Academic Council Meeting No. and Date : September 04, 2023

Agenda Number : 02 **Resolution Number : 34, 35 / 2.19, 2.40**

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme : Master of Science

Specific Programme : Information Technology

[M.Sc. (I.T.)]

Revised under NEP

From academic year 2023 - 2024

Sr. No.	Heading	Particulars
1.	Title of the Programme	**M.Sc. (Information Technology)**
2.	Eligibility for Admission	B.Sc. (Information Technology) / B.Sc. (Computer Science) / B.Sc. (Data Science) / B.Sc. (Artificial Intelligence) / B.Sc (Cloud Computing)/ B.Sc. Mathematics / B.Sc. Physics / B.Sc. Statistics / B.Sc. Electronics / B.E. (Information Technology / B.E. (Computer Science) / B.E. (Electronics) and allied branches / BCA
3.	Passing Marks	40%
4.	Ordinances / Regulations (if, any)	As applicable for all M.Sc. Programmes, Universityof Mumbai
5.	Number of years / Semesters	One Year – Two Semesters – Two Years – Four Semesters
6.	Level	P.G.
7.	Pattern	Semester, Choice Based under NEP 2020
8.	Status	New under NEP 2020/ ~~Revised~~
9.	To be implemented from Academic year	**2023 – 2024**

Preamble

1) Introduction

Master of Science (Information Technology) is a Programme designed to meet the needs of the market for expertise in Information Technology (IT). The Programme is intended to address the increasing demand in the work-place for IT professionals with a broad and sound knowledge of both technical and managerial skills. A master degree is granted to individuals who have undergone study demonstrating a mastery or high-order overview of a specific area.

2) Aims and Objectives

1. To equip postgraduate students with an integrated set of skills that will allow them to develop their professional careers in Information Technology.
2. To equip students with the theoretical and practical knowledge that is necessary to enable them to understand the design of complex computer applications/science.
3. The programme also prepares students to embrace future developments in the field and has a demonstrated professional relevance.
4. The programme helps students to acquire the latest skills and build their future capabilities using world-class technology. At the end of this programme, a student will possess a strong foundation of computer systems and information technology.
5. Dexterity in advanced programming languages; power to build sophisticated software for wide area of applications.
6. Skills to work with higher end applications in internet technologies; also, managerial ability to analyze, design, develop and to maintain software development.

3) Learning Outcomes

1. Apply the knowledge of mathematics, science and computing in the core information technologies.
2. Identify, design, and analyze complex computer systems and implement and interpret the results from those systems.
3. Design, implement and evaluate a computer-based system, or process component, to meet the desired needs within the realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Review literature and indulge in research using research-based knowledge and methods to design new experiments, analyze, and interpret data to draw valid conclusions.
5. Select and apply current techniques, skills, and tools necessary for computing practice and integrate IT-based solutions into the user environment effectively.
6. Apply contextual knowledge to assess professional, legal, health, social and cultural issues during profession practice.
7. Analyze the local and global impact of computing on individuals, organizations, and society.
8. Apply ethical principles and responsibilities during professional practice.
9. Function effectively as a team member or a leader to accomplish a common goal in a multidisciplinary team.
10. Communicate effectively with a range of audiences using a range of modalities including written, oral and graphical.
11. Apply the knowledge of engineering and management principles to manage projects effectively in diverse environments as a member or a leader in the team.
12. Engage in independent and life-long learning for continued professional development

Credit Distribution Structure for Two Years/ One Year PG / M.Sc(Information Technology)

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Level</th><th rowspan="2">Sem</th><th colspan="4">Major</th><th rowspan="2">RM</th><th rowspan="2">OJT/FP</th><th rowspan="2">RP</th><th rowspan="2">Cum. Cr.</th><th rowspan="2">Degree</th></tr>
<tr><th colspan="3">Mandatory</th><th>Electives</th></tr>
<tr><td rowspan="11">1</td><td rowspan="11">6.0</td><td rowspan="6">Sem I</td><td colspan="3">3*4+1*2</td><td>4</td><td>4</td><td rowspan="6">-</td><td rowspan="6">-</td><td rowspan="6">22</td><td rowspan="17">PG Diploma (after 3 Years Degree)</td></tr>
<tr><td>Data Science</td><td>TH</td><td>4</td><td rowspan="5">Security Breaches and Countermeasures
(OR)
Data Centre Virtualization
(OR)
Image Processing</td><td rowspan="5">Research Methodology</td></tr>
<tr><td>Cloud Computing</td><td>TH</td><td>4</td></tr>
<tr><td>Soft Computing Techniques</td><td>TH</td><td>4</td></tr>
<tr><td>Data Science Practical</td><td rowspan="2">PR</td><td rowspan="2">2</td></tr>
<tr><td>Soft Computing Techniques Practical</td></tr>
<tr><td rowspan="5">Sem II</td><td colspan="3">3*4+1*2</td><td>4</td><td rowspan="5">-</td><td rowspan="5">4</td><td rowspan="5">-</td><td rowspan="5">22</td></tr>
<tr><td>Big Data Analytics</td><td>TH</td><td>4</td><td rowspan="5">Computer Forensic
(OR)
Embedded Systems
(OR)
Computer Vision</td></tr>
<tr><td>Microservices Architecture</td><td>TH</td><td>4</td></tr>
<tr><td>Modern Networking</td><td>TH</td><td>4</td></tr>
<tr><td>Modern Networking Practical</td><td rowspan="2">PR</td><td rowspan="2">2</td></tr>
<tr><td>Big Data Analytics Practical</td></tr>
<tr><td colspan="3">Cum. Cr. For PG Diploma</td><td colspan="3">28</td><td>8</td><td>4</td><td>4</td><td></td><td>44</td></tr>
<tr><td colspan="12">Exit Option: PG Diploma (44 credits) after Three Year UG Degree</td></tr>
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<table>
<tr><th>Year</th><th>Level</th><th>Sem (2yr)</th><th colspan="4">Major</th><th>RM</th><th>OJT/FP</th><th>RP</th><th>Cum. Cr.</th><th>Degree</th></tr>
<tr><td rowspan="8">2</td><td rowspan="8">6.5</td><td rowspan="5">Sem III</td><td colspan="2">3*4+1*2</td><td>4</td><td rowspan="5">Natural Language Processing
(OR)
Security Operations Center
(OR)
Server Virtualization on VMWare Platform</td><td rowspan="5">-</td><td rowspan="5">4</td><td rowspan="5"></td><td rowspan="5">22</td><td rowspan="13">PG Degree after 3-yr UG or PG Degree after 4-yr UG</td></tr>
<tr><td>Advanced AI</td><td>TH</td><td>4</td></tr>
<tr><td>Storage as a Service</td><td>TH</td><td>4</td></tr>
<tr><td>Machine Learning</td><td>TH</td><td>4</td></tr>
<tr><td>Machine Learning Practical</td><td rowspan="2">PR</td><td rowspan="2">2</td></tr>
<tr><td rowspan="3">Sem IV</td><td>Advanced AI Practical</td></tr>
<tr><td colspan="2">3*4</td><td>4</td><td rowspan="4">Robotic Process Automation
(OR)
Cyber Forensics
(OR)
Advanced IoT</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">6</td><td rowspan="4">22</td></tr>
<tr><td>Blockchain</td><td>TH</td><td>4</td></tr>
<tr><td>Deep Learning</td><td>TH</td><td>4</td></tr>
<tr><td>Blockchain Practical</td><td rowspan="2">PR</td><td rowspan="2">4</td></tr>
<tr><td colspan="2">Deep Learning Practical</td><td>Cum. Cr. For 1 Yr PG Degree</td><td colspan="2">26</td><td>8</td><td></td><td></td><td>10</td><td>44</td></tr>
<tr><td colspan="3">Cum. Cr. For 2 Yr PG Degree</td><td colspan="2">54</td><td>16</td><td>4</td><td>4</td><td>10</td><td>88</td></tr>
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Semester I

