

Course Objectives:
The objective of this course is to make students to learn how cyber security for the IoT works along with key technical details, process flows, definitions of terms and practical examples.

UNIT I
Fundamentals of encryption for cyber security: Cryptography – Need and the Mathematical basics- History of cryptography, symmetric ciphers, block ciphers, DES – AES. Public-key cryptography: RSA, Diffie-Hellman Algorithm, Elliptic Curve Cryptosystems, Algebraic structure, Triple Data Encryption Algorithm (TDEA) Block cipher

UNIT II
IoT security framework : IOT security frame work, Security in hardware, Bootprocess, OS & Kernel, application, run time environment and containers. Need and methods of Edge Security, Network Security: Internet, Intranet, LAN, Wireless Networks, Wireless cellular networks, Cellular Networks and VOIP

UNIT III
Elementary blocks of IoT Security & Models for Identity Management: Vulnerability of IoT and elementary blocks of IoT Security, Threat modeling – Key elements. Identity management Models and Identity management in IoT, Approaches using User-centric, Device-centric and Hybrid

UNIT IV
Identity Management and Trust Establishment: Trust management lifecycle, Identity and Trust, Web of trust models. Establishment: Cryptosystems – Mutual establishment phases – Comparison on security analysis. Identity management framework
Access Control in IoT and light weight cryptography: Capability-based access control schemes, Concepts, identity-based and identity-driven, Light weight cryptography, need and methods, IoT use cases

UNIT V
Security and Digital Identity in Cloud Computing: **S**ecurity, Digital identity management in cloud, Classical solutions, alternative solutions, Management of privacy and personal data in Cloud; Cyber Crimes, Hackers and Forensics: Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Cyber Forensics and incident Response – Network Forensics

Reference Books:

1. John R. Vacca, “Computer and Information Security Handbook”, Elsevier, 2013.
2. Parikshit Narendra Mahalle , Poonam N. Railkar, “Identity Management for Internet of Things”, River Publishers, 2015.
3. William Stallings, “Cryptography and Network security: Principles and Practice”, 5th Edition, 2014, Pearson Education, India.
4. Maryline Laurent, Samia Bouzefrane, “Digital Identity Management”, Elsevier, 2015.
5. Joseph Migga Kizza, “Computer Network Security”, Springer, 2005.
6. Christof Paar and Jan Pelzl, “Understanding Cryptography – A Textbook for Students and Practitioners”, Springer, 2014.
7. Behrouz A.Forouzan : Cryptography & Network Security – The McGraw Hill Company, 2007.

8. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: “Private Communication in a public World”, PTR Prentice Hall, Second Edition, 2002.
9. Alasdair Gilchrist, “IoT security Issues”, Oreilly publications, 2017.

Course Outcomes:

On successful completion of this course the students will be able to-

1. Design and implement cryptography algorithms
2. Solve network security problems in various networks
3. Build security systems using elementary blocks
4. Build Trustable cloud based IoT systems
5. Solve IoT security problems using light weight cryptography and appreciate the need for cyber security laws and methods.

MTIN 203- CLOUD AND FOG COMPUTING

Course Objectives:

The objective of this course is to discuss cloud and fog computing as an increasingly viable means of achieving enhanced monitoring and control of industrial processes, differentiate between Cloud and edge-fog computing and what role the two technologies will increasingly play in process control and automation.

UNIT I

Cloud Computing Fundamentals: Motivation for Cloud Computing, Defining Cloud Computing, Principles of Cloud Computing , Five Essential Characteristics, Cloud Ecosystem, Requirements for Cloud Services, Cloud Applications, Benefits and Drawbacks, Cloud Architecture, Network Connectivity in Cloud Computing, Managing the Cloud, Migrating Application to Cloud

UNIT II

Cloud Deployment Models: Private Cloud, Public Cloud, Community Cloud, Hybrid Cloud; Cloud Service Models: Infrastructure as a Service, Platform as a Service, Software as a Service, Their characteristics, Suitability, Pros and Cons, Cloud Service Providers

UNIT III

Technological Drivers of Cloud Computing: Virtualization, Approaches in Virtualization, Hypervisor and Its Role, Types of Virtualization; Memory and Storage Technologies, Networking Technologies, Web 2.0 and Web 3.0, Agile SDLC for Cloud Computing, Programming Models for Cloud Computing

UNIT IV

Security in Cloud Computing: Security Aspects, Data Security, Virtualization Security, Network Security, Security Issues in Cloud Service Models, Audit and Compliance, Data Protection in the Cloud, Cloud Security as a Service; Advanced Concepts in Cloud Computing: Intercloud, Cloud Management, Mobile Cloud, Cloud Governance, Green Cloud, Cloud Analytics

UNIT V

Introduction to Fog Computing, Difference between cloud computing and fog computing, Fog Computing benefits and drawbacks, Applications of Fog computing, Role of Fog computing in Internet of Things, Need for Fog computation, Fog data processing layers.