Course Code	Course Title	Credits	No. of lectures
23BPIT1T1	**Data Science**	04	

Course Objectives (COs): To enable the students to:
CO1: Develop in depth understanding of the key technologies in data science and business analytics: data mining, machine learning, visualization techniques, predictive modelling and statistics.
CO2: Practice problem analysis and decision-making.
CO3: Gain practical, hands-on experience with statistics programming languages and big data tools through coursework and applied research experiences.

Unit I	**Data Science Introduction & Basics** a. **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. b. **Layered Framework:**Definition of Data Science Framework, Cross-Industry 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 c. **Business Layer:**Business Layer, Engineering a Practical Business Layer d. **Utility Layer:**Basic Utility Design, Engineering a Practical Utility Layer	15 Hrs [OC1, OC2, OC3]
Unit II	**Statistics for Data Science** a. **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 b. **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. **c. Assess Superstep:**Assess Superstep, Errors, Analysis of Data, Practical Actions, Engineering a Practical Assess Superstep	15 Hrs [OC4, OC5, OC6]
Unit III	**Data Analysis with Python & Data Visualization** a. **Process Superstep:**Data Vault, Time-Person-Object-Location-Event Data Vault, Data Science Process, Data Science, **b. Transform Superstep:**Transform Superstep, Building a Data Warehouse, Transforming with Data Science, Hypothesis Testing, Overfitting and Underfitting, Precision-Recall, Cross-Validation Test	15 Hrs [OC7, OC8, OC9, OC10]
Unit IV	**Machine Learning for Data Science** a. **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. **b. Organize and Report Supersteps:**Organize Superstep, Report Superstep, Graphics, Pictures, Showing the Difference	15 Hrs [OC7, OC8, OC9, OC10]

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
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
5	Experimental Design in Data science with Least Resources	N C Das	Shroff Publishers		2018

Course Outcomes(OCs)

Upon completing this course, the student will be able to:

1. 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.
2. Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.
3. Apply ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions.
4. Demonstrate knowledge of statistical data analysis techniques utilized in business decision making.
5. Apply principles of Data Science to the analysis of business problems.
6. Use data mining software to solve real-world problems.
7. Employ cutting edge tools and technologies to analyze Big Data.
8. Apply algorithms to build machine intelligence.
9. Demonstrate use of team work, leadership skills, decision making and organization theory.

Course Code 23BPIT1T2	Course Title **Cloud Computing**	Credits 04	No. of lectures

Course Objectives(COs): CO1. To learn how to use Cloud Services.
CO2. To implement Virtualization.
CO3. To implement Task Scheduling algorithms.
CO4. Apply Map-Reduce concept to applications.
CO5. To build Private Cloud.

Unit 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	15 Hrs
Unit II	**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 Hrs
Unit III	**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	15 Hrs
Unit IV	**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 Hrs

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
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 Outcomes(COs)

Upon completing this course, the student will be able to:

OC1 Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures.

OC2 Design different workflows according to requirements and apply map reduce programming model.

OC3 Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.

OC4 Create combinatorial auctions for cloud resources and design scheduling algorithms for computing cloud.

OC5 Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application

Course Code 23BPIT1T3	Course Title **Soft Computing Techniques**	Credits 04	No. of lectures

Course Objectives (COs): To enable the students to:

CO1: Soft computing concepts like fuzzy logic, neural networks and genetic algorithm, where Artificial Intelligence is mother branch of all

CO2 All these techniques will be more effective to solve the problem efficiently

Unit I	**a) 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. **b) Artificial Neural Network -** Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloh-Pitts Neuron, Linear Separability, Hebb Network**.** **c) 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	15 Hrs
Unit II	**a) Associative Memory Networks -** 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. Kohonen self-organizing feature maps, learning vectors quantization, counter propogation networks, adaptive resonance theory networks. **b) Special Networks -** 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 **c) Third Generation Neural Networks -** Spiking Neural networks, convolutional neural networks, deep learning neural networks, extreme learning machine model. **d) UnSupervised Learning Networks -** Fixed weight competitive nets	15 Hrs
Unit III	**a) Introduction to Fuzzy Logic, Classical Sets and Fuzzy sets -** Classical sets, Fuzzy sets. **b) Classical Relations and Fuzzy Relations -** Cartesian Product of relation, classical relation, fuzzy relations, tolerance and equivalence relations, non-iterative fuzzy sets. **c) Membership Function -** features of the membership functions, fuzzification, methods of membership value assignments. **d) Defuzzification -** Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods. **e) Fuzzy Arithmetic and Fuzzy measures -** fuzzy arithmetic, fuzzy measures, measures of fuzziness, fuzzy integrals.	15 Hrs
Unit IV	**a) 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. **b) 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 Hrs

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Artificial Intelligence and Soft Computing	Anandita Das Battacharya	SPD	3rd	2018
2.	Principles of Soft computing	S.N.Sivanandam S.N.Deepa	Wiley	3rd	2019
3.	Neuro-Fuzzy and Soft Computing	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
5.	Fuzzy Logic with Engineering Applications	Timothy J.Ross	McGraw-Hill		1997
6.	Genetic Algorithms: Search, Optimization and Machine Learning	Davis E.Goldberg	Addison Wesley		1989
7.	Introduction to AI and Expert System	Dan W. Patterson	Prentice Hall of India		2009

Course Outcomes(OCs)

Upon completing this course, the student will be able to:

OC1 Gain a solid understanding of the fundamental concepts underlying soft computing, including the differences between soft computing and traditional hard computing methods.

OC2 Familiarize with a variety of soft computing techniques such as fuzzy logic, neural networks, genetic algorithms, swarm intelligence, and probabilistic reasoning.

OC3 Apply soft computing techniques to solve real-world problems from various domains such as engineering, finance, healthcare, and more.

OC4 Formulate problems in a way that lends itself to the application of soft computing techniques, taking into account the uncertainties and imprecision present in real-world data.

OC5 Understand of how fuzzy logic works and its applications in modeling and decision-making under uncertainty.

OC6 Gain knowledge of neural network architectures, training algorithms, and their applications in pattern recognition, regression, and classification tasks.

OC7 Understand genetic algorithms, their components, and their use in optimization problems and search spaces.

Course Code 23BPIT1P1	Course Title **Data Science & Soft Computing Techniques Practical**	Credits 02	No. of lectures

Course Objectives (OCs): To enable the students to:

CO1 To Develop statistical and analytical modelling using data science concepts

CO2 To develop data visualization

CO3 To Gain practical, hands-on experience with statistics programming languages and big data tools through coursework and applied research experiences

Units	Sr No.	Name of Practical	
I	1	Creating and using database in Cassandra	15 Hrs (OC1-OC4)
	2	Write the programs for the following:	
	2a	Text Delimited CSV to HORUS format	
	2b	XML to HORUS format	
	2c	JSON to HORUS format	
	2d	MySql database to HORUS format	
	2e	Picture(JPEG) to HORUS format	
	2f	Video to HORUS format	
	2g	Audio to HORUS format	
	3a	Fixers Utilities	
	3b	Data Binning or Bucketing	
	3c	Averaging of data	
	3d	Outlier Detection	
	3e	Logging	
II	4a	Perform following data processing using R	20 Hrs (OC5-OC7)
	4b	Program retrieve different attributes of data	
	4c	Data pattern	
	4d	Loading IP_DATA_ALL	
	5a	Perform error management on the given data using pandas package	
	5b	Write python/R program to create the network routing diagram from the given data on routers	
	5c	Write a python/R program to build acyclic graph	
	5d	Write python/R program to pick the content for BillBoards from the given data	
	5e	Write a python/R program to generate GML file from given csv file	
	5f	Write python/R program to plan location of warehouse from the given data	
	5g	Write python/R program using data science via clustering to determine new warehouse using the given data	
	5h	Using the given data Write python/R program to plan the shipping routers from best-fit international logistics	
	5i	Write python/R program to delete the best packing option to ship in container from the given data	
	5j	Write python program to create delivery route using the given data	
	5k	Write python program to crate simple forex trading planner from the given data	
	5l	Write python program to process the balance sheet to ensure the only good data is processing	
	5m	Write python program to generate payroll from the given data	
III	6	Build the time hub, links and satellites	15 Hrs (OC8-OC9)
	7	Transforming data	
	8	Organizing data	
	9	Generating data	
	10	Data visualisation using power Bi	

Course Outcomes(OCs)

Upon completing this course, the student will be able to:

OC 1. Apply quantitative modelling and data analysis techniques to the solution of real world business problems, communicate findings, and effectively present results using data visualization techniques.
OC 2. Recognize and analyze ethical issues in business related to intellectual property, data security, integrity, and privacy.
OC 3. Apply ethical practices in everyday business activities and make well-reasoned ethical business and data management decisions.
OC 4. Demonstrate knowledge of statistical data analysis techniques utilized in business decision making.
OC 5. Apply principles of Data Science to the analysis of business problems.
OC 6. Use data mining software to solve real-world problems.
OC 7. Employ cutting edge tools and technologies to analyze Big Data.
OC 8. Apply algorithms to build machine intelligence.
OC 9. Demonstrate use of team work, leadership skills, decision making and organization theory.