Reference Books:

1. K. Chandrasekaran, “Essentials of Cloud Computing”, CRC Press, 2015
2. Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-on Approach”, 2013.
3. Rajkumar Buyya, James Broberg, Andrzej Goscinski, “Cloud Computing: Principles and Paradigms”, Wiley
4. Rajkumar Buyya, Satish Narayana Srirama, “ Fog and Edge Computing: Principles and Paradigms”, Wiley
5. Assad Abbas, Samee U. Khan, Albert Y. Zomaya “Fog Computing: Theory and Practice”, Wiley, 2020

Course Outcomes:

On successful completion of this course the students will be able to-

1. Articulate the main concepts, key technologies, strengths, and limitations of cloud computing
2. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Have understanding of the Technological Drivers of Cloud Computing
4. Explain the core issues of cloud computing such as security, privacy, and interoperability and provide the appropriate cloud computing solutions and recommendations according to the applications used.
5. Attempt to generate new ideas and innovations in cloud computing and Fog computing.

MTIN 204[A] BIG DATA ANALYTICS FOR IOT

Course Objectives:

The objective of this course is to introduce big data technology platforms and how these can be applied to IoT data.

UNIT I

Introducing IoT Analytics: Types of Data Sources, Understanding Big Data, Applications of Big Data Analytics, IoT Data and Big Data, Defining IoT Analytics, Challenges of IoT Analytics, IoT Analytics Lifecycle and Techniques

UNIT II

IoT, Cloud and Big Data Integration for IoT Analytics: Cloud-based IoT Platform, Requirements of IoT Big Data Analytics Platform, Functional Architecture, Data Analytics for the IoT, Characteristics of IoT Generated Data, Data Analytic Techniques and Technologies, Data Collection Using Low-power, Long-range Radios, IoT Analytics for the cloud

UNIT III

Searching the Internet of Things: A Search Architecture for Social and Physical Sensors, Local Event Retrieval, Using Sensor Metadata Streams to Identify Topics of Local Events in the City, Venue Recommendation, Development Tools for IoT Analytics Applications; IoT Analytics as a Service: Architecture for IoT Analytics-as-a-Service, Sensing-as-a-Service, Scheduling, Metering and Service Delivery, Sensing-as-a-Service Example, From Sensing-as-a-Service to IoT-Analytics- as-a-Service

UNIT IV

Data Science for IoT Analytics: Machine Learning, Feature Engineering with IoT Data, Validation Methods, Bias, Variance, Comparing different Models to find the Best fit, Anomaly Detection, Forecasting, Deep Learning with IoT data; Strategies to organize data for Analytics; The Economics of IoT Analytics: Cost Considerations for IoT Analytics

UNIT V

IoT Analytics Applications and Case Studies: Data Analytics in Smart Buildings, Internet-of-Things Analytics for Smart Cities, Ethical IoT

Reference Books:

1. John Soldatos, “Building Blocks for IoT Analytics”, River Publishers, 2017
2. Andrew Minteer, “Analytics for the Internet of Things”, Packt Publishing, 2017

Course Outcomes:

On successful completion of this course the students will be able to-

1. Understand IoT Analytics Lifecycle and Techniques
2. Know the characteristics of IoT Generated Data
3. Use development tools for IoT Analytics Applications
4. Learn Machine Learning for IoT data
5. Understand IoT Data Analytics applications

MTIN 204[B] MOBILE APPLICATION DEVELOPMENT

Course Objectives:
The objective of this course is to make students to understand basic concepts of mobile application development.

UNIT I

Overview of Mobile App Development: Mobile Applications, A formula for designing engaging applications, Unique challenges for development of engaging applications, Enterprise mobile development, Mobile App Development Lifecycle Overview

UNIT II

Importance of Design, App Design issues and considerations, Scope of Design in Mobile App Development, Design Principles and Guidelines, Some Design Methods, Factors for choosing mobile app, Mobile App Architectural Components, Mobile App Flow, Mobile App Deployment Considerations

UNIT III

Building Mobile Apps Powered by Enterprise Backend, Connecting the Mobile App with Enterprise IT Services and Data, Types of IT Backend to Integrate from Mobile Apps, Type of API Protocols, Security Integration, Mobile Devices Security Considerations, Secured Data Store and Synchronization, Enterprise Mobile Application Management and Device Management, Special Challenges in Managing Mobile Applications and Devices

UNIT IV

Quality, Cost of Quality, Automated versus Manual Testing, Preproduction versus Post release, Automated Mobile App Testing Considerations, Monetizing Apps, Publishing Apps

UNIT V

The Android Operating System, Working of Android Apps, Programming languages used for developing Android Apps, Android Studio, Emulators, General Procedure for developing an App

Reference Books:

1. Leigh Williamson, Roland Barcia, Omkar Chandgadkar, Ashish Mathur, Soma Ray, Darrell Schrag, Roger Snook, Jianjun Zhang, " Enterprise Class Mobile Application Development", IBM Press Pearson plc, 2016
2. Jakob Iversen Michael Eierman, "Learning Mobile App Development", Pearson Education, 2014
3. J. Paul Cardle, "Android App Development in Android Studio", Manchester Academic Publishers

Course Outcomes:
On successful completion of this course the students will be able to-

1. Understand the entire lifecycle involved in mobile app development
2. Design a mobile app
3. Understand Security considerations in mobile app development
4. Know about the range of techniques available for testing of Mobile Apps and understand when one approach is better than the others.
5. Follow general procedure for developing an App

MTIN 204[C] WEARABLE COMPUTING

Course Objectives:
The objective of this course is to familiarize the students with the need for development of wearable devices and its implications on various sectors.

Unit I
Introduction to Wearable Devices: Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

Unit II
Wearable Inertial Sensors: Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients; Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

Unit III
Wearable Devices for Healthcare: Wearable ECG devices: Basics of ECG and its design, Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Study of flexible and wearable Piezoresistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles; Noninvasive Glucose Monitoring Devices, wearable pulse oximeter

Unit IV
Wearable Cameras and Microphones for Navigation: Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist, for arm and feet, vests and belts, head-mounted devices

Unit V
Other Wearable Devices: Wearable devices with Global Positioning System (GPS) integration for tracking and navigation. Wearable Optical Sensors -chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture.

References:

1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010

Course Outcomes:
After the completion of this course, the students will be able to:
1. Identify and understand the need for development of wearable devices and its influence on various sectors.
2. Discus the applications of various wearable inertial sensors for biomedical applications.

3. Comprehend the design and development of various wearable activity monitoring devices for use in healthcare applications.
4. Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.
5. Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistive devices.

MTIN 205[A] DATA VISUALIZATION

Course Objectives:
The objective of this course is to make students understand the methodologies used to visualize large data sets

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

Unit II
Visualizing Data Methods: Mapping - Time series - Connections and correlations – Indicator-Area chart-Pivot table- Scatter charts, Scatter maps - Tree maps, Space filling and non-space filling methods-Hierarchies and Recursion - Networks and Graphs-Displaying Arbitrary Graphs-node link graph-Matrix representation for graphs- Info graphics

Unit III
Visualizing Data Process : Acquiring data, - Where to Find Data, Tools for Acquiring Data from the Internet, Locating Files for Use with Processing, Loading Text Data, Dealing with Files and Folders, Listing Files in a Folder ,Asynchronous Image Downloads, Advanced Web Techniques, Using a Database, Dealing with a Large Number of Files. Parsing data - Levels of Effort, Tools for Gathering Clues, Text Is Best, Text Markup Languages, Regular Expressions (regexps), Grammars and BNF Notation, Compressed Data, Vectors and Geometry, Binary Data Formats, Advanced Detective Work.

Unit IV
Interactive Data Visualization: Drawing with data – Scales – Axes – Updates, Transition and Motion – Interactivity - Layouts – Geomapping – Exporting, Framework – T3, .js, tablo

Unit V
Security Data Visualization: Port scan visualization - Vulnerability assessment and exploitation - Firewall log visualization - Intrusion detection log visualization -Attacking and defending visualization systems – Creating security visualization system

References:

1. Scott Murray, “Interactive data visualization for the web”, O‟Reilly Media, Inc., 2013.
2. Ben Fry, “Visualizing Data”, O‟Reilly Media, Inc., 2007.
3. Greg Conti, “Security Data Visualization: Graphical Techniques for Network Analysis”, No Starch Press Inc, 2007.