Soft Computing Techniques Practical

Course Objectives (COs)

CO1. Hands-On Implementation
CO2. Algorithm Understanding
CO3. Real-World Applications
CO4. Develop students' programming skills by experimenting with soft computing algorithms.
CO5. Train students to visualize and interpret the results of soft computing techniques effectively.

Units	Sr. No.	Details	Lecture Hrs 2 Credits
I	**1**	Implement the following:	20 Hrs [OC1-OC2]
	A	Design a simple linear neural network model.	
	B	Calculate the output of neural net using both binary and bipolar sigmoidal function.	
	2	Implement the following:	
	A	Generate AND/NOT function using McCulloch-Pitts neural net.	
	B	Generate XOR function using McCulloch-Pitts neural net.	
	3	Implement the Following	
	A	Write a program to implement Hebb's rule.	
	B	Write a program to implement of delta rule.	
II	**4**	Implement the Following	20 Hrs [OC3-OC5]
	A	Write a program for Back Propagation Algorithm	
	B	Write a program for error Backpropagation algorithm.	
	5.	Implement the Following	
	A	Write a program for Hopfield Network.	
	B	Write a program for Radial Basis function	
	6.	Implement the Following	
	A	Kohonen Self organizing map	
	B	Adaptive resonance theory	

III	**7.**	Implement the Following	20 Hrs [OC6-OC7]
	A	Write a program for Linear separation.	
	B	Write a program for Hopfield network model for associative memory	
	8.	Implement the Following	
	A	Membership and Identity Operators | in, not in,	
	b.	Membership and Identity Operators is, is not	
	9.	Implement the Following	
	A	Find ratios using fuzzy logic	
	B	Solve Tipping problem using fuzzy logic	
	10.	Implement the Following	
	A	Implementation of Simple genetic algorithm	
	B	Create two classes: City and Fitness using Genetic algorithm	

Course Outcomes (COs)

Upon completing this course, the student will be able to:

OC 1:Identify and describe soft computing techniques and their roles in building intelligent machines

OC 2: Recognize the feasibility of applying a soft computing methodology for a particular problem

OC 3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems

OC 4: Apply genetic algorithms to combinatorial optimization problems

OC 5: Apply neural networks for classification and regression problems

OC 6: Effectively use existing software tools to solve real problems using a soft computing approach

OC 7: Evaluate and compare solutions by various soft computing approaches for a given problem.

Course Code 23BPIT1T4	Course Title **Elective I: Security Breaches and Countermeasures**	Credits 04	No. of lectures

Course Objectives(COs):

- To get the insight of the security loopholes in every aspect of computing.
- To understand the threats and different types of attacks that can be launched on computing systems.
- To know the countermeasures that can be taken to prevent attacks on computing systems.
- To test the software against attacks.

Unit I	a. Use the following tools to perform footprinting and reconnaissance , Recon-ng (Using Kali Linux) , FOCA Tool, Windows Command Line Utilities, Ping, Tracert using Ping, Tracert , NSLookup , Website Copier Tool – HTTrack, Metasploit (for information gathering), Whois Lookup Tools for Mobile – DNS Tools, Whois, Ultra Tools Mobile, Smart Whois, eMailTracker Pro, Tools for Mobile – Network Scanner, Fing – Network Tool, Network Discovery Tool, Port Droid Tool	15 [OC1-OC2]
Unit II	a. Perform Enumeration using the following tools: Nmap, NetBIOS Enumeration Tool, SuperScan Software, Hyena, SoftPerfect Network Scanner Tool, OpUtils, SolarWinds Engineer's Toolset, Wireshark b. Perform the vulnerability analysis using the following tools: Nessus, OpenVas, Perform mobile network scanning using NESSUS. Perform the System Hacking using the following tools: Winrtgen, PWDump, Ophcrack , Flexispy, NTFS Stream Manipulation, ADS Spy, Snow, Quickstego , Clearing Audit Policies , Clearing Logs, Use wireshark to sniff the network. Use SMAC for MAC Spoofing.	15 [OC3-OC5]

Course Code 23BPIT1P4	Course Title **Elective I: Security Breaches and Countermeasures Practical**	Credits 04	No. of lectures

List of Practicals

1. Use of Recon-ng, FOCA, Windows Command Line Utilities tools to perform footprinting and reconnaissance
2. Scan the network using Advanced IP Scanner, CurrPorts, Colasoft Packet Builder, The Dude
3. Use Proxy Workbench to see the data passing through it and save the data to file
4. Perform Network Discovery using Solar Wind Network Topology Mapper, LANState Pro

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	CEHv10, Certified Ethical Hacker Study Guide	Ric Messier	Sybex - Wiley	-	2019
2.	All in One, Certified Ethical Hacker	Matt Walker	Tata McGraw Hill	-	2012
3.	CEH V10: EC-Council Certified Ethical Hacker Complete Training Guide	I.P. Specialist	IPSPECIALIST	-	2018

Course Outcome(OCs)

Upon completing this course, the student will be able to:

OC 1: The student should be able to identify the different security breaches that can occur. The student should be able to evaluate the security of an organization and identify the loopholes. The student should be able to perform enumeration and network scanning.

OC 2: The student should be able to identify the vulnerability in the systems, breach the security of the system, identify the threats due to malware and sniff the network. The student should be able to do the penetration testing to check the vulnerability of the system towards malware and network sniffing.

OC 3: The student should be able to perform social engineering and educate people to be careful from attacks due to social engineering, understand and launch DoS and DDoS attacks, hijack and active session and evade IDS and Firewalls. This should help the students to make the organization understand the threats in their systems and build robust systems.
OC 4: The student should be able to identify the vulnerabilities in the Web Servers, Web Applications, perform SQL injection and get into the wireless networks. The student should be able to help the organization aware about these vulnerabilities in their systems.
OC 5: The student should be able to identify the vulnerabilities in the newer technologies like mobiles, IoT and cloud computing. The student should be able to use different methods of cryptography.

Course Code	Course Title	Credits	No. of lectures
23BPIT1T5	**Elective II: Data Center Virtualization**	**04**	

Course Objectives(COs):

- Identify important requirements to design and support a data center.
- Determine a data center environment's requirement including systems and network architecture as well as services.
- Evaluate options for server farms, network designs, high availability, load balancing, data center services, and trends that might affect data center designs.
- Assess threats, vulnerabilities and common attacks, and network security devices available to protect data centers.
- Design a data center infrastructure integrating features that address security, performance, and availability.
- Measure data center traffic patterns and performance metrics.

Unit I	**Virtualization -** Virtualization History and Definitions **Virtualization and Network Technologies – I -** Data Center Network Evolution Beginning of Network Virtualization **Virtualization and Network Technologies – II - Ace** Virtual Contexts Virtual Device Contexts **Fooling Spanning Tree Virtualized Chassis with Fabric Extenders -** History of Data Centers **Virtualization in Storage Technologies – I - Storage** Evolution	15 [OC1-OC2]
Unit II	**Virtualization in Storage Technologies – II -** Islands in SAN **Secret Identities** One Cable to Unite Us All **Server Evolution Changing Personalities Transcending the Rack -** Moving Targets **End to End Virtualization -** Virtual Data Center and Cloud Computing	15 [OC3-OC5]

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Data Center Virtualization Fundamentals	Gustavo Alessandro Andrade Santana	Cisco Press	1st	2014

Course Code	Course Title	Credits	No. of lectures
23BPIT1P5	**Elective II: Data Center Virtualization Practical**	**04**	

List of Practicals

5. Implement vmwareESXi,for server virtualization
6. Implement XEN for server virtualization
7. Implement Hyper-V server virtualization
8. Manage vmwareESXi with vCentre server
9. Manage xen server Xen center
10. Understanding blade server with cisco UCS/HP eva simulator

Course Outcomes(OCs):

After completion of the course, a student should be able to:

OC 1: Understand basic concepts in Virtualization.
OC 2: Use concepts of Load Balancing and Aggregation /virtual switching
OC 3: Configure Data center Migration and Fabric Building
OC 4: Understand various Changes in Server Architecture
OC 5: Use the concepts of Cloud computing and how to move towards a cloud computing technology.

Course Code	Course Title	Credits	No. of lectures
23BPIT1T6	**Elective III: Image Processing**	04	

Course Objectives(COs):

CO1. Review the fundamental concepts of a digital image processing system.
CO2. Analyze images in the frequency domain using various transforms.
CO3. Evaluate the techniques for image enhancement and image restoration.
CO4. Categorize various compression techniques.
CO5. Interpret Image compression standards.
CO6. Interpret image segmentation and representation techniques

Unit I	**Introduction:** Digital Image Processing, Origins of Digital Image Processing, Applications and Examples of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, **Digital Image Fundamentals:** Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships Between Pixels, Basic Mathematical Tools Used in Digital Image Processing, **Intensity Transformations and Spatial Filtering:** Basics, Basic Intensity Transformation Functions, Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing (Lowpass) Spatial Filters, Sharpening (Highpass) Spatial Filters, Highpass, Bandreject, and Bandpass Filters from Lowpass Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering **Image Restoration and Reconstruction:** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-----Spatial Filtering, Periodic Noise Reduction Using Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Image Reconstruction from Projections	15 [OC1-OC4]
Unit II	**Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image Processing, Full-Color Image Processing, Color Transformations, Color Image Smoothing Sharpening, Using Color Image Segmentation, Noise Color Images, Color Image Compression. **Image Compression and Watermarking:** Fundamentals, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run-length Coding, Symbol-based Coding, 8 Bit-plane Coding, Block Transform Coding, Predictive Coding, Wavelet Coding, Digital Image Watermarking **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Morphological Algorithms, Morphological Reconstruction, Morphological Operations on Binary Images, Grayscale Morphology	15 [OC5-OC7]

Course Code	Course Title	Credits	No. of lectures
23BPIT1P6	**Elective III: Image Processing Practical**	04	

List of Practicals

11. WAP to study the effects of reducing the quantization values and spatial resolution
12. Write a program for Image enhancement (Thresholding, Contrast adjustment, Brightness adjustment, Gray level slicing)
13. Write a program to demonstrate Basic Transformations (Log transformation, Power law transformation, Negation)
14. Write a program to apply a mask on the image.
15. Write a program to plot a Histogram.

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Digital Image Processing	Gonzalez and Woods	Pearson/Prentice Hall	Fourth	2018
2.	Fundamentals of Digital Image Processing	A K. Jain	PHI		
3.	The Image Processing Handbook	J. C. Russ	CRC	Fifth	2010

OC 1: Understand the relevant aspects of digital image representation and their practicalimplications.

OC 2: Have the ability to design pointwise intensity transformations to meet statedspecifications.

OC 3: Understand 2-D convolution, the 2-D DFT, and have the abitilty to design systems usingthese concepts.

OC 4: Have a command of basic image restoration techniques.

OC 5: Understand the role of alternative color spaces, and the design requirements leading to choices of color space.

OC 6: Appreciate the utility of wavelet decompositions and their role in image processing systems.

OC 7: Have an understanding of the underlying mechanisms of image compression, and the ability to design systems using standard algorithms to meet design specifications.

Course Code	Course Title	Credits	No. of lectures
23BPRM1T7	**Research Methodology**	04	

Course Objectives(COs)

CO1. To be able to conduct business research with an understanding of all the latest theories

CO2. To develop the ability to explore research techniques used for solving any real world or innovate problem

Unit 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 [OC1-OC2]**
Unit II	**Research Methods and Data Collection:** Survey research, communicating with respondents, Observation methods, Experimental research	**15 [OC3-OC4]**
Unit III	**Measurement Concepts, Sampling and Field work:** Levels of Scale measurement, attitude measurement, questionnaire design, sampling designs and procedures, determination of sample size	**15 [OC5-OC6]**
Unit 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 [OC7-OC8]**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
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
4.	Multivariate Data Analysis	Hair	Pearson	7e	2014

Course Outcomes(OCs): A learner will be able to:

OC 1: Solve real world problems with scientific approach.