Course Outcomes:
After the completion of this course, the students will be able to:
1. Understand the representation of complex and voluminous data
2. Design and use various methodologies present in data visualization
3. Understand the various process and tools used for data visualization
4. Use interactive data visualization to make inferences
5. Discuss the process involved and security issues present in data visualization

MTIN 205[B] BLOCKCHAIN TECHNOLOGY

Course Objectives:
The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes.

Unit I Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Cryptocurrency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain; Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency

Unit II Understanding Block chain with Crypto currency: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.
Working with Consensus in Bitcoin**:** Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, HashCash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool

Unit III Understanding Block chain for Enterprises: Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

Unit IV Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, and Identity on Block chain

Unit V Block chain application development: Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda

References:

1. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O’Reilly, 2015
2. Josh Thompsons, “Block Chain: The Block Chain for Beginners- Guide to Block chain Technology and Leveraging Block Chain Programming”
3. Daniel Drescher, “Block Chain Basics”, Apress; 1stedition, 2017
4. Anshul Kaushik, “Block Chain and Crypto Currencies”, Khanna Publishing House, Delhi.
5. Imran Bashir, “Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing
6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Import, 2018

Course Outcomes:

After the completion of this course, the students will be able to:

1. Understand block chain technology
2. Acquire knowledge of cryptocurrencies
3. Develop block chain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks
4. Build and deploy block chain application for on premise and cloud based architecture
5. Integrate ideas from various domains and implement them using block chain technology in different perspectives

MTIN 205[C] SDN AND NFV FOR IOT

Course Objectives:

The objective of this course is to develop understanding of the two most important network technologies that will transform networks operated by Carrier Service Providers: Software Defined Networking (SDN) and Network Functions Virtualization (NFV).

UNIT I

Software Defined Networks: Background and Motivation, Evolving Network Requirements, The SDN Approach, SDN Architecture, SDN- and NFV-Related Standards

UNIT II

SDN Data Plane and OpenFlow: SDN Data Plane Functions and Protocols, OpenFlow Logical Network Device, OpenFlow Protocol; SDN Control Plane: SDN Control Plane Architecture, ITU-T Model, OpenDaylight, REST, Cooperation and Coordination Among Controllers; SDN Application Plane: SDN Application Plane Architecture, Network Services Abstraction Layer, Traffic Engineering, Measurement and Monitoring, Security, Data Center Networking, Information-Centric Networking

UNIT III

Network Functions Virtualization: Concepts and Architecture, Background and Motivation for NFV, Virtual Machines, NFV Concepts, NFV Benefits and Requirements, NFV Reference Architecture; NFV Functionality: NFV Infrastructure, Virtualized Network Functions, NFV Management and Orchestration, NFV Use Cases, SDN and NFV; Network Virtualization: Virtual LANs, OpenFlow VLAN Support, Virtual Private Networks, Network Virtualization, Software-Defined Infrastructure

UNIT IV

Defining And Supporting User Needs: Quality of Service, QoS Architectural Framework, Integrated Services Architecture, Differentiated Services, Service Level Agreements, IP Performance Metrics, OpenFlow QoS Support; QoE: User Quality of Experience: QoE, Service Failures Due to Inadequate QoE Considerations, Definition of Quality of Experience, Factors Influencing QoE, Measurements of QoE, Applications of QoE

UNIT V

Security: Security Requirements, SDN Security, NFV Security, Cloud Security, IoT Security

Reference Books:

1. William Stallings, “Foundations of Modern Networking”, Pearson Education, 2016
2. Paul Goransson, “Software Defined Networks A Comprehensive Approach”, Morgan Kaufmann, Elsevier
3. Thomas D. Nadeau, Ken Gray, “Software Defined Networks”, O’Reilly
4. Guy Pujolle, “Software Networks”, Wiley

Course Outcomes:
On successful completion of this course the students will be able to-

1. Have knowledge of SDN concepts and technology
2. Know about the application areas that can be supported by SDN and provides a number of examples of SDN applications
3. Discuss NFV concepts, technology, and applications, as well as network virtualization
4. Understand quality of service (QoS) and quality of experience (QoE) to determine customer needs and network design responses to those needs
5. Analyse the security issues that have emerged with the evolution of SDN and NFV