OC 2: Develop analytical skills by applying scientific methods.

OC 3: Recognize, understand and apply the language, theory and models of the field of business analytics

OC 4: Foster an ability to critically analyze, synthesize and solve complex unstructured business problems

OC 5: Understand and critically apply the concepts and methods of business analytics

OC 6: Identify, model and solve decision problems in different settings

OC 7: Interpret results/solutions and identify appropriate courses of action for a given managerial situation whether a problem or an opportunity

OC 8: Create viable solutions to decision making problems

Semester II

Course Code	Course Title	Credits	No. of lectures
23BPIT2T1	**Big Data Analytics**	04	

Course Objectives:

- 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 I	• Introduction 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 [OC1-OC2]**
Unit 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. • 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 Text, Representing Text, Term Frequency-Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments	**15 [OC3-OC4]**
Unit III	• 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, Advanced MapReduce. In-Memory Computing with Spark, Spark Basics, Interactive Spark with PySpark, Writing Spark Applications	**15[OC5-OC6]**
Unit IV	• 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, Injesting stream data with flume. Analytics with higher level APIs, Pig, Spark's higher level APIs	**15 OC7**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
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 Outcomes(OCs)

Upon completion of this course the Students will be able to:

OC1 Understand Big Data Concepts

OC2 Do Data Collection and Integration

OC3 Develop Data Storage and Management

OC4 Perform Data Preprocessing and Cleaning

OC5 Understand Data Transformation and Feature Engineering

OC6 Perform Exploratory Data Analysis (EDA)

OC7 Use Big Data Analytics Tools

Course Code	Course Title	Credits	No. of lectures
23BPIT2T2	**Microservices Architecture**	**04**	

CO1. Gain a thorough understanding of the philosophy and architecture of Web applications using ASP.NET Core MVC;
CO2. Gain a practical understanding of.NET Core;
CO3. Acquire a working knowledge of Web application development using ASP.NET Core MVC 6 and Visual Studio
CO4. Persist data with XML Serialization and ADO.NET with SQL Server
CO5. Create HTTP services using ASP.NET Core Web API;
CO6. Deploy ASP.NET Core MVC applications to the Windows Azure cloud

Unit I	• **Microservices:**Understanding Microservices, Adopting Microservices, The Microservices Way. **Microservices Value Proposition:** Deriving Business Value, defining a Goal-Oriented, Layered Approach, Applying the Goal-Oriented, Layered Approach.	**15 [OC1]**
Unit II	• **Designing Microservice Systems:** The Systems Approach to Microservices, A Microservices Design Process, Establishing a Foundation**:** Goals and Principles, Platforms, Culture	**15 [OC1]**
Unit III	• **Service Design:**Microservice Boundaries, API design for Microservices, Data and Microservices, Distributed Transactions and Sagas, Asynchronous Message-Passing and Microservices, dealing with Dependencies,**System Design and Operations:**Independent Deployability, More Servers, Docker and Microservices, Role of Service Discovery, Need for an API Gateway, Monitoring and Alerting	**15 [OC2]**
Unit IV	• **Adopting Microservices in Practice:** Solution Architecture Guidance, Organizational Guidance, Culture Guidance, Tools and Process Guidance, Services Guidance.	**15 [OC2]**

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Microservice Architecture: *Aligning Principles, Practices, and Culture*	Irakli Nadareishvili, Ronnie Mitra, Matt McLarty, and Mike Amundsen	O'Reilly	First	2016
2.	Building Microservices with ASP.NET Core	Kevin Hoffman	O'Reilly	First	2017
3.	Building Microservices: Designing Fine-Grained Systems	Sam Newman	O'Reilly	First	
4.	Production-ready Microservices	Susan J. Fowler	O'Reilly		2016

Course Outcomes:

OC 1: Develop web applications using Model View Controller.

OC 2: Think and apply the microservices way to software development

Course Code 23BPIT2T3	Course Title **Modern Networking**	Credits 04	No. of lectures

Course Objectives(COs)

CO1. To understand the state-of-the-art in network protocols, architectures and applications.
CO2. Analyze existing network protocols and networks.
CO3. Develop new protocols in networking
CO4. To understand how networking research is done
CO5. To investigate novel ideas in the area of Networking via term-long research projects

Unit 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 TechnologyTypes of Network and Internet Traffic,Elastic Traffic,Inelastic Traffic, Real-Time Traffic CharacteristicsDemand: 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 Software-Defined Networking,Network Functions Virtualization Modern Networking Elements	**15 Hrs [OC 1, OC 2]**
Unit 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 ApproachRequirementsSDN ArchitectureCharacteristics of Software-Defined Networking, SDN- and NFV-Related StandardsStandards-Developing OrganizationsIndustry ConsortiaOpen Development Initiatives, SDN Data Plane and OpenFlow SDN Data Plane, Data Plane FunctionsData Plane Protocols OpenFlow Logical Network DeviceFlow Table StructureFlow Table Pipeline, The Use of Multiple TablesGroup TableOpenFlow Protocol, SDN Control Plane SDN Control Plane ArchitectureControl Plane Functions, Southbound InterfaceNorthbound InterfaceRouting, ITU-T Model, OpenDaylightOpenDaylight ArchitectureOpenDaylight Helium, RESTREST ConstraintsExample REST API, Cooperation and Coordination Among Controllers, Centralized Versus Distributed Controllers, High-Availability ClustersFederated SDN Networks, Border Gateway ProtocolRouting and QoS Between Domains, Using BGP for QoS ManagementIETF SDNiOpenDaylight SNDiSDN Application PlaneSDN Application Plane ArchitectureNorthbound InterfaceNetwork Services Abstraction LayerNetwork Applications, User Interface, Network Services Abstraction LayerAbstractions in SDN, Frenetic Traffic EngineeringPolicyCop Measurement and Monitoring Security OpenDaylight DDoS ApplicationData Center Networking, Big Data over SDNCloud Networking over SDN Mobility and Wireless Information-Centric NetworkingCCNx, Use of an Abstraction Layer	**15 Hrs [OC 3, OC 4]**

Unit III	Virtualization, Network Functions Virtualization: Concepts and Architecture, Background and Motivation for NFV, Virtual Machines The Virtual Machine Monitor,Architectural ApproachesContainer Virtualization, NFV ConceptsSimple Example of the Use of NFV, NFV PrinciplesHigh-Level NFV Framework, NFV Benefits and RequirementsNFV Benefits, NFV Requirements, NFV Reference ArchitectureNFV Management and Orchestration, Reference PointsImplementation, NFV Functionality, 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 CasesArchitectural 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,Software-Defined Storage, SDI Architecture	**15 Hrs [OC 5, OC 6]**
Unit 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, Service Level 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 ConsiderationsQoE-Related Standardization Projects, Definition of Quality of Experience, Definition of Quality, Definition of ExperienceQuality Formation Process, Definition of Quality of 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 QoENetwork Design Implications of QoS and QoEClassification of QoE/QoS Mapping Models, Black-Box Media-Based QoS/QoE Mapping Models, Glass-Box Parameter-Based QoS/QoE Mapping Models,Gray-Box QoS/QoE Mapping Models, Tips for QoS/QoE Mapping Model Selection,IP-Oriented Parameter-Based QoS/QoE Mapping Models,Network Layer QoE/QoS Mapping Models for Video Services, Application Layer QoE/QoS Mapping Models for Video ServicesActionable 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	**15 Hrs [OC 7, OC8]**

Books and References:					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud	William Stallings	Addison-Wesley 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	Addison-Wesley		
4.	CCIE and CCDE Evolving Technologies Study Guide	Brad Dgeworth, Jason Gooley, Ramiro Garza Rios	Pearson Education, Inc		2019

Course Outcomes(OCs)

Upon completion of the course, the learners will be able to:

CO 1: Analyze and compare various network architectures and their application in real-world scenarios, such as global network architecture and cloud networking.

CO 2: Identify and discuss the different layers and components of the Internet of Things (IoT), emphasizing the role of network convergence in enabling seamless communication among IoT devices.

CO 3: 3.Recognize the increasing demand for network resources, complex traffic patterns, and the inadequacies of existing network solutions.

CO 4: 4.Compare and contrast centralized and distributed controllers, and comprehend the cooperation and coordination mechanisms among controllers in SDN environments.

CO 5: 5.Describe the principles, benefits, and requirements of NFV, including its role in simplifying network operations and improving flexibility.

CO 6: 6.Understand the concepts of network virtualization, including Virtual LANs (VLANs), Virtual Private Networks (VPNs), and the benefits of network virtualization.

CO 7: Define the concept of Quality of Service (QoS) in networking and its significance in meeting user expectations for network performance.

CO 8: Discuss various QoE/QoS mapping models, including black-box media-based models, glass-box parameter-based models, and gray-box models, and how they relate to network design implications.

Course Code 23BPIT2P1	Course Title **Big Data Analytics and Modern Networking Practical**	Credits 02	No. of lectures

Big Data Analytics Practical

Sr. No	Details	
1	Install, configure and run Hadoop and HDFS ad explore HDFS.	30 Hrs [OC1-OC2]
2	Implement word count / frequency programs using MapReduce	
3	Implement an MapReduce program that processes a weather dataset.	
4	Implement an application that stores big data in Hbase / MongoDB and manipulate it using R / Python	
5	Implement the program in practical 4 using Pig.	
6	Configure the Hive and implement the application in Hive.	
7	Write a program to illustrate the working of Jaql.	
9	Implement Decision tree classification techniques	
10	Implement SVM classification techniques	30 Hrs [OC3-OC54
11	Solve the following:	
A	REGRESSION MODEL Import a data from web storage. Name the dataset and now do Logistic Regression to find out relation between variables that are affecting the admission of a student in an institute based on his or her GRE score, GPA obtained and rank of the student. Also check the model is fit or not. require (foreign), require(MASS).	
B	MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.	
14	Solve the Following:	
A	CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for classification problem. c. Evaluate the performance of classifier.	
B	CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b.Plot the cluster data using R visualizations.	

OC 1: Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.

OC 2: Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.

OC 3: Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.

OC 4: Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Modern Networking Practical

Sr. No	Details	
1	Configure IP SLA Tracking and Path ControlTopology	30 hrs [OC1-OC2]
2	Using the AS_PATH Attribute	
3	Configuring IBGP and EBGP Sessions, Local Preference, and MED	
4	Secure the Management Plane	
5	Configure and Verify Path Control Using PBR	
6	IP Service Level Agreements and Remote SPAN in a Campus Environment	30 Hrs [OC2-OC3]
7	Inter-VLAN Routing	
8	Simulating MPLS environment and Simulating VRF	
9	Simulating SDN with • OpenDaylight SDN Controller with the Mininet Network Emulator • OFNet SDN network emulator	
10	Simulating OpenFlow Using MININET	

OC 1:Demonstrate in-depth knowledge in the area of Computer Networking.

OC 2: To demonstrate scholarship of knowledge through performing in a group to identify, formulate and solve a problem related to Computer Networks

OC 3: Prepare a technical document for the identified Networking System Conducting experiments to analyze the identified research work in building Computer Networks.

Course Code	Course Title	Credits	No. of lectures
23BPIT2T4	**Elective I: Computer Forensics**	04	

Course Outcomes:

1. Explain laws relevant to computer forensics
2. Seize digital evidence from pc systems
3. Recover data to be used as evidence
4. Analyse data and reconstruct events

Unit I	Computer Forensics and Investigation Processes, Understanding Computing Investigations, The Investigator's Office and Laboratory, Data Acquisitions	15 [OC1-OC3]
Unit II	Processing Crime and Incident Scenes, Working with Windows and DOS Systems, Current Computer Forensics Tools.	15 [OC4-OC5]

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	The official CHFI Exam 312-49 study Guide	Dave Kleiman	SYNGRESS		
2.	Digital Forensics and Incident Response	Gerard Johansen	Packt Publishing		
3.	Practical Cyber Forensics	Niranjan Reddy	Apress		

Course Code	Course Title	Credits	No. of lectures
23BPIT2P4	**Elective I: Computer Forensic Practical**	04	

List of Practicals

1. File System Analysis
2. Using Windows forensics tools
3. Using Data acquisition tools
4. Using file recovery tools
5. Forensic Investigation
6. Using Steganography tools
7. Using Password Cracking tools
8. Using Wireless forensics tools

Course Outcomes:

OC1 : Identify and analyze risks, threats, and vulnerabilities associated with digital tools.
OC2: Monitor digital components connected to computer networks.
OC3: Explain various operating systems; operating system roles
OC4: Performing Static Analysis on a Suspicious File, System Behavior Analysis, and Forensic Examination of a Suspicious Microsoft Office Document.
OC5: Utilize forensic investigative strategies and tools

Course Code	Course Title	Credits	No. of lectures
23BPIT2T5	**Elective II: Embedded Systems**	04	

Course Objectives (COs)

- To understand what is an Embedded System.
- Classify embedded systems
- Evaluate and rank tradeoffs such as cost, power, and performance for different embedded systems applications; and describe architectural features of the target embedded system
- Create programs that perform a set of input/output operations

Unit I	**Introduction:** What is an Embedded System, Embedded System vs General Computing System. **The Typical Embedded System:** Core of Embedded System, Memory, Sensors and Actuators,Communication Interface, Embedded Firmware. **Characteristic and quality attributes of Embedded System** Characteristics of an Embedded System, Quality Attributes of Embedded System. **Embedded product development life cycle:** What is EDLC, Why EDLC? Objectives of EDLC, Different Phases of EDLC	15 [OC1]
Unit II	**Hardware Software Co-design and Program Modeling** Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modelling Language (UML), Hardware Software Trade-offs. **Embedded Hardware design and development:** Analog Electronic Components, Digital Electronic Components, Electronic design Automation (EDA) Tools, The PCB Layout design. **Embedded Firmware design and development** Embedded Firmware Design Approaches, Embedded Firmware Development Languages **Real Time Operating System(RTOS):** Operating System Basics, Types of Operating Systems, Device Drivers, How to choose an RTOS	15 [OC2 OC3]

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
4.	Introduction to embedded systems	Shibu K. V	Tata McGraw-Hill	2nd	
5.	Embedded Systems Architecture, Programming and Design	Raj Kamal	Tata McGraw-Hill	2nd	
6.	Embedded Systems: A Contemporary Design Tool	James K. Peckol	Wiley Edition	1st	

Course Code	Course Title	Credits	No. of lectures
23BPIT2P5	**Elective III: Embedded Systems Practical**	04	

List of Practicals

9. Study of hardware components (8051 Microcontroller, Resistors (color code, types), Capacitors, ADC, DAC, Operational Amplifiers, Transistors, Diode, Crystal Oscillator, Types of Relays, Sensors, Actuator, Types of connectors)
10. WAP to blink an LED
11. WAP block transfer of data
12. WAP to serial data interface
13. WAP for the keypad and LCD interface

OC1: Select the relevant microcontrollers for various industrial applications

OC2: Interpret communication standards of embedded systems

OC3: Interpret features of Real Time Operating Systems.

Course Code	Course Title	Credits	No. of lectures
23BPIT2T6	**Elective III: Computer Vision**	04	

Course Objectives (COs)

- To develop the student's understanding of the issues involved in trying to define and simulate perception.
- To familiarize the student with specific, well known computer vision methods, algorithms and results.
- To provide the student additional experience in the analysis and evaluation of complicated systems.
- To provide the student additional software development experience.
- To provide the student with paper and proposal writing experience.

Unit I	Introduction to Computer Vision, Geometric primitives and transformations, Photometric image formation, The digital camera, Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization	15 [OC1-OC2]
Unit II	Points and patches, Edges, Lines, Active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods	15 [OC3]

Books and References:

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Computer Vision: Algorithms and Applications	Richard Szeliski	Springer	1st	2010

Course Code	Course Title	Credits	No. of lectures
23BPIT2P6	**Elective III: Computer Vision Practical**	04	

List of Practicals

16. Implementing various basic image processing operations in python/matlab/open-CV: Reading image, writing image, conversion of images, and complement of an image
17. Implement contrast adjustment of an image. Implement Histogram processing and equalization.
18. Implement the various low pass and high pass filtering mechanisms.
19. Use of Fourier transform for filtering the image.
20. Utilization of SIFT and HOG features for image analysis.
21. Performing/Implementing image segmentation
22. Implement optical flow computation algorithm.
23. Demonstrate the use of optical flow in any image processing application
24. Object detection and Recognition on available online image datasets
25. Character or digit or face classification project

Course Outcome

CO1 : Learn fundamentals of computer vision and its applications
CO2: Understand the basic image processing operations to enhance, segment the images.
CO3: Apply the knowledge in solving high level vision problems like object recognition, image classification etc